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Analyzing Defined Contribution Pension Reform in Korea Using a General Equilibrium Model†

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Korea's National Pension Fund (NPF) is projected to be in deficit by the 2040s and exhausted by the 2050s. Increasing contribution rates may be unaffordable, prompting consideration of structural reforms, particularly shifting from a defined benefit (DB) to a defined contribution (DC) system. The DC system links benefits to contributions and investment returns, ensuring financial stability but raising concerns about income adequacy and redistribution. This study uses an overlapping generations model with heterogeneous agents to assess these reforms. By 2070, demographic changes will make the DB system unsustainable without substantial government subsidies, adversely affecting taxes, income, and savings. Conversely, the DC system would remain balanced without subsidies, resulting in lower interest rates, higher wages, and better economic output. The model shows that the DB system would require an annual subsidy of 11.3% of GDP at a 9% contribution rate by 2070, while the DC system would be self-sufficient. Even with lower returns, the DC system could be more efficient and equitable with partial subsidies, improving economic outcomes and reducing inequality.

Key Word: Defined Benefit, Defined Contribution, Pay-as-you-go, Public Pension, General Equilibrium, OLG, Aging
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I. Introduction

The finances of the National Pension Fund (NPF) are deteriorating, with projections indicating a deficit by the 2040s and complete exhaustion by the 2050s. The media and experts frequently advocate for raising the contribution rate as a solution. However, the required increase to stabilize the fund's finances may exceed what individuals can afford, rendering this approach insufficient. Consequently, there is a growing call for structural reforms rather than mere parametric adjustments. Among the various proposals for structural reform, the shift to a defined contribution (DC) pension system has gained traction. Unlike the current defined benefit (DB) system, where benefits are largely decoupled from contributions, the DC system ensures financial stability by aligning benefits with contributions and investment returns.

Despite the potential advantages of the DC system, public skepticism persists. Concerns include the possibility that, if implemented at the current contribution rate, the DC system may result in a lower income replacement rate, thereby jeopardizing the adequacy of retirement income. Additionally, the DC system could lack the redistributive function inherent in the DB system. Unfortunately, there is a paucity of research on the economic impacts of possible DC pension reforms in Korea. The prevalent fiscal projection model used by the Korean government is inadequate for addressing these concerns, as it does not track individual behaviors and is homogeneous in its categorization of individuals by gender, age, and contribution period. This model also fails to consider endogenous changes in macroeconomic variables such as interest rates and wages. To overcome these limitations, this study employs a stationary general equilibrium analysis using an overlapping generations model with heterogeneous agents to examine the endogenous economic responses of various age and income groups to changes in the pension system and the economic environment.

According to Future Population Projections (2021), the working-age to retirement-age ratio is expected to decline from 79.2:20.8 in 2022 to 48.7:51.3 by 2070. Maintaining the DB pension system under these demographic conditions is theoretically unsustainable without significant financial support from the government. Potential consequences include higher tax burdens, reduced after-tax income, lower savings, increased interest rates, lower wage rates, and diminished GDP. Additionally, a reduced labor force per capita may lower firms' capital demand, causing interest rates to fall, wage rates to rise, and aggregate output to decline. The correlation between the population structure and savings lifecycle may weaken, reducing the aggregate supply of capital. Even if households maintain their savings behavior, the aggregate supply of capital may decline due to an increased population in lower-saving age groups. Conversely, declining mortality may lead households to increase savings, resulting in lower interest rates, higher wage rates, and higher aggregate output.

The DC system, in contrast, maintains a financial balance without government intervention. This ensures that some funds are invested domestically, potentially lowering interest rates, raising wage rates, and increasing gross product relative to the DB system. While the aging population and declining mortality rates affect both systems somewhat similarly, the DC system amplifies the initial interest rate changes. For instance, a capital demand shock in the DC system leads to declining interest rates and fund returns, reducing pension benefits and prompting households to save more. Similarly, supply shocks to capital may cause households to reduce savings in response to rising interest rates and increasing pension benefits, eventually amplifying the effect. Declining mortality can further increase household savings under the DC system as pension benefits decrease due to the DC benefit formula. However, excessively low interest rates and high wage rates could worsen inequality, benefiting working-age individuals more than retirees.

The macroeconomic impacts on the DB and DC pension systems by 2070 differ significantly in direction and magnitude. Given the unprecedented rate of aging in Korea, an empirical analysis would be limited. Thus, this study employs a structural general equilibrium model, calibrated to the Korean economy, to assess the potential outcomes of changes to the National Pension system.

The model, adapted from Lee *et al.* (2019), analyzes households in a lifecycle framework, distinguishing between working and retirement ages. Working-age individuals supply inelastic labor and make consumption and savings decisions subject to productivity shocks, while retirees base their decisions on National Pension and Basic Pension benefits. Firms operate using a Cobb-Douglas production function, combining capital and labor. The government balances its budget through various taxes and finances pension deficits, with the consumption tax serving as the baseline due to its age neutrality and minimal labor market distortions. For the DC system analysis, the model includes a minimum foreign investment share, with foreign interest rates setting the lower bound for domestic rates.

Reflecting realistic macroeconomic conditions is challenging. The total amount of pension contributions is "mature," but the distribution of contribution periods is mature only up to age 40 as of 2022, as the expansion of the National Pension Scheme to cover the entire population was only recently implemented in 1998. Full maturity of total benefits will not be achieved until all 41-year-olds in 2022 have died, diverging from a stationary equilibrium. To address this, the study estimates an exogenous labor supply and pension contribution function, fitting contribution period distribution data for individuals up to age 40 and employment rate data for those at older ages. The contribution rate is adjusted to match the 2022 ratio of total contributions to GDP, and the income replacement rate coefficient is adjusted accordingly.

The model predicts that in 2070, maintaining the DB system would require an annual government subsidy amount equivalent to 11.3% of GDP at a 9% contribution rate, or 8.8% of GDP even if the rate is increased to 18%. In contrast, the DC system would achieve fiscal balance without government support.

The comparative analysis shows that at the same contribution rate, the DC system without foreign returns (0% foreign return) may lower retirement living standards compared to the DB system due to lower interest rates and higher wage rates. However, if only a portion of the DB subsidy is redirected to supplement the universal pension as part of the Basic Pension under the DC system, it can provide greater economic benefits and a better income redistribution in retirement.

Even under conservative assumptions regarding the fund rate of return, a defined contribution (DC) system with fiscal subsidies can achieve greater efficiency. This efficiency is evident in the higher gross product and total after-tax income associated with the DC system. When a certain amount of the DC funds is invested domestically, both gross output and total after-tax income surpass those of the defined benefit (DB) system even without fiscal support, although addressing inequality remains a challenge. A modest increase in the universal pension benefit can significantly narrow the income gap between working-age and retirement-age individuals. This adjustment prompts households to reduce their savings, subsequently lowering wage rates and raising interest rates, which in turn elevates pension levels. Furthermore, increasing the contribution rate from 9% to 18% enhances the average pension benefit level under the DC system, thereby reducing the need for additional financial support.

Additionally, for a given contribution rate, the DC system can offer higher long-term pension benefits compared to the unfunded pay-as-you-go (PAYGO) system, provided the fund rate of return exceeds the nominal growth rate, known as the "Aaron (1966) condition." This relationship holds true even in realistically quantified models. As the population continues to age, the disparity between the DC and PAYGO systems will widen due to a smaller working-age population supporting a larger number of retirees. This underscores the long-term advantages of transitioning to a DC system in terms of sustainability and economic outcomes.

This study relates to previous Korean research on the income redistribution effects of the National Pension. Kim (2002) examines the impact of the National Pension's introduction of the Gini coefficient using Daewoo panel data. Kang *et al.* (2008) find that the 2007 reform of the National Pension reduced pension benefits, leading to a higher Gini coefficient. Yuh and Yang (2011) demonstrate a significant income redistribution effect of the National Pension through analyses of expected return ratios that account for survival rates by income decile. Lee *et al.* (2016), Choi (2016), Choi and Han (2017), and Choi (2021b) also investigate the income redistribution effect of the return ratio.

This study is also related to macroeconomic analyses of the National Pension, such as those by Jeon (1997), Kim (2003), Jeon and Yoo (2004), Nam (2008), and Kim (2018). Notably, Shin *et al.* (2010), Kim (2011), Oh (2012), Moon and Lee (2013), Choi *et al.* (2015), Kwon (2016), Hong *et al.* (2016), Hong (2018), Lee *et al.* (2019), Kim and Lee (2019), Lim and Kim (2021), Choi (2021a), Woo (2021), and Yoon *et al.* (2022) have analyzed the relationship between the National Pension system and future demographic trends using a variety of different macroeconomic models. This study closely references Lee *et al.* (2019), which offers detailed insights into old-age income and redistribution effects through model construction and quantification. Of course, Kwon (2016) and Woo (2021) include the endogenous labor supply, unlike Lee *et al.* (2019), and offer useful tools for analyzing the transition path of a pension reform. However, they do not address the distribution of contribution periods, resulting in lower specificity regarding the distribution of retirement income. Therefore, the model by Lee *et al.* (2019) was chosen.

Additionally, while there are discussions of DC pension systems within a macroeconomic context in Heo (2007), Park and Heo (2008), Park (2009), and Heo (2016), research on social inequality related to DC public pensions is scarce. To the best of my knowledge, this is the first study in Korea to analyze the long-term macroeconomic and distributional impacts of reforming from a DB to a DC pension system using a heterogeneous agent general equilibrium model in a future demographic context.

Section 2 outlines the overlapping generations general equilibrium model, Section 3 details the calibration methodology, Section 4 explains the theoretical framework, Section 5 presents the experimental results, and Section 6 concludes the paper.

II. Model

The overlapping generations model used in this study is primarily based on the work of Lee, Han, and Hong (2019). For more details, please refer to their paper.

Consider a general equilibrium model consisting of overlapping generations of households, representative firms, and the government. Households are utility maximizers, firms are profit maximizers, and the public sector (including the general government and the National Pension Service) adjusts tax rates to satisfy budget constraints. We analyze this through a stationary equilibrium model where individual household states (and thus decisions) can change over time, but the macro distribution remains invariant. For simplicity, we assume the labor supply to be inelastic.

A. *Household Problem*

The household utility maximization problem in the overlapping generations model assumes a lifecycle framework. A continuum of heterogeneous households is economically active at each age $i \in \{1, \cdots, I\}$. Households are given with exogenous and independent mortality probabilities γ_i at age $i+1$ before reaching the final age of $i+I$, where $\gamma_I = 1$ is given for the final age.

A household enters the labor market at age $i=1$ to earn labor income y_i^l and can work until age $i = i_R - 1$ Ages $i \in \{1, \cdots, i_R - 1\}$ are called the "working age." Labor income $y_i^l = w\varepsilon_i xl$ is composed of labor productivity shock x, labor hours l (interpreted as the number of months in a year) given by an exogenous transition function, age-specific labor productivity ε_i, and wage w determined by the general equilibrium. A household pays capital income tax $\tau_k ra$ given asset a and capital income ra, and pays income tax $T(y_i)$ given gross income $y_i = (1-\tau_k)ra + y_i^l$.[1] Those whose working hours l exceed the lower limit $\underline{l}$ are recognized as enrolled in the National Pension and pay contributions of $\tau_{ss}\min(\kappa, w\varepsilon_i x)l$ to the National Pension Service; i.e., the lower value between the monthly labor income $wx\varepsilon_i$ and the upper limit of recognized income κ is applied along with working hours and the contribution rate τ_{ss}. The upper limit κ is defined as the product of a constant k and gross domestic product Y:

$$\kappa = k \times Y .$$

Given disposable income $(1-\tau_k)ra + y_i^l - 1_{[l>\underline{l}]}\tau_{ss}\min(\kappa, w\varepsilon_i x)l - T(y_i)$, a household

[1]This is interpreted as a corporate tax, allowing for double taxation.

decides upon saving $a' - a$ and consumption c and pays consumption tax $\tau_c c$, where saving is subject to the incomplete financial market constraint $a' \geq 0$. Each age is associated with a period utility function $u(c) = (c^{1-\sigma_u} - 1)/(1-\sigma_u)$, which is discounted over time by β. The progressive income tax is modeled using the formulation in Heathcote *et al.* (2017):

$$T(y_i) = \max[y_i - \lambda y_i^{1-\tau}, 0].$$

The distribution of future labor hours l' is determined by the current labor hours via the transition function $l' = \Lambda^i(l)$. Independent and heterogeneous labor productivity shocks follow an AR(1) process:

$$\ln(x') = \rho_x \ln(x) + v_{x'},\ v_x \sim N(0, \sigma_x^2).$$

Age $i \in \{i_R, \cdots, I\}$ is referred to as the "retirement age." During this period, a household does not generate any labor income but receives interest income ra, National Pension income ξ,[2] and the Basic Pension income $\hat{\varphi}$. Similar to the working age, the household pays both income tax and capital gains tax. Additionally, consumption taxes are incurred as the household makes saving and consumption decisions based on disposable income.

The household utility maximization problem at retirement age is represented by the Bellman equation:

$$V_R^i(a; B, n) = \max_{c,a'} \{u(c) + \beta(1-\gamma_i)(1+g_z)^{1-\sigma_u} V_R^{i+1}(a'; B, n)\}$$

$$s.t.$$

$$(1+\tau_c)c + a'(1+g_z) = a + (1-\tau_k)ra + \xi(B, n; A, \alpha) + \hat{\varphi}(a, B, n; A, \alpha) - T(y_i),$$

$$y_i = (1-\tau_k)ra,$$

$$T(y_i) = \max[y_i - \lambda y_i^{1-\tau}, 0],$$

$$a \geq 0,\ c \geq 0,\ n < i_R.$$

Here, g_z is the adjustment factor for growth via total factor productivity z. National Pension income $\xi(B, n; A, \alpha)$ is determined by the average monthly labor income during the months the household was enrolled (B), the contribution period (n), average monthly labor income of all enrolled members (A), and the income replacement rate[3] coefficient (α). The income formula of the current DB pension system, which will be used as a baseline system, is as follows:

[2]In the real world, national pensions are also subject to income tax, but the tax credit is large compared to that for labor income and is thus ignored here.

[3]The income replacement rate (%) is defined as $100 \times \xi / (12 \times B)$.

$$\xi(B,n;A,\alpha)=\begin{cases}\alpha(A+B)\cdot(1+0.05\times 1_{[n\geq 10]}(n+20)) & \text{if } n\geq 10\\ \alpha(A+B)\cdot 0.5 & \text{o.w.}\end{cases}.$$[4]

A and B are combined at a ratio of 1:1, implying an income redistribution function. The formula for the A value is

$$A\equiv\frac{w\times\sum_{i=1}^{i_R-1}\mu_i\varepsilon_i\int xl1_{[l\rangle \underline{l}]}\psi^i(l,x)}{12\times\sum_{i=1}^{i_R-1}\mu_i\int l1_{[l\rangle \underline{l}]}\psi^i(l)}.$$

The Basic Pension $\hat{\varphi}(a,B,n;A,\alpha)$ is also affected by the same four inputs as the National Pension income because it is affected by the amount of National Pension income. Additionally, it is influenced by asset a, as the Basic Pension can only be received when the combined income from interest and the National Pension is less than $\overline{y}$, which represents the lower 70% income level of retirement age. The following formulas hold for the Basic Pension:

$$\hat{\varphi}(a,B,n;A,\alpha)=\min\{\varphi,\max\{\overline{y}-(y_i+\xi(B,n;A,\alpha)),0\}\},$$

$$\varphi(B,n;A,\alpha)=\begin{cases}\overline{\varphi} & \text{if } \xi(B,n;A,\alpha)\leq 1.5\overline{\varphi}\\ \max\{\varphi_1,\varphi_2\} & \text{if } 1.5\overline{\varphi}<\xi(B,n;A,\alpha)\end{cases},$$

$$\varphi_1=\max[\overline{\varphi}-(2/3)INC_A(n;A,\alpha),0]+0.5\overline{\varphi},$$

$$\varphi_2=\max\{2.5\overline{\varphi}-\xi(B,n;A,\alpha),0\},$$

$$INC_A(n;A,\alpha)=\xi(A,n;A,\alpha).$$

When National Pension income ξ is less than or equal to 1.5 times base pension $\overline{\varphi}$, the potential Basic Pension φ is $\varphi=\overline{\varphi}$. If ξ increases to more than 1.5 times $\overline{\varphi}$, φ decreases as much as ξ increases $(\xi+\varphi=2.5\overline{\varphi})$ until it reaches $\overline{\varphi}+(2/3)INC_A$, where INC_A is the National Pension income when $B=A$. φ is fixed at $\varphi=\varphi_1$ if ξ increases further and φ decreases to reach lower bound φ_1.[5] For ξ values that are even greater, φ is adjusted so the total retirement income $y_i+\xi+\varphi$ does not exceed $\overline{y}$.

The working-age utility maximization problem can be expressed as a Bellman equation:

[4]The original National Pension Regulation refers to the first 20 years of contributions as "full old-age pension" and the second 10 years or more but less than 20 years as "reduced old-age pension," but because the benefit amount is linear, the same formula can be used.

[5]https://basicpension.mohw.go.kr/menu.es?mid=a10103010000.

$$V^i(l,a,x,B,n) = \max_{c,a'}\{u(c) + \beta(1-\gamma_i)(1+g_z)^{1-\sigma_u} E_{(x',l')|(x,l)} V^{i+1}(l',a',x',B',n)\}$$

$$s.t.$$

$$(1+\tau_c)c + a'(1+g_z) = a + (1-\tau_k)ra + y_i{}^l - 1_{[l>\underline{l}]}\tau_{ss}\min(\kappa, w\varepsilon_i x)l - T(y_i),$$

$$y_i = (1-\tau_k)ra + y_i{}^l,$$

$$y_i{}^l = w\varepsilon_i xl,$$

$$n' = \begin{cases} n+1 & \text{if } l > \underline{l} \\ n & \text{if } l = \underline{l} \end{cases},$$

$$B' = \begin{cases} \dfrac{B \times 12n + \min(\kappa, w\varepsilon_i x)l}{12n'} & \text{if } l > \underline{l} \\ \text{B} & \text{if } l = \underline{l} \end{cases},$$

$$\log x' = \rho_x \log x + v_x, \quad v_x \sim N(0, \sigma_x{}^2),$$

$$a \geq 0, \quad c \geq 0, \quad n \leq i.$$

For each age i, if $l > \underline{l}$, l is recognized as a contribution period, included in the calculation of n', and, together with the lower limit of $wx\varepsilon_i$ and the upper limit κ, reflected in the calculation of the average monthly labor income B'. Age $i = 1$ takes $a = n = B = 0$ as the initial condition.

The model does not include all specific provisions of the National Pension and the Basic Pension. For example, the model does not account for pension reductions due to early receipt or increases due to deferred pensions, nor does it specifically address income taxes or tax credits on pensions. However, we believe that we have captured the essential elements of our research topic.

B. *Firm Problem*

Homogeneous firms use capital inputs K, labor inputs N, total factor productivity z, and the capital income share θ to generate gross domestic product Y through Cobb-Douglas production technology:[6]

$$Y = zK^{\theta}N^{1-\theta}.$$

Firms face depreciation rate δ, interest rate r, and wage rate w when solving the following problem:

[6]Total factor productivity z grows by $(1+g)^{1-\theta}$ every year.

$$\max_{K,N}\{zK^{\theta}N^{1-\theta}-(r+\delta)K-wN\}.$$

The optimal conditions are:

$$w=(1-\theta)zN^{-\theta}K^{\theta},$$
$$r+\delta=\theta zN^{1-\theta}K^{\theta-1}.$$

The wage rate and the interest rate are the marginal product of labor and capital, respectively. As the relative size of capital to labor K/N decreases, capital becomes scarcer and labor becomes more abundant, causing w to decrease and r to increase. Conversely, if K/N increases, the opposite occurs.

From these formulas, we can show that the income share of total output is also unchanged:

$$\theta Y=RK,$$
$$(1-\theta)Y=wN.$$

Thus, if N is exogenously given, the only reason labor income could rise is that aggregate output rises.

C. *Public Sector*

The public sector is divided into two sectors: the National Pension Service and the general government. The contribution revenue of the National Pension Service, given population μ_i and age I, is as follows:

$$T_p=\sum_{i-1}^{i_R-1}\mu_i\int(\tau_{ss}\cdot 1_{[l>\underline{l}]}\min(\kappa,w\varepsilon_i x)l)d\psi^i(l,a,x,B,n).$$

Here, $\psi^i(l,a,x,B,n)$ is the density function of age i, and T_p is the result of integrating contribution revenue over the working-age population. National Pension payments $\aleph$ are expressed as:

$$\aleph=\sum_{i=i_R}^{I}\mu_i\int\xi(B,n;A,\alpha)d\psi^i(a,B,n).$$

These payments are initially covered by contribution revenue T_p, and the shortfall is covered by government subsidy G_p according to

$$G_p=\aleph-T_p.$$

The government raises revenue T through consumption, capital, income, and death taxes, as follows:

$$T = \sum_{i=1}^{I} \mu_i \int [\tau_c c + T(y_i) + \frac{\gamma_{i-1}}{1-\gamma_{i-1}} a] d\psi^i(l,a,x,B,n) + \tau_k rK \ ,$$

with $\gamma_0 = 0$. This revenue T is comprised of the government subsidy for the National Pension G_p, government consumption G, and the total Basic Pension amount Φ:

$$T = G + \Phi + G_p \ ,$$

$$\Phi = \sum_{i=i_R}^{I} \mu_i \int \hat{\varphi}(a,B,n;A,\alpha) d\psi^i(a,B,n) \ ,$$

$$G = \bar{g} \times \sum_{i=1}^{I} \mu_i \ .$$

Government spending is assumed to be a constant, $\bar{g}$, multiplied by the population. The government can consider consumption tax rates, income tax levels, and corporate tax rates to achieve a fiscal balance. In this study, we focus on adjusting the consumption tax rate τ_c.

D. *Market Clearing*

At each age i, the aggregate labor supply is expressed as

$$N_i = \mu_i \int \varepsilon_i x l d\psi^i \ .$$

The labor market clearing condition is that labor demand and supply must be equal:

$$N = \sum_{i=1}^{i_R - 1} N_i \ .$$

For the capital market, we assume a small open economy in which domestic investors can freely invest abroad. This reflects a realistic economic environment where domestic interest rates are not excessively lowered due to the availability of overseas investment opportunities. Additionally, we assume that foreigners cannot invest in the country due to capital restrictions. This setup reflects the supply and demand dynamics in the domestic capital market without embracing the characteristics of a complete small open economy. K^* is defined as the capital level for which the overseas interest rate r^* equals the domestic after-tax interest rate, as follows:

$$r^* = (1-\tau_k) \times (z\theta K^{*\theta-1} N^{1-\theta} - \delta) \ ,$$

$$K^* \equiv [\frac{z\theta}{r^*/(1-\tau_k)+\delta}]^{1/(1-\theta)} N \ .$$

The capital market clearing conditions, which require the supply and demand of capital to match, are expressed as follows:

$$K = \min[\sum_{i=1}^{I} \mu_i \int a d\psi^i, K^*].$$

This means that the foreign interest rate r^* is the lower bound on the domestic after-tax interest rate $(1-\tau_k)r$. Households will choose to invest domestically when the domestic interest rate is higher than the foreign interest rate.

E. *Definition of Stationary Equilibrium*

The conditions for stationary equilibrium in this model are as follows:

1. Households are utility maximizers.
2. Firms are profit maximizers.
3. Public sector budget constraints are satisfied.
4. The capital and labor markets clear.
5. The macro distribution is dynamically consistent.

In this study, we modify one of the original equilibrium conditions, in this case dynamic consistency. While the original equilibrium condition states that if economic agents act rationally in anticipation of the future population structure through exogenous mortality, the macroeconomic distribution should not change in the next period, the exogenous mortality and population structure of this model are not dynamically consistent in a strict sense. Given that one of the most critical elements of this study is the population structure (μ_i) of an aging society in 2070, it had to be extracted exogenously from data rather than being derived from exogenous mortality (γ_i). However, dynamic consistency is still maintained by interpreting μ_i as the age-specific weights that make up the aggregate variables, and redefining dynamic consistency as the macroeconomic distribution not changing over time as a result of economic agents accepting this as true and acting on it. While the model is not fully consistent with the rational expectations hypothesis and may be unconventional to experts, we believe that this equilibrium is sufficient to capture the macroeconomic effects central to the subject of this study, as in Lee *et al.* (2019).

This study is limited by the exclusion of an analysis of the transition path of pension reform from the DB to the DC system. Specifically, it does not consider the already promised pension benefits in the DB system at the time of the DC reform. Therefore, it does not accurately analyze the economic phenomena that will actually occur in 2070. Instead, it is confined to analyzing the long-term effects of each pension system within the context of an aging society in 2070, leaving the analysis of the transition path for future research.

F. *Definition of the DC Pension System*

Let's modify the DB pension system defined above into a DC system. A collective defined contribution (CDC) pension system insures survivorship by contracting within a cohort to receive a pension until death. If we reform to a CDC, we change the B value dynamics and the calculation of the pension income ξ as follows:

$$B' = B(1+\tilde{r})/(1-\gamma_{i-1}) + \tau_{ss}\min(\kappa, w\varepsilon_i x)l\,,$$

$$\xi(B) = \frac{B(1+\tilde{r})/(1-\gamma_{i_R-1})}{1+\dfrac{1-\gamma_{i_R}}{1+\tilde{r}}+\cdots+(1-\gamma_{i_R})\times\cdots\times(1-\gamma_{I-1})(1+\tilde{r})^{-(I-i_R)}}\,,$$

$$1+\tilde{r} \equiv \frac{1+\hat{r}}{1+g_z}\,,$$

where $\hat{r}$ is the fund rate of return. This formula can be interpreted such that the funds of deceased members are transferred to the funds of survivors within a cohort, with the cohort's accumulated balance continuing to be capitalized and earning interest even after retirement until it is exhausted. An individual's pension benefit in such a DC pension system is no longer directly dependent on the contribution period n or the A value, which is determined by the income of others. In this study, we limit our discussion of "DC" to these cohort-specific CDC schemes.

In the DC, let the amount of capital invested at each age (or cohort) be F_i. The formula for this variable until retirement then becomes

$$F_i = \frac{\mu_i}{(1-\gamma_{i-1})(1+g_z)} \times \sum_{j=1}^{i-1}[(1+\tilde{r})^{i-1-j}\tau_{ss}\int y_i{}^l 1_{[l>\underline{l}]}d\psi^i(l,a,x,B,n) \times \prod_{m=0}^{i-1-j}\gamma_m{}^{-1}]$$

$$(2 \le 1 < i_R)\,,$$

$$F_1 = 0\,,$$

$$\overline{B} \equiv \sum\nolimits_{j=1}^{i_R-2}[(1+\tilde{r})^{i-1-j}\tau_{ss}\int y_i{}^l 1_{[l>\underline{l}]}d\psi^i(l,a,x,B,n)\times\prod\nolimits_{m=1}^{i-1-j}\gamma_m{}^{-1}]\,,$$

$$F_i = \frac{\mu_i}{(1-\gamma_{i-1})(1+g_z)}\sum_{j=1}^{i-1}\{\overline{B}\frac{1+\tilde{r}}{1-\gamma_{i_R-1}}(1+\hat{r})^{I-i_R}\prod_{j=i_R}^{i-1}\gamma_j{}^{-1} - \xi(\overline{B})\sum_{j=i_R}^{i}(1+\tilde{r})^{j-i_R}\prod_{m=i_R-1}^{j-1}\frac{\gamma_{i_R-1}}{\gamma_j}\}$$

$$(i_R \le i \le I)\,.$$

The specific derivation of these expressions is described in the Appendix. $\overline{B}$ is the cohort average of the fund at retirement in stationary equilibrium.[7] If we define

[7]Therefore, for convenience, we also assume $INC_A(n;A,a) = INC_A(\overline{B})$ for all n.

the foreign investment ratio of the total DC funds F as $1-\omega$,[8] the following new capital market clearing conditions hold:

$$F=\sum_{i=1}^{I}F_i\,,$$
$$\hat{r}=\omega r+(1-\omega)r^*$$
$$K=\min[\sum_{i=1}^{I}\mu_i\int a d\psi^i+\omega F, K^*]\,.$$

One of the important features of the DC is that there is always an investment fund, as you receive pension benefits only to the extent that you pay contributions and earn investment returns, regardless of economic changes. For this reason, unlike the DB, the government in the DC case does not need to fund the National Pension Service and only needs to cover government consumption and Basic Pension expenditures. This creates a new government budget formula:

$$T=G+\Phi\,.$$

If population μ_i and mortality γ_i are consistent in equilibrium, then the following equations hold:

$$Ex=\sum_{i=i_R}^{I}\mu_i\int\xi(B)d\psi^i(B)\,,$$
$$\mathrm{Re}v=\tau_{ss}w\sum_{i=1}^{I_R-1}\mu_i\int y_i^l 1_{[l>\underline{L}]}d\psi^i(l)\,,$$
$$Ex+(1+g_\mu)(1+g_z)F=F(1+\hat{r})+\mathrm{Re}v\,,$$
$$Ex-\mathrm{Re}v\approx F\times(\hat{r}-g_\mu-g_z)\,.$$

In other words, if $\gamma_i=\mu_{i+1}/[\mu_i\times(1+g_\mu)]$ is true for the population growth rate g_μ, the primary deficit of pension (left-hand side) is equal to real interest (right-hand side), resulting in a fiscal balance. For simplicity, we will interpret the average of the residual term g_μ in this equation, $\gamma_i=\mu_{i+1}/[\mu_i\times(1+g_\mu)]$, as the population growth rate.

G. *Growth Adjustments*

The endogenous variables in this study are considered as per capita variables because they are essentially adjusted for population growth. This means that the endogenously determined variables, other than the interest rate variables $(r,\,\hat{r},\,r^*,\,\tilde{r})$, are interpreted as increasing by $(1+g_z)$ per year in the model. The exogenous population variable μ_i is interpreted as increasing by $(1+g_\mu)$, and labor N is taken as labor per capita and is assumed to remain unchanged.

[8]The reason for assuming a minimum share of foreign investment is to avoid analyzing a full small open economy in the first analysis and to reflect the effects of supply and demand in the domestic capital market.

III. Calibration

There are several challenges with regard to making a reasonable projection of the macroeconomic environment surrounding the National Pension in 2070. As of 2022, the National Pension's total contribution amount is already mature, but the contribution period is only mature from age 18 to age 40. It will take another 24 years for all contribution periods to reach maturity, and an additional 35 years after that for the total benefit to mature. From a stationary equilibrium perspective, in 2022, working-age people are paying contributions in the mature stage, and up to the age of 40, are engaged in consumption and savings activities with a view to a mature pension benefit. However, individuals over 40 and under 64 are engaged in savings activities with a view to an immature pension benefit. Additionally, individuals at retirement age are receiving benefits in the immature stage and their saving choices and total pension benefits are also thus immature. Therefore, it is difficult accurately to project the situation in 2070 by simply quantifying the stationary equilibrium model based on the situation in 2022. The different stages of maturity for various age groups make it challenging to capture the long-term dynamics and effects on the pension system.

To address this problem, we employed the following strategy. First, we estimated an exogenous function Λ of hours worked and the contribution period by fitting to the 2022 contribution period distribution data only up to age 40. For individuals over 40, we used employment rate data to identify the maturity stage of the contribution period. Simply applying the function Λ of the maturity stage to 2022 data would overestimate the total amount of National Pension benefits and, consequently, government support. Therefore, we assumed that the National Pension finances do not affect the government budget only when fitting to the 2022 data. On the other hand, because the contribution revenue as a percentage of GDP is already mature in 2022 and serves as an important measure of the overall size of the pension, it is necessary to fit it accurately. While the actual contribution rate is 9%, we adjust τ_{ss} to match the total contribution revenue. Additionally, keeping α fixed at 1.2 and adjusting τ_{ss} would introduce bias into the actual payroll as a percentage of GDP. Thus, α is adjusted so that its ratio to 1.2 equals the ratio of τ_{ss} to 9%. As a result, these estimates provide a good representation of the economic incentives for those under 40 in 2022 and of the current and future financial situation of the National Pension Service.[9]

Here's how we quantify this. First, the baseline model assumes the current DB system and population structure μ_i and mortality rate γ_i of 2022. Some exogenously determined parameters of the model, primarily referring to Lee *et al.* (2019), are as follows: $\sigma_u = 1.5$, $\rho_x = 0.92$, $\sigma_x = 0.05$, $\theta = 0.36$, $\delta = 0.08$, and $\tau_1 = 0.0365$. Age $i = 1$ corresponds to 20 years old, $i = i_R$ is 65 years old, and $i = I$ is set to 98 years old. The difference between Lee *et al.* (2019) and this study is that we set the present year to 2022 instead of 2016 and the future year to 2070 instead of 2040 for an aging society by extracting population μ_i and mortality rates

[9]In the model, those over age 40 may have a lower incentive to save due to higher pension benefits than in 2022, which may introduce an estimation bias.

γ_i directly from Future Population Projections (2021). For convenience, we adjusted the population in 2022 such that it sums to 1. Labor Productivity by age ε_i was extracted from the Korean Labor Panel (2019)[10] by dividing the average income by the average working status for each age. ε_i is later adjusted so that $N=1$ using the explicit derivation of the labor hours distribution from Λ. In anticipation of targeting $K/N=3$, we adjust z in advance so that $Y=1$.[11] Based on a 2022 corporate tax revenue-to-GDP ratio of 4.79%, we set $\tau_k=0.3992$.[12]

For the exogenous labor-hour transfer function Λ, similar to Lee *et al.* (2019), the states are $l \in \{1/3,\ 2/3,\ 1\}$ with $\underline{l}=1/3$. The working age is divided into three bins (20-34, 35-49, and 50-64) and therefore we estimate three 3×3 matrices and the initial labor distribution. Given that the national pension is only mature until the age of 40, we fit the distribution data of the age 32 and age 40 contribution periods of 2022 provided by the Ministry of Health and Welfare. To identify the labor supply after age 40, we estimate the transfer function Λ by fitting its distribution of working hours to a combination of the employment rate data by age group from the Economic Activities Census and the average working status by age from the Korean Labor Panel (2019). Figures 1, 2, and 3 show that these targets are well met, indicating high explanatory power. In the model, retirees have an average contribution period of 23.5 years, which is more mature than the average contribution period of 59-year-olds in 2022, which is 13.9 years. If we assume that all employed people over the age of 20 contribute, the average contribution period from the Economic Activity Survey (2019) is 31.7 years, indicating that the model's contribution period is much lower than the ideal contribution period. The contribution period distribution across all ages in the model and data is presented in the Appendix.

(Unit: Density)

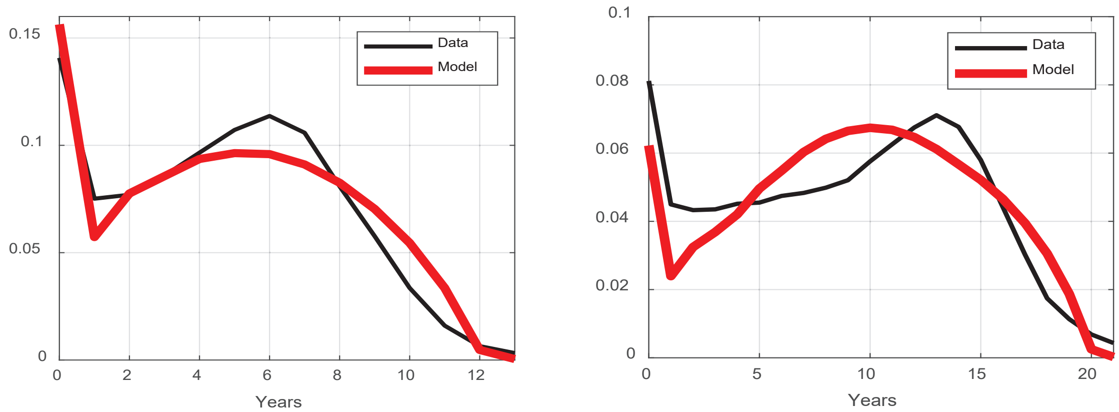

FIGURE 1. MODEL TO DATA COMPARISON OF THE AGE 32 (LEFT) AND AGE 40 (RIGHT) CONTRIBUTION PERIOD DENSITY LEVELS

Source: Author's figure based on 2022 population data by age×contribution period from the Ministry of Health and Welfare.

[10]We chose 2019 because it is the last year without the impact of COVID-19 and it is possible that the labor environment after 2019 has not recovered from the impact of COVID-19.

[11] $z=1/K^{\theta}N^{1-\theta}$

[12] $\tau_k=4.79(\%)/(\theta-\delta K/Y)$

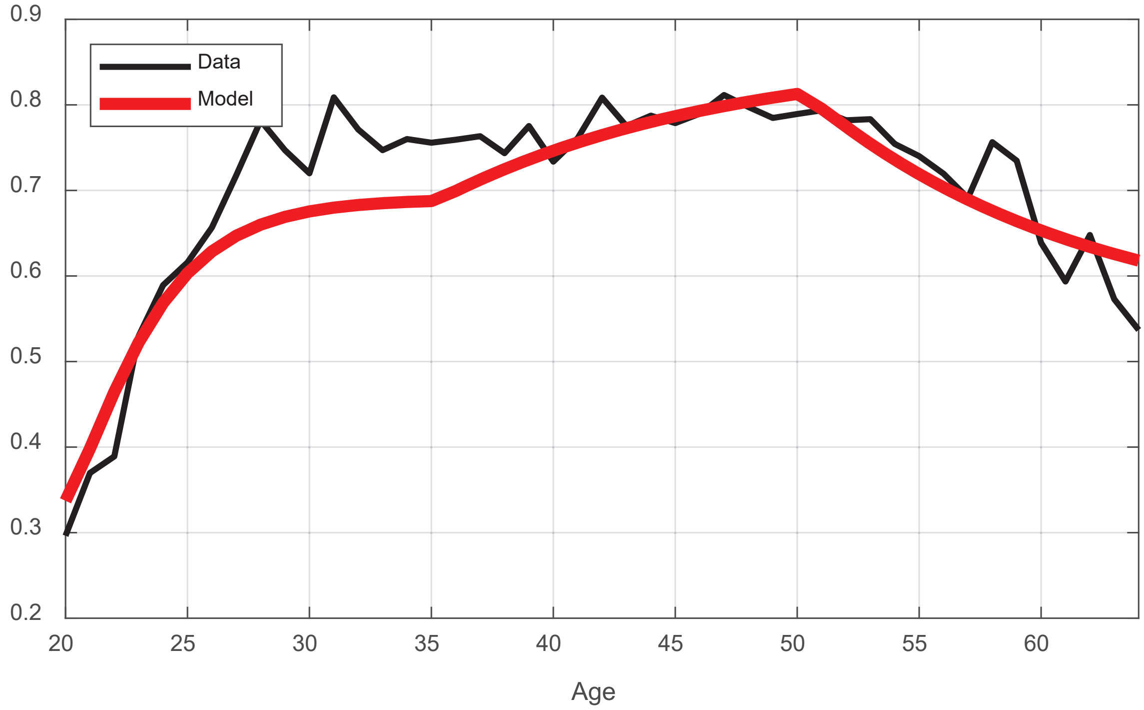

FIGURE 2. EMPLOYMENT RATE DATA VS MODEL

Source: Author's figure based on labor hours data from the Korea Labor Panel (2019).

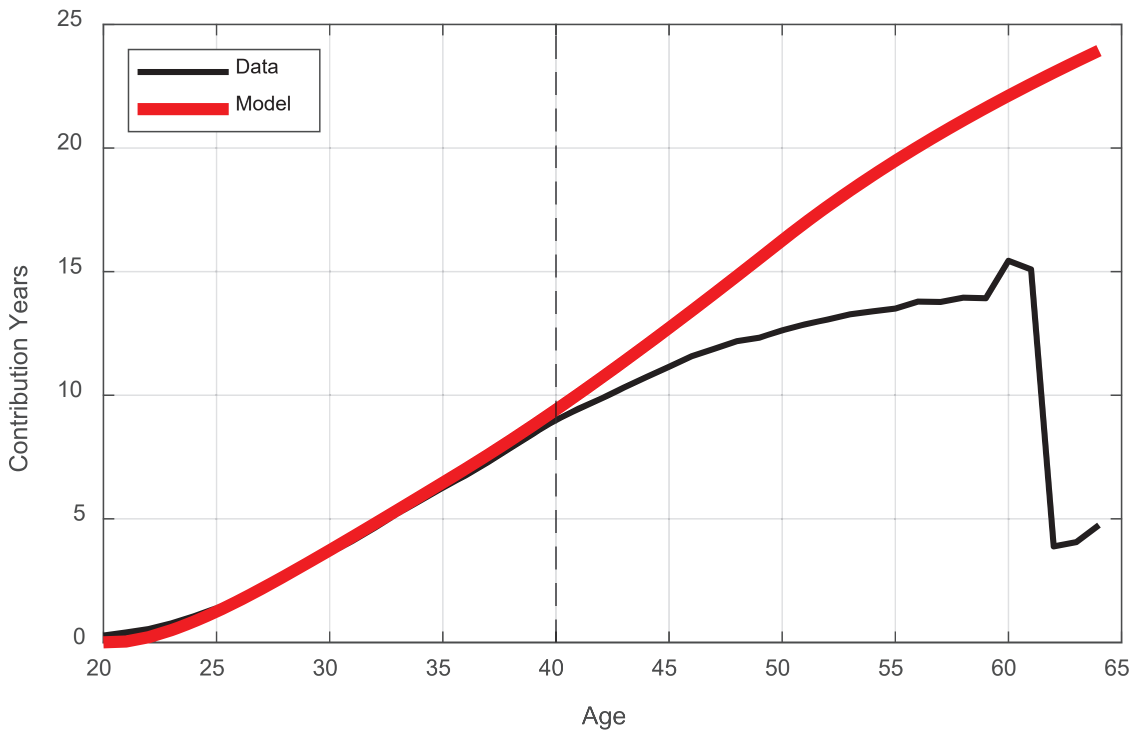

FIGURE 3. MODEL TO DATA COMPARISON OF LABOR HOURS

Source: Author's figure based on 2022 population data by age×contribution period of the Ministry of Health and Welfare.

The following parameters were estimated by solving the model. β, following Lee *et al.* (2019), is calibrated so that $K/Y=3$. λ_l is set to match the 2022 income tax revenue to GDP ratio 5.96%. τ_c is adjusted so that the consumption tax revenue ratio is 3.78%, and $\overline{\varphi}$ is set to achieve the Basic Pension expenditure ratio of 0.75%. The upper limit of monthly contribution κ is based on an average of 13.5% of members falling within the upper limit. The contribution rate was 9% in 2022, but because the size of the National Pension system as a share of GDP is critical to the results of this study, we estimated $\widehat{\tau_{ss}}$ to match the 2022 contribution to GDP ratio of 2.59%. To simulate a future contribution rate of 18%, we double the contribution rate to $\tau_{ss}=2*\widehat{\tau_{ss}}$. The income replacement rate coefficient was adjusted to $\alpha=1.2*\widehat{\tau_{ss}}/0.09$.

In that the National Pension Fund had not yet been exhausted in 2022, we assume that the fund M was as large as 42% of GDP solely for the purpose of quantifying the model to match the 2022 economic environment. Consequently, we modify the capital market clearing condition as follows:

$$K=\min[\sum_{i=1}^{I}\mu_i\int a d\psi^i+\omega M, K^*].$$

Here, $1-\omega=0.506$ represents the current proportion of foreign investments, which is also used in the experiments for the DC system. The derivation of this figure is detailed in the Appendix.

Because the National Pension Fund remains in surplus until 2022, we assume that the National Pension Service's finances do not affect the government budget constraint to reflect this accurately. Thus, the government budget constraint is modified only in the estimation phase, as follows:

$$T=G+\Phi.$$

For the baseline fund rate of return, the foreign interest rate is set to $r^*=0$ to compare DB and DC under similar circumstances. Later, we adjust r^* to analyze the impact of foreign interest rates on DC.

IV. Theory

The main focus of this study is the effect of each pension system on the economy under the 2070 demographic environment (population structure and mortality). Before reviewing the results of the analysis, we provide a theoretical discussion of the macroeconomic consequences of changes in the demographic environment and corresponding increases in contribution rates for both the DB and DC systems within the overlapping generations model.

As mentioned earlier, in our model, population structure μ_i is not determined by mortality rate γ_i; instead, each is exogenously inputted using data from the

Prospective Population Projections dataset (2021). Therefore, it is necessary to clearly distinguish the roles of the population structure and mortality in the model. In the model, households are unaware of the population structure but assume that their mortality rate is γ_i. Thus, utility-maximizing households are informed with regard to prices, macro variables, and mortality, but not μ_i. Moreover, mortality affects benefit levels and the death tax revenue in DC systems, as shown in the model's equations. The population structure μ_i is used as a weight to aggregate individual variables to form aggregate variables, mainly affecting market clearing and government budget constraints.

We begin by summarizing the theoretical discussion of the macroeconomic effects changes in the population structure, declines in mortality rates, and increases in contribution rates in each pension system.

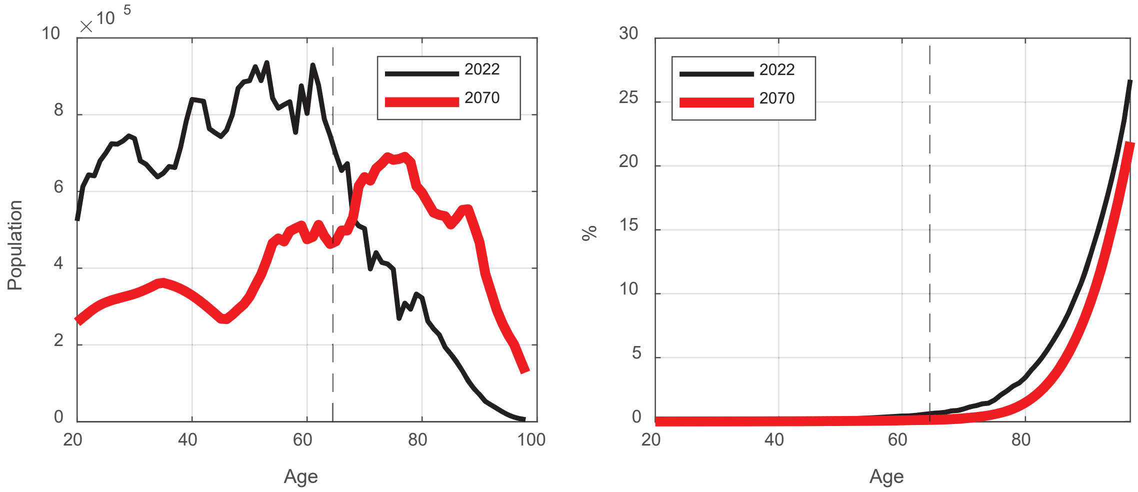

FIGURE 4. CHANGES IN POPULATION STRUCTURE (LEFT) AND MORTALITY (RIGHT)

Note: The vertical dashed line indicates the age of retirement.

Source: Author's illustration based on Future Population Projections (2021).

TABLE 1. 2022 VS 2070: POPULATION, POPULATION STRUCTURE, LABOR, AND MORTALITY RATES

		All ages	Ages 20-64	Ages 65-98
2022	Model Population	1.000	0.792	0.208
	Population Density	1.000	0.792	0.208
	N / μ_i	1.000	1.262	0.000
	Mortality	0.031	0.002	0.072
2070	Model Population	0.770	0.375	0.395
	Population Density	1.000	0.487	0.513
	N / μ_i	0.597	1.227	0.000
	Mortality	0.021	0.000	0.049

Note: Mortality rates weigh each age equally; N / μ_i is labor per capita, which is total labor divided by the population of each age group.

A. *Impact of the Aging Population Structure*

The most significant difference between the population structures of 2070 and 2022 is the much higher dependency ratio of the elderly. As shown in Table 1, the share of retirement-age adults is projected to increase from 20.8% in 2022 to 51.3% in 2070, representing a 146.6% increase. Conversely, the share of working-age people eligible for pensions will decrease, resulting in less contribution revenue for the pension funds. The share of working-age people is expected to drop from 79.2% in 2022 to 48.7% in 2070, a decrease of 38.5%.

The macroeconomic effects of the demographic transition to 2070 include a decrease in the labor supply per capita. As the labor supply per capita falls, firms with Cobb-Douglas function production technology will reduce their demand for complementary capital in production. Consequently, in equilibrium, capital per capita falls, the interest rate falls, the wage rate rises, and aggregate output rises. The primary economic phenomenon that occurs when the wage rate rises is that the consumption and income gap between the working-age and retirement-age groups widens. Although the level of pension benefits at retirement age also increases as the wage rate rises, inequality worsens because the working-age population gains more from wages.

A second macroeconomic effect of the 2070 population structure is a potential decline in the correlation between lifecycle savings and the weighting of the population structure. While savings typically peak in the life cycle just before retirement, Figure 4 shows that in 2022, the population has a relatively high proportion of people nearing retirement. In contrast, by 2070, the highest proportion will be in their mid-70s, a period when savings have significantly declined. This suggests that even if people maintain the same savings patterns throughout their lives, the demographic shift alone can reduce total savings per capita. In response to this capital supply shock, aggregate capital decreases, interest rates increase, wage rates decrease, and aggregate output decreases. If a demand shock for capital occurs simultaneously with the decline in the per capita labor supply, the decline in aggregate output is theoretically certain, but the final directions of changes in interest rates and wage rates are uncertain.

While the first two shocks can occur in both the DB and DC cases, it is only in the DB case that the aging population structure leads to a deficit in the pension fund and a higher tax burden. This occurs because the pension benefit of the current extreme DB system in Korea responds to the overall income level of the population, as shown in the benefit formula, and does not respond to demographic changes. Because the contribution rate and the level of benefits applied to members are separate, a higher dependency ratio of the elderly may simply increase the proportion of people receiving benefits, worsening the finances. In such a situation, if the contribution rate is not high enough, the total contributions will be insufficient to cover the total benefits each year. Consequently, in the long run, the economy will need continuous injections of general government funds to achieve equilibrium with the same population structure as in 2070. Higher taxes would reduce households' after-tax income, potentially leading to lower savings, which in turn could lead to higher interest rates, lower wage rates, and decreased output.

Assuming that the government's proposal to increase tax rates to close the funding deficit in the DB system passes, the fiscal balance would have to be achieved through three main sources: income taxes, corporate taxes, and consumption taxes. Increasing income taxes to finance pension deficits tends to reduce inequality within the working-age group due to the progressive nature of income taxes. However, because the largest portion of income taxes is levied on working-age incomes, this approach reduces the disparity in disposable income between working-age and retirement-age individuals, potentially improving inequality measures such as the Gini coefficient.

Another feature of higher income taxes is that interest income can also be subject to income tax, which can reduce overall savings and thus investment. This can cause interest rates to rise and the economy to contract. Wage rates will also decline along with gross domestic product, reducing pensions but reducing overall inequality as well.

On the other hand, corporate taxes can depress the economy by lowering after-tax interest income, which discourages saving and investment. Given that corporate taxes are purely targeted at capital income, their depressive effect may be stronger than that of income taxes if the same revenue is targeted. As a result, capital may decrease, raising the marginal product of capital. This, in turn, lowers wages, which generally lowers consumption overall.

Compared to the features of income and corporate taxes, consumption taxes are neutral for the population as a whole, as everyone is taxed at a single rate, and if labor supply is inelastic, tax distortions are minimized. Unlike income taxes, consumption taxes do not directly shift the burden to the working-age population, and the tax burden is relatively high for the retired population. To remain neutral on the age concentration of the effects and labor distortions, we use consumption taxes as the main source of revenue in this study.[13] Regardless of the chosen revenue source, households' after-tax income falls, leading to reduced savings, which has a contractionary effect on the economy, although the intensity of this effect may vary depending on the type of tax selected.

Whereas DB faces a serious problem of rising tax rates, DC remains financially stable even if the elderly dependency ratio rises, as shown in Figure 4. This arises because individuals only receive benefits equivalent to contributions and investment returns. As a result, some of the funds are invested domestically, which is why interest rates can be lower in the DC case even under conditions identical to those of the DB case. Therefore, DC can have higher total capital, lower interest rates, higher wage rates, and higher gross product than DB.

B. *Impact of Lower Mortality*

Declining mortality gives households an incentive to increase savings at most ages as life expectancy increases. As shown in Table 1, the decline in mortality is more pronounced in the retirement-age group than in the working-age group. Consequently, the retirement-age group may save more to self-insure against longer lifespans. As overall savings rise, the interest rates fall, and the wage rate rises, increasing wages

[13]Of course, effective tax rates vary by age, which should be interpreted with some caution. For example, Kim (2020) shows that the proportion of tax-exempt consumption is higher among the older and the elderly, so an increase in consumption taxes could narrow the gap between the working and retirement age groups.

for working-age individuals. This can exacerbate inequality measures by further widening the income gap between working-age and retirement-age individuals.

C. *Effect of Reduced Savings as DC Benefits Decline*

In general, households tend to increase their savings in response to an expected decrease in future pension benefits. However, while DB does not adjust benefit levels in response to factors other than income levels, the benefit levels of DC can change elastically with interest rates, making the equilibrium outcome responsive to various external shocks. When interest rates rise, the pension fund grows, leading to higher benefit levels, which subsequently reduces savings and further increases interest rates. Conversely, a decrease in interest rates has an amplifying effect in the opposite direction, causing interest rates to fall further.

If we express this in a partial equilibrium of the capital market, the slope of the capital supply curve of DC is steeper than that of DB. The total supply curve of DC is divided into the capital supply of households and the supply of funds through the DC fund. The total amount of the DC fund in this case slopes upward relative to the interest rate because the fund also grows as the rate of return $\hat{r}$ (proportional to the interest rate) rises. With regard to the supply of household capital, some incentives may be upwardly sloping, as in DB, but there is also an incentive for households to save less as pension benefits increase when interest rates rise. As a result, the capital supply curve for DC is likely to be counterclockwise steeper than the DB capital supply curve. From the perspective of a general equilibrium analysis, both the DB and DC capital supply curves may be steeper than the slopes in partial equilibrium because when interest rates fall, wages necessarily rise, increasing the income level of households. However, the capital supply curve is still steeper in the DC case than in the DB case because households have an incentive to reduce their capital supply further as interest rates rise.

In such a situation, a demographic demand shock that reduces labor per capita will cause interest rates to fall more in DC than in DB. However, equilibrium per capita capital will fall less in the DC case, resulting in a smaller decline in aggregate output, as shown in Figure 5. This outcome is primarily due to households increasing

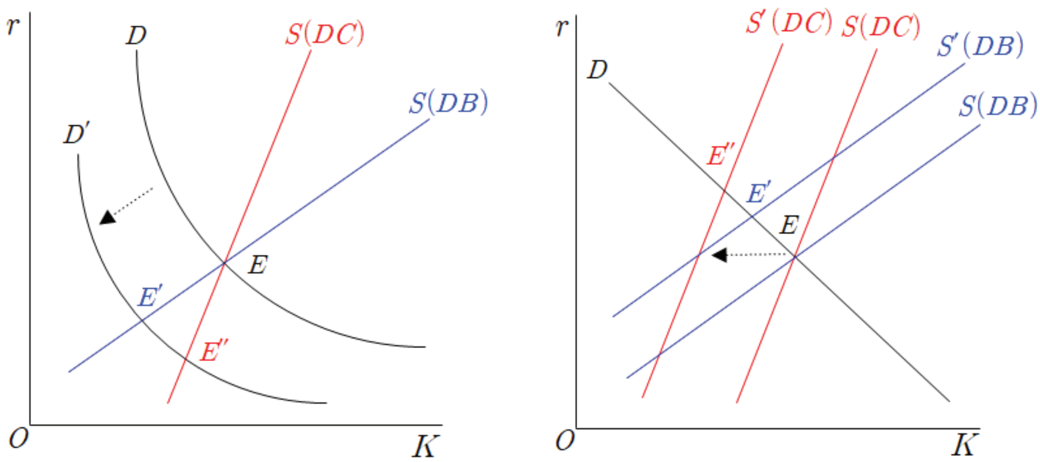

FIGURE 5. DB VS DC RESULTS FOR DEMAND SHOCKS (LEFT) AND SUPPLY SHOCKS (RIGHT) OF CAPITAL

their savings in response to lower interest rates as pension benefits are reduced. Conversely, if there is a supply shock due to a decline in the correlation between capital and the population structure, the same shock may cause interest rates to rise more and aggregate output to fall more in DC than in DB. This is due to the savings response effect, as shown in Figure 5.

Mortality is also a factor that affects benefit levels in DC, meaning that a decline in mortality may have different impacts on DC and DB. Like DB, DC benefits from the savings boost that comes from longer life expectancy. However, lower mortality directly reduces the level of benefits under the DC benefit formula. Because the contractual terms of DC dictate that the funds originally belonging to deceased individuals are passed on to the survivors, the later the population in the cohort dies, the lower the benefit level. The resulting rise in savings can boost the economy, lower interest rates, and increase wage rates, potentially leading to a rise in inequality indices.

D. *Effect of Contribution Rate Increases*

It is possible for DB to remain in place and for the contribution rate to rise as the system's finances deteriorate toward 2070. Another possibility is that the DC reform would occur only after an 18% increase in the contribution rate as DB remains in place. Alternatively, the DC reform may occur when the contribution rate is 9%, but the rate would need to be raised due to an insufficient income replacement rate. Therefore, let's briefly discuss the implications of having a contribution rate higher than 9% in each pension system.

A simple interpretation of increasing contribution rates in the DB case within this model is that, instead of financing the pension deficit with consumption taxes, it is financed with a single-rate labor income tax. An increase in the contribution rate would reduce saving among the working-age population, which is the main saving age group, leading to reductions in gross domestic product and wage rates. This redistributive effect increases the after-tax income of the retirement-age group while decreasing the after-tax income of the working-age group, thus improving the inequality index. However, if the increase in the contribution rate replaces corporate or income taxes rather than consumption taxes, it may actually increase savings. The final equilibrium capital gains or losses may depend on the choice of tax adjusted to achieve a fiscal balance.

On the other hand, the DC case does not have the same substitution effect on tax revenues compared to DB. An increase in the contribution rate in the DC case increases the amount of funds directly invested in Korea but also increases pension benefits, which creates an incentive for households to save less. Additionally, working-age individuals who make higher contributions due to the increased contribution rate will have lower after-tax incomes, similar to the DB case, and thus have an incentive to save less. Essentially, the relative magnitudes of these three effects determine whether capital is ultimately increased or decreased. If the increase in pension funds invested domestically is not substantial, the working-age group is likely to be the worse off due to lower wage rates, which could lead to an improvement in inequality measures.

TABLE 2. DB GENERAL EQUILIBRIUM EFFECT DIAGRAM

Shock	Channel	Result
Pension Deficit↑ →	Taxes↑→ [After-tax Income↓ Savings↓ Interest Rate↑]	Capital↓ Interest Rate↑ Wage Rate↓ Gross Product↓
Labor↓ →	Capital Demand↓→ Interest Rate↓	Capital↓ Interest Rate↓ Wage Rate↑ Gross Product↓
Savings × Population Structure↓ →	Capital Supply↓→ Interest Rate↑	Capital↓ Interest Rate↑ Wage Rate↓ Gross Product↓
Mortality↓ →	Savings↑→ Interest Rate↓	Capital↑ Interest Rate↓ Wage Rate↑ Gross Product↑
Contribution Rate↑ →	[After-tax Income↓ Savings↓ Interest Rate↑] Deficit↓ → Taxes↓→ [After-Tax Income↑ Savings↑ Interest Rate↓]	Capital (↓) Interest Rate (↑) Wage Rate (↓) Gross Product (↓)

Note: Parentheses indicate ambivalent results. Single arrows indicate an effect. Double arrows indicate a strong effect.

TABLE 3. DC GENERAL EQUILIBRIUM EFFECT DIAGRAM

Shock	Channel	Result
Funds Investment↑ →	Capital Supply↑ → Interest Rate↓→ [Benefit↓ Savings↑ Interest Rate↓]	Capital↑↑ Interest Rate↓↓ Wage Rate↑↑ Gross Product↑↑
Labor↓ →	Capital Demand↓ → Interest Rate↓→ [Benefit↓ Savings↑ Interest Rate↓]	Capital (↓) Interest Rate↓↓ Wage Rate↑↑ Gross Product↓
Savings × Population Structure↓ →	Capital Supply↓ → Interest Rate↑→ [Benefit↑ Savings↓ Interest Rate↑]	Capital↓↓ Interest Rate↑↑ Wage Rate↓↓ Gross Product ↓↓
Mortality↓ →	Savings↑ → Interest Rate↓→ [Benefit↓ Savings↑ Interest Rate↓] [Benefit↓ Savings↑ Interest Rate↓]	Capital↑↑ Interest Rate↓↓ Wage Rate↑↑ Gross Product↑↑
Contribution Rate↑ →	[After-tax Income↓ Savings↓ Interest Rate↑] → [Benefit↑ Savings↓ Interest Rate↑] [Benefit↑ Savings↓ Interest Rate↑] Funds↑ → Interest Rate↓→ [Benefit↓ Savings↑ Interest Rate↓]	Capital (↓) Interest Rate (↑) Wage Rate (↓) Gross Product (↓)

Note: Parentheses indicate ambivalent results. Single arrows indicate an effect. Double arrows indicate a strong effect.

However, rather than focusing on the effect of increasing the contribution rate, this study examines on the impact of changing the pension system at a given contribution rate. Regarding the effect of an increase in the contribution rate in the DB case, see Lee *et al.* (2019).

E. *Summary*

Tables 2 and 3 summarize this discussion. The main difference between the two pension systems is that the capital supply curve is more counterclockwise in the DC than in the DB case. This is due to the effect of the saving response to changes in pension benefits, making the interest rate more elastic to any shock. Additionally, it is evident that the directions of pension benefits and wage rates are always opposite in the DC case. This occurs because the interest rate and wage rate are negatively correlated according to the firm's optimization formula, while pension benefits and interest rates are positively correlated through the pension formula and the household's savings response. Therefore, for any shock, the gains of working-age and retirement-age individuals move in opposite directions, leading to corresponding changes in the Gini coefficients.

V. Counterfactual Experiment Results

This section highlights the challenges in maintaining the DB pension system over the long term in the 2070 demographic environment and suggests that a DC reform could be a viable solution. We also propose a supplementary reform of the Basic Pension system as a way to address the issues associated with the DC reform. In this section, we assume that the government primarily adjusts the consumption tax rate to achieve a fiscal balance. This section assumes that $g_z = 0$.

A. *Results of the Demographic Environment Change*

1. DB Pension System

a) Pension fund deficit results

Table 4 shows the projected deficit for DB in 2070. If the current demographic environment (population structure and mortality) continues as it is today (2022) with a 9% contribution rate, the underlying fiscal deficit of the National Pension Fund is only 0.8% of GDP each year. Doubling the contribution rate to address this would result in a fiscal surplus of 1.8% of GDP annually. Currently, proposals to increase the contribution rate to 13% or 15% are frequently discussed in the media, suggesting that such an increase would be sufficient to balance the fund. However, if the demographic environment projected for 2070 persists, a 9% contribution rate will

TABLE 4. IMPACT OF AGING ON DB DEFICITS

(Unit: % of GDP)

Contribution Rate	Population structure	Pension Deficit	Contribution Income	Pension Spending
9	2022	0.80	2.59	3.39
	2070	11.35	2.57	13.92
	Difference	10.55	-0.02	10.53
18	2022	-1.79	5.18	3.39
	2070	8.78	5.14	13.92
	Difference	10.57	-0.04	10.53

Note: Author's creation based on the model.

b) Household Analysis

TABLE 5. IMPACT OF AGING ON THE DB SYSTEM

Population Structure	2022	2070	2070	2022
Mortality	2022	2070	2022	2070
Pension Systems	DB	DB	DB	DB
Contribution rate	9%	9%	9%	9%
Gross Product	0.983	0.683	0.651	1.019
Capital (demand)	2.864	2.598	2.278	3.160
Consumption	0.544	0.369	0.370	0.537
Disposable Income	0.661	0.515	0.502	0.675
After-tax Income	0.617	0.331	0.336	0.619
Labor	1.000	0.597	0.597	1.000
K/N	2.864	4.348	3.814	3.160
Interest Rate	0.044	0.015	0.023	0.036
Wage Rate	0.629	0.731	0.698	0.652
Gini Consumption	0.232	0.264	0.274	0.226
Gini Disposable Income	0.344	0.408	0.404	0.345

Note: Normalized to per capita population.

result in a deficit of 11.4% of GDP each year. Even increasing the contribution rate to 18% to address this situation would still result in an annual deficit of 8.8%. To sustain the pension system in a state of stationary equilibrium, the government would have to raise taxes to cover the deficit, imposing a significant burden on the public.

To examine the effects of the population structure and mortality on households' economic activity separately, we substitute them into the model one by one. For convenience, only some of the results for the 9% contribution rate are presented here. First, the results of the experiment in which only the 2070 demographic structure is substituted into DB are as follows. As shown in Table 5, there is a demand shock for capital that reduces labor per capita by about 40%. This is accompanied by a decline in the supply of capital due to the weakened correlation between the population ratio and savings over the life cycle, resulting in a decline in output as well. However, as the decline in capital per capita does not match the decline in labor, K / N is higher than before. Consequently, the equilibrium state is characterized by a lower interest rate and a higher wage rate. The decline in the interest rate indicates that the effect of the demand shock was greater than the supply shock. As the wage rate rises, the disposable income of working-age people increases. However, their consumption and after-tax income levels (equivalent to disposable income minus consumption tax) fall because consumption taxes must be higher to cover the pension deficit. For retirees, the higher wage rate raises pension levels, but consumption, disposable income, and after-tax income all decline. As a result, retirees are more adversely affected, leading to higher Gini coefficients for all ages.

An experiment in which only the 2070 decline in mortality is considered under DB results in the following outcomes. All age groups in the household increase their savings in anticipation of living longer, leading to a rise in aggregate output, a decline in interest rates, and a rise in wage rates. Pension benefits rise in turn, raising everyone's disposable income. However, capital tax revenue decreases because the stronger impact of the fall in interest rates outweighs the increase in aggregate capital. Additionally, tax revenue declines due to a reduction in death tax revenue caused by the lower mortality rate. This leads to an increased consumption tax burden, which reduces overall consumption. The negative impact is greater for the working-age group, as shown by the improvement in the all-age consumption Gini coefficient.

Substituting both the population structure and mortality of 2070 shows that the impact of the population structure is more pronounced for most variables. In particular, Table 5 shows that capital declines in the lower mortality scenario, in contrast to the results for the higher mortality scenario. However, Figure 6 shows that saving does not change much, suggesting that the decline in capital is more attributable to the reduced correlation between the population structure and lifecycle than a decline in overall lifecycle savings levels.

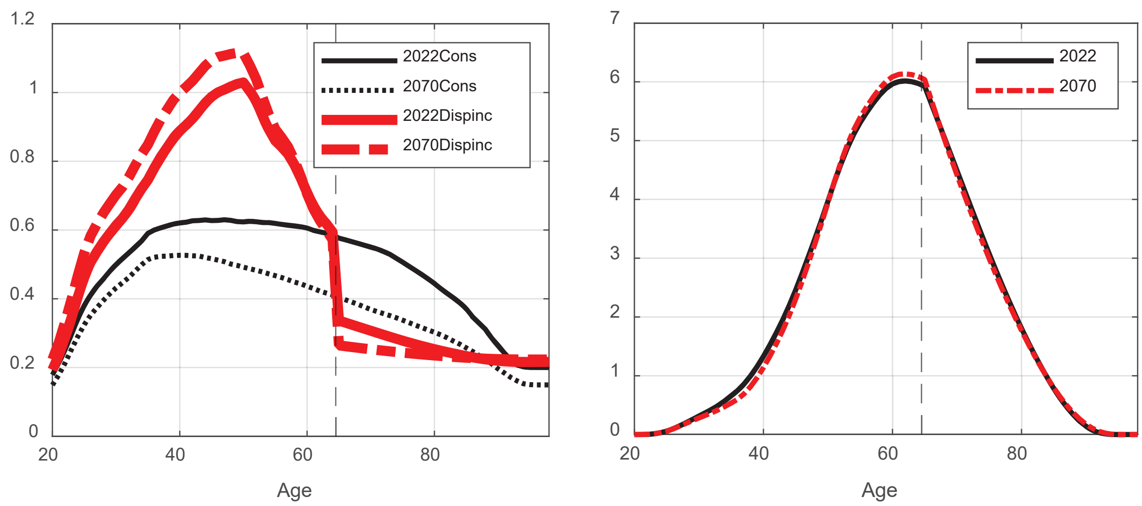

FIGURE 6. DB CONTRIBUTION RATE 9%: LIFECYCLE OF CONSUMPTION AND DISPOSABLE INCOME (LEFT) AND ASSETS (RIGHT)

Note: Vertical dashed line indicates the age of retirement.

2. DC Pension System

TABLE 6. IMPACT OF AGING ON THE DC SYSTEM

Population Structure	2022	2070	2070	2022
Mortality	2022	2070	2022	2070
Pension System	DC	DC	DC	DC
Contribution Rate	9%	9%	9%	9%
Gross Product	1.053	0.750	0.747	1.100
Capital (demand)	3.461	3.376	3.333	3.908
Capital (household)	3.006	3.648	2.860	3.462
Consumption	0.548	0.411	0.424	0.533
Disposable Income	0.667	0.466	0.477	0.680
After-tax Income	0.624	0.360	0.379	0.622
Labor	1.000	0.597	0.597	1.000
K/N	3.461	5.651	5.578	3.908
Interest Rate	0.030	0.000	0.001	0.021
Wage Rate	0.674	0.804	0.800	0.704
Gini Consumption	0.231	0.288	0.310	0.224
Gini Disposable Income	0.370	0.544	0.517	0.381

Note: Normalized to per capita population.

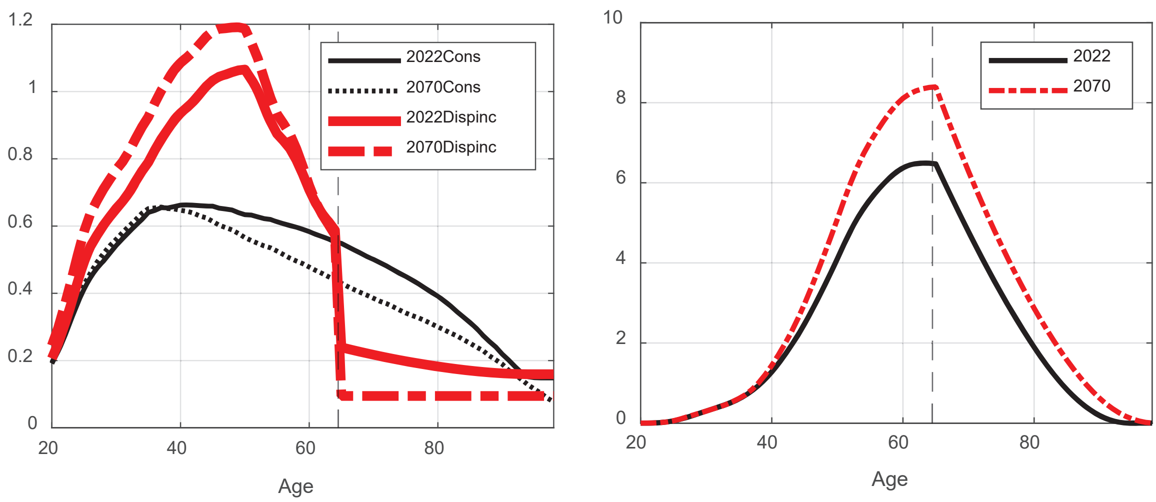

FIGURE 7. DC CONTRIBUTION RATE 9%: LIFECYCLE OF CONSUMPTION AND DISPOSABLE INCOME (LEFT) AND ASSETS (RIGHT)

Note: The vertical dashed line indicates the time of retirement.

For the DC case, let's keep the mortality rate at 2022 but change the population structure to that of 2070. By definition, a financial burden associated with DC does not exist, as each cohort only receives benefits equivalent to the exact amount of contributions and investment returns. Hence, there are no concerns about depleting the fund. However, as shown in Table 6, the interest rate is lowered due to a capital demand shock that reduces labor per capita, and the impact of a capital supply shock is relatively small. Unlike the DB case, in the DC case, the level of pension benefits is lowered primarily due to lower interest rates. Households respond by increasing their savings such that total capital per capita does not decrease as much as in the DB case.[14] As a result, gross output per capita is still lower, although not as much as labor per capita. In this situation, the working-age group benefits relatively more from the higher wage rate, while the retirement-age group loses more due to the lower interest rate, which reduces pension benefits. Consequently, inequality measures such as consumption and the disposable income Gini coefficient worsen.

If only mortality is changed from 2022 to 2070, DC is more affected than DB. In the DB case, despite the fact that pension benefits are fixed, households will increase their savings in anticipation of a higher survival rate. However, in the DC case, the benefit level directly decreases due to the additional decrease in mortality. As a result, households start increasing their savings from a younger age to prepare for their old age. As shown in Table 6, the labor income of working-age individuals increases as savings rise and wage rates increase. Gross output increases compared to the 2022 environment, but consumption and after-tax income decrease. This is due to lower mortality reducing death tax revenue and lower capital tax revenue from decreased lower interest rates, increasing the consumption tax burden. This trend affects all age groups. However, the working-age population shows a stronger tendency to consume less and save more, resulting in a lower all-age consumption Gini coefficient.

When both the population structure and mortality rates of 2070 are applied to DC, gross output falls as in the demographic change scenario, but capital demand rises as in the mortality decline scenario. However, it can be concluded that the overall impact of the population structure is stronger than that of mortality, similar to the DB case.

B. *Comparison of DB and DC in 2070*

Let's directly compare the DB and DC cases under the 2070 population structure and mortality rates. As shown in Table 7, disposable income in DB is higher than in DC at a 9% contribution rate and similar to DC at an 18% contribution rate. However, DC results in higher after-tax income and consumption levels. This can be interpreted as the DB system having a higher consumption tax due to a larger fiscal deficit, resulting in lower after-tax income and consumption levels. Additionally, the DC system benefits from increased total output, as its funds can be partially invested domestically rather than being exhausted.

Figure 8 shows that disposable income is higher in DC than in DB for the working-age population and lower for the retirement-age population.[15] In Table 7, the Gini coefficient of disposable income at all ages is absolutely higher for DC. Similarly, other indicators show that DC does not provide sufficient retirement income

[14] After-tax income decreases by 46% in the DB system and 39% in the DC system, while capital supply decreases by 20% in the DB system and only 5% in the DC system. This large double differential is driven by the difference in the slopes of the capital supply curves.

[15] While the higher disposable income of DC in the working-age group may make it appear as if DC has higher aggregate disposable income, the higher retirement population proportion is such that the DC case ends up with lower aggregate disposable income.

TABLE 7. DB VS DC IN 2070

Pension System	DB	DC	DB	DC
Contribution Rate	9%	9%	18%	18%
Gross Product	0.683	0.750	0.658	0.750
Capital (demand)	2.598	3.376	2.342	3.376
Capital (household)	2.598	3.648	2.342	2.513
Consumption	0.369	0.411	0.352	0.402
Disposable Income	0.515	0.466	0.488	0.488
After-tax Income	0.331	0.360	0.326	0.368
Labor	0.597	0.597	0.597	0.597
K/N	4.348	5.651	3.921	5.651
Interest Rate	0.015	0.000	0.021	0.000
Wage Rate	0.731	0.804	0.705	0.804
Income Replacement Rate	0.142	0.048	0.142	0.095
Pension Return Ratio (beta)	0.988	0.332	0.494	0.332
Gross Return Ratio (beta)	0.108	0.063	0.105	0.097
Gini Consumption	0.264	0.288	0.248	0.280
Gini After-tax	0.408	0.544	0.390	0.456
Consumption (work)	0.444	0.529	0.415	0.514
Disposable Income (work)	0.806	0.858	0.750	0.818
After-tax Income (work)	0.585	0.721	0.559	0.665
Gini Consumption (work)	0.227	0.223	0.215	0.220
Gini Disposable (work)	0.303	0.305	0.293	0.295
Consumption (ret)	0.298	0.299	0.292	0.296
After-tax Income (ret)	0.239	0.095	0.239	0.175
Disposable Income (ret)	0.091	0.018	0.106	0.086
Gini Consumption (ret)	0.252	0.266	0.240	0.253
Gini Disposable (ret)	0.152	0.044	0.153	0.104

Note: "Return Ratio" is the present value ratio of benefits to contributions. "Pension" only considers the National Pension, "Gross" considers the government fiscal sector as well, and "(beta)" uses a discount rate of $1/\beta - 1$ to calculate the present value; Values are normalized to per capita figures. Here, "(work)" denotes working age and "(ret)" denotes retirement age. Except for the Gini coefficient and population, variables with "(work)" and "(ret)" are normalized to their respective population ratios.

compared to DB. As shown in Table 7, the income replacement rate is significantly lower in DC, and the gross return ratio,[16] whose present values are calculated through the discount rate of $1/\beta - 1$[17] and mortality, is also lower in DC. Additionally, the average disposable income and after-tax income at retirement age are both lower in

[16]The gross return ratio is the return ratio, which is the present value ratio of benefits to contributions, taking into account the government fiscal sector (i.e., taxes, Basic Pension).

[17] $1/\beta - 1 = 0.0318$

the DC case. This occurs because DC benefits are more elastic with respect to interest rates. While working-age people benefit from the increase in capital (and subsequently output) and wage rates in DC, it does not lead to an equivalent increase in pension benefits as in the DB scenario. Furthermore, the decline in interest rates results in a decline in DC benefits at retirement age, increasing income inequality across all ages. Although consumption at retirement age is slightly higher in DC, the consumption gap with the working-age population is larger in DC, resulting in a higher all-age consumption Gini coefficient.

When the contribution rate increases to 18%, the difference between DB and DC remains qualitatively similar, with DB offering higher retirement disposable and after-tax incomes. However, the gap in the Gini coefficients of disposable income between the two schemes narrows. As the contribution rate rises, pension benefits rise in the DC case, which reduces savings, wage rates, and gross product, thereby reducing the income gaps between retirement and working ages. Although the

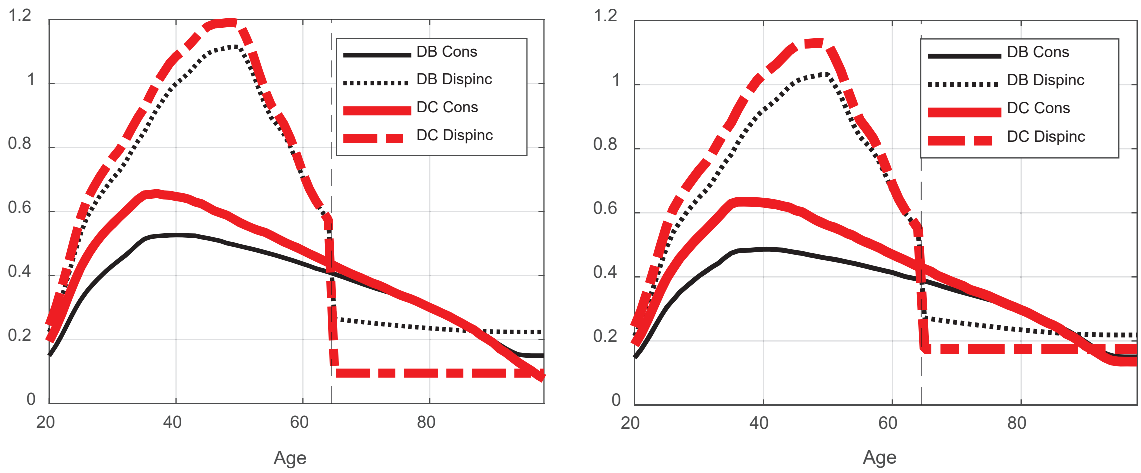

FIGURE 8. COMPARISON OF DB-DC LIFECYCLES IN 2070: 9% (LEFT) AND 18% (RIGHT) CONTRIBUTION RATES

Note: The vertical dashed line indicates the age of retirement.

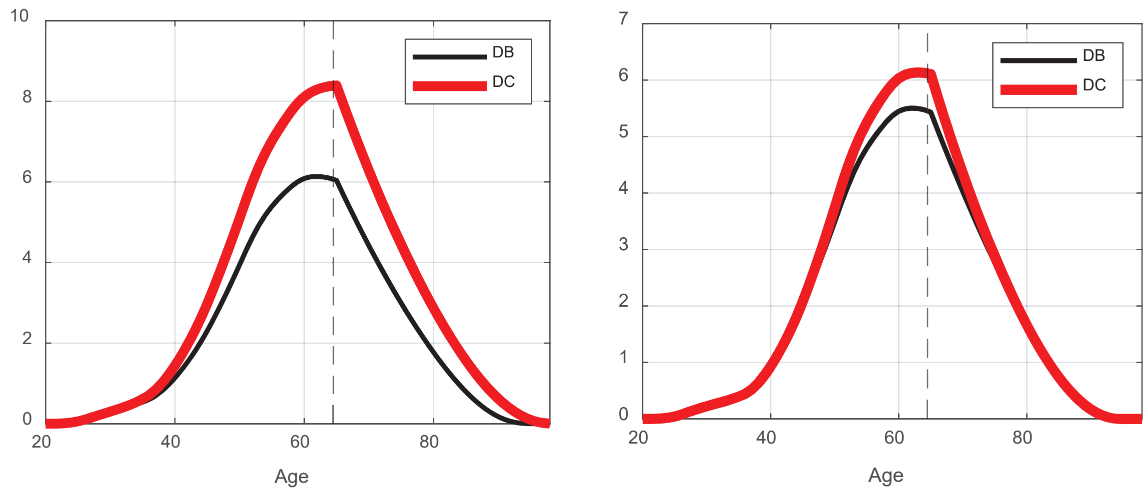

FIGURE 9. COMPARISON OF DB-DC ASSET LIFECYCLES IN 2070: 9% (LEFT) AND 18% (RIGHT) CONTRIBUTION RATES

Note: The vertical dashed line indicates the age of retirement.

disposable income Gini coefficient is lower in DB as the contribution rate increases, the improvement is more significant in DC. On the other hand, the gap in consumption Gini coefficients between the two pension systems widens. While an increase in the contribution rate also reduces the consumption of working-age people in the DC case, for DB, the economic contraction affects working-age people more, leading to a greater improvement in consumption inequality in DB.

One of the weaknesses often cited in relation to DC systems is the inability of these systems to redistribute income in life in later, though this is only partially true. Admittedly, the DC case, in contrast to the Korean DB system that equally weighs the A and B values in the benefit, are based on the concept that individuals contribute and receive only as much as they invest. This suggests that DC would have higher income inequality in retirement. However, the Gini coefficient of retirement disposable income is actually lower for the DC than the DB case. Although the Gini coefficient of retirement disposable income for DC increases when the contribution rate rises to 18%, it is still lower than that of DB.

The reason for this lower inequality in retirement disposable income in the DC case is that everyone's benefit level is very low in the DC system, as shown in Figure 8.[18] Of course, raising the contribution rate until the level of retirement disposable income in DC is similar to that in DB could make the Gini coefficient of retirement disposable income in the DC case higher, but the feasibility of this approach is doubtful given the common notion that an 18% contribution rate is already too burdensome for households in Korea. Thus, while it is plausible that DC reforms could widen the social gap between the working- and retirement-age groups, leading to greater overall inequality than in the DB case, it is important to examine further whether inequality within the retirement-age group itself will worsen.

C. *Analyzing the Universal Pension Policy under DC*

As we have seen, one of the main problems with the DC system is not the redistribution of income in retirement but rather the generally low level of retirement income. We find that DC could be worse than DB in terms of the income replacement rate, return ratio, disposable income at retirement age, and after-tax income at retirement age. We also find that the Gini coefficient of consumption in retirement age is higher in DC, primarily because pension benefits are too low in DC, causing households to rely more on savings for consumption. As a solution to these problems, we propose expanding government fiscal support for retirement-age individuals. For simplicity, we assume a universal pension that provides the same amount of transfer payments to all retirement-age groups.[19] The Basic Pension is assumed to be reduced based on the sum of the National Pension and the universal pension. We also consider this universal pension when calculating the income replacement rates.

Unlike the DB case, the DC case is not financially problematic; however, the

[18]The higher Gini coefficient of retirement consumption for the DC system is also due to the fact that retirement age income is so low that they rely primarily on savings for consumption, while savings inequality is higher than that of the pension benefit.

[19]How to implement these subsidies in the real world through the Basic Pension system is left for future research.

DC system's pension benefits are highly sensitive to decreases in interest rates. Additionally, the increase in savings in preparation for such situations can further decrease pension benefits through additional decreases in interest rates. Although it is inevitable that interest rates and pension benefit levels will fall due to the initial decline in the labor force per capita, we suggest expanding the universal pension to mitigate the phenomenon of households increasing their savings even more to prepare for their own retirement, which in turn lowers the level of benefits. The reason this study proposes this solution instead of increasing the contribution rate further to 18% is to emphasize the need for structural reform by making a direct comparison with the current DB pension system in an equalized environment. We have already shown that a government transfer of 9-11% of GDP to the pension each year would be necessary to maintain the DB in the 2070 demographic environment. If such policy is feasible, it may be realistic as well to provide a smaller fraction of this transfer as a universal pension under the DC system. Model experiments can be used to determine the amount of the additional universal pension benefit needed to achieve the welfare effects of the DB system.

To determine whether DC is better than DB, we will use the following criteria, referred to as the "key indicators:" (1) the average standard of living at working age (consumption and after-tax income), (2) the average standard of living at retirement age (consumption, after-tax income, income replacement rate, and gross return ratio), and (3) inequality within the retirement-age group (consumption and disposable income Gini coefficients). Because this analysis relies on consumption tax as the main source of government revenue, average disposable income that does not consider consumption tax is not a good measure of welfare. Moreover, given that after-tax income can be negative in reality, we will consider disposable income instead of after-tax income for the Gini coefficient. We also exclude the inequality index within the working-age group to focus on the pension and welfare of the retirement-age group. However, readers are free to use their own criteria to compare pension systems.

For the 2070 demographic environment and the given contribution rate, we experimented on the DC system by a adding universal pension amounting to only a fraction of the 100% of the government transfer needed to maintain the DB system.[20] The results of the key indicators in Table 8, Table 9, Figure 10, and Figure 11 show that at a contribution rate of 9% in 2070, DC needs less than 90% of the government transfer required to maintain DB to improve the key indicators compared to DB. At an 18% contribution rate, a subsidy of less than 60% is sufficient to improve the key indicators.[21]

The primary reason why DC is more efficient overall than DB after accounting for government subsidies is that the total output and after-tax income are inherently higher in the DC case. Even without the supplemental universal pension, total output and after-tax income are higher in DC than in DB, meaning that the main issue with DC remains redistribution. As we have seen, there is an amplifying effect between interest rates, pension benefits, and household savings in the DC case, which can lead to a larger income gap between working and retirement ages than in the DB

[20]Therefore, for the same weight (%), the subsidy is larger at a 9% contribution rate than at an 18% contribution rate.

[21]Consumption and disposable income Gini coefficients, working-age consumption and disposable income Gini coefficients worsen.

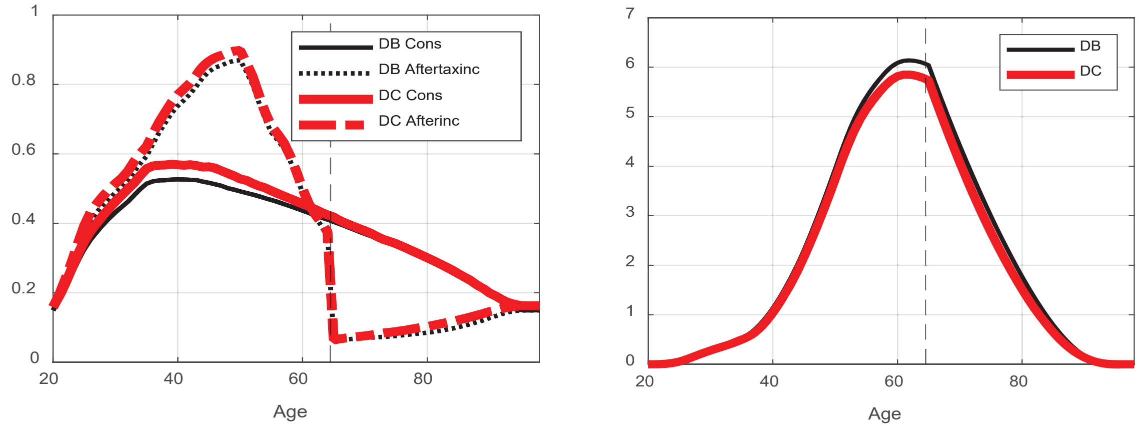

FIGURE 10. DB VS DC (90% SUPPLEMENTAL) AFTER-TAX INCOME-CONSUMPTION (LEFT) AND SAVINGS (RIGHT): 9% CONTRIBUTION RATE

Note: The vertical dashed line indicates the age of retirement.

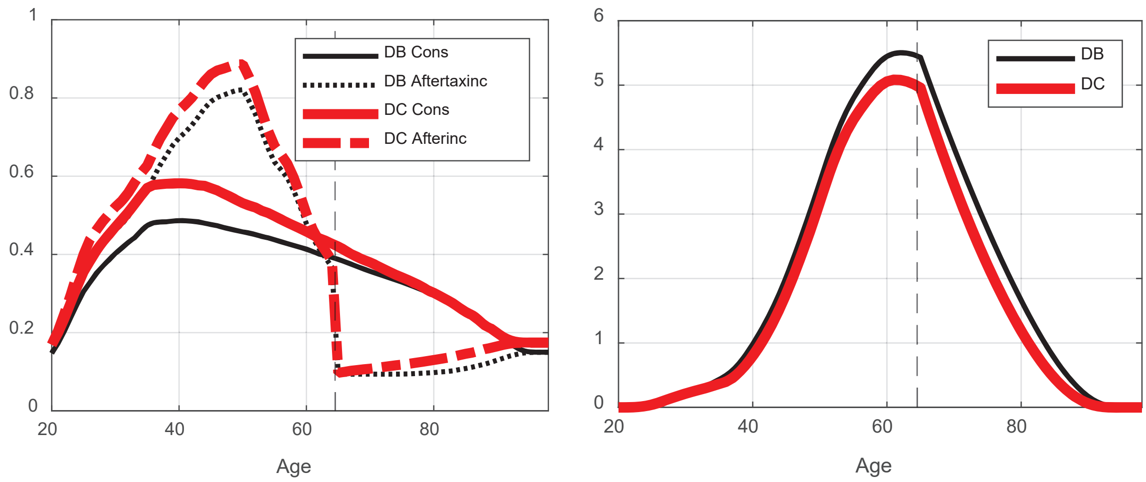

FIGURE 11. DB VS DC (60% SUPPLEMENTAL) AFTER-TAX INCOME - CONSUMPTION (LEFT) AND SAVINGS (RIGHT): 18% CONTRIBUTION RATE

Note: The vertical dashed line indicates the age of retirement

case. However, this amplifying effect also means that even a small government subsidy can significantly reduce the gap. Geometrically speaking, the capital supply curve of DC is steeper than that of DB, which means that it is possible to reduce the gap in living standards between the working-age and retirement-age groups by raising interest rates and lowering wage rates with less government transfer. If the contribution rate increases, although the after-tax income of the working-age group will decrease, the retirement-age group will need even less financial support through the universal pension due to the higher DC pension benefit.

The second reason is that when the fund rate of return is higher than the nominal growth rate (interpreted as nominal wage growth plus population growth rates) and the population structure is aging, the pay-as-you-go (PAYGO) system becomes very inefficient in the long run.[22] For example, if we assume that the same amount of

[22]The fact that funded system is better than the PAYGO system if the fund rate of return is higher than the sum of population growth and wage growth rates is called the Aaron (1966) condition.

government transfer goes to the DC economy as to the DB economy, the relative efficiency of each system for a given contribution rate is theoretically determined by the difference between the fund rate of return and the nominal growth rate. In this analysis, we assume that wage growth is $g_z = 0$ and assume as well a negative population growth rate $(g_\mu < 0)$ consistent with a larger population of several age groups than younger groups, with fund rates of return between 0% and 0.5% (depending on the size of the universal pension). Although the fund rate of return is affected by the assumption of 0% foreign interest rates, this analysis assumes a smaller gap between the fund rate of return and wage growth than in general pension projections, which is less favorable for the DC case.[23] In such a situation where the fund rate of return is greater than the nominal growth rate, the PAYGO system

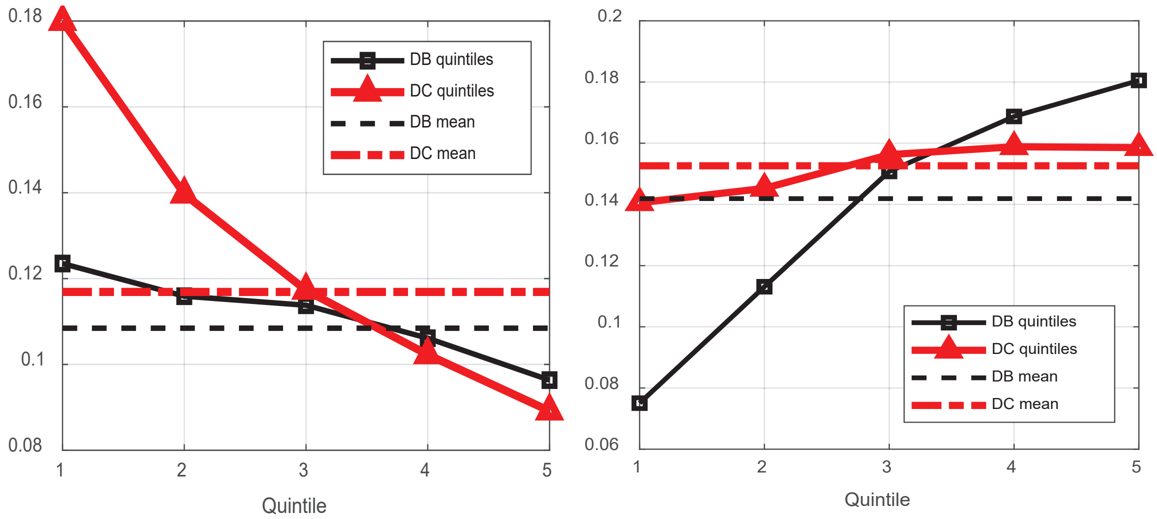

FIGURE 12. DB VS DC (90% SUPPLEMENTAL) GROSS RETURN RATIO (LEFT) AND INCOME REPLACEMENT RATE (RIGHT): 9% CONTRIBUTION RATE

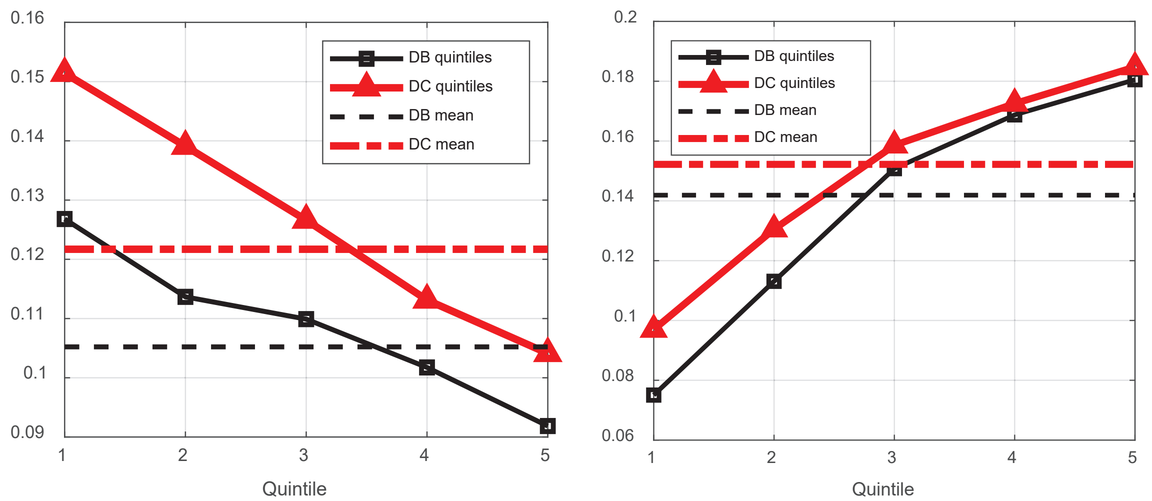

FIGURE 13. DB VS DC (60% SUPPLEMENTAL) RETURN RATIO (LEFT) AND INCOME REPLACEMENT RATE (RIGHT): 18% CONTRIBUTION RATE

[23]The Fifth Government Pension Projection assumes a long-term nominal wage growth rate of 3.7% and a fund rate of return of 4.5%.

becomes increasingly inefficient as the demographic structure ages. This inefficiency arises because a smaller number of working-age individuals must support a larger number of retirement-age individuals without benefiting from of high fund rate of return. A mathematical explanation of this phenomenon is provided in the Appendix.

Regarding inequality within the retirement-age group, we initially observe that the Gini coefficient of disposable income is already lower in the DC case without a government subsidy compared to the DB case. This occurs simply because DC has lower benefit levels. Conversely, the Gini coefficient for consumption at retirement age is higher in DC, which is interpreted as a result of the higher dependence of consumption on savings. Therefore, increasing the level of disposable income through the universal pension while lowering the Gini coefficient of disposable income can lower the Gini coefficient of consumption. An increase in the universal pension lowers the Gini coefficient of disposable income because it raises the living standard of everyone within the retirement age group by the same amount. It is likely that the Gini coefficient of consumption will also be reduced, unless an interest rate increase due to lower household saving leads to a very strong increase in the variance of pension benefits.

Furthermore, we analyzed the gross return ratio and income replacement rate of the combined universal and DC National Pension by lifecycle income quintiles, whose present values are calculated with the discount factor $1/\beta-1$. The results show that the inequality in the gross return ratio improves, as indicated by the lower slope of the quintile figures for DC compared to DB, as shown in Figure 12. Similarly, the inequality in the income replacement rate improves, as the slope of the quintile figures for DC is also lower than that of DB, as shown in Figure 13.

TABLE 8. 2070 DC+UNIVERSAL PENSION, 9% CONTRIBUTION RATE

	DB	DC	DC Univ. 60%	DC Univ. 70%	DC Univ. 80%	DC Univ. 90%	DC Univ. 100%
Gross Product	0.683	0.750	0.739	0.728	0.718	0.708	0.698
Capital (demand)	2.598	3.376	3.239	3.107	2.984	2.868	2.765
Capital (household)	2.598	3.648	2.781	2.650	2.528	2.412	2.310
Consumption	0.369	0.411	0.395	0.392	0.389	0.386	0.382
Disposable Income	0.515	0.466	0.509	0.514	0.520	0.525	0.531
After-tax Income	0.331	0.360	0.353	0.352	0.351	0.349	0.347
Labor	0.597	0.597	0.597	0.597	0.597	0.597	0.597
K/N	4.348	5.651	5.422	5.200	4.994	4.800	4.628
Interest Rate	0.015	0.000	0.002	0.004	0.007	0.009	0.011
Wage Rate	0.731	0.804	0.792	0.780	0.769	0.758	0.748
Income Tax	0.040	0.043	0.043	0.042	0.041	0.041	0.040
Consumption Tax	0.183	0.106	0.156	0.162	0.169	0.176	0.184
Capital Tax	0.015	0.000	0.003	0.005	0.008	0.010	0.012
Death Tax	0.009	0.016	0.009	0.009	0.008	0.007	0.007
Government Spending	0.117	0.117	0.117	0.117	0.117	0.117	0.117
Pension Spending	0.095	0.035	0.035	0.036	0.036	0.036	0.037
Pension Contribution	0.018	0.019	0.019	0.019	0.018	0.018	0.018
Pension Fund	0.000	0.930	0.928	0.926	0.924	0.922	0.921
Basic Pension	0.017	0.014	0.012	0.012	0.013	0.013	0.013
Universal Pension	0.000	0.000	0.046	0.054	0.062	0.070	0.077
Income Replacement Rate	0.142	0.048	0.113	0.126	0.139	0.153	0.166
Pension Return Ratio (beta)	0.988	0.332	0.339	0.347	0.355	0.363	0.371
Gross Return Ratio (beta)	0.108	0.063	0.098	0.105	0.111	0.117	0.123
Pension Return Ratio	2.197	1.000	0.978	0.955	0.933	0.911	0.892
Gross Return Ratio	0.222	0.177	0.258	0.263	0.266	0.268	0.270
Gini Consumption	0.264	0.288	0.276	0.271	0.265	0.260	0.255
Gini Disposable	0.408	0.544	0.451	0.431	0.413	0.396	0.380
Gini Asset	0.577	0.546	0.593	0.601	0.609	0.617	0.624
Consumption (work)	0.444	0.529	0.501	0.492	0.483	0.474	0.466
Disposable (work)	0.806	0.858	0.849	0.840	0.832	0.823	0.816
After-tax (work)	0.585	0.721	0.652	0.637	0.622	0.607	0.592
Asset (work)	2.866	3.759	3.050	2.934	2.827	2.725	2.633
Income Tax (work)	0.081	0.089	0.088	0.086	0.085	0.084	0.083
Consumption Tax (work)	0.221	0.137	0.197	0.204	0.210	0.217	0.223
Gini Consumption (work)	0.227	0.223	0.223	0.222	0.221	0.220	0.220
Gini Disposable (work)	0.303	0.305	0.305	0.304	0.304	0.304	0.304
Gini Capital (work)	0.595	0.593	0.612	0.614	0.617	0.619	0.622
Consumption (ret)	0.298	0.299	0.296	0.298	0.300	0.302	0.304
Disposable (ret)	0.239	0.095	0.186	0.205	0.224	0.243	0.261
After-tax (ret)	0.091	0.018	0.070	0.082	0.094	0.105	0.115
Asset (ret)	2.343	3.541	2.526	2.381	2.244	2.116	2.004
Income Tax (ret)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Consumption Tax (ret)	0.148	0.077	0.116	0.123	0.131	0.138	0.146
Gini Consumption (ret)	0.252	0.266	0.248	0.242	0.236	0.231	0.226
Gini Disposable (ret)	0.152	0.044	0.045	0.047	0.048	0.050	0.051
Gini Asset (ret)	0.543	0.486	0.561	0.574	0.588	0.601	0.614
Population	0.770	0.770	0.770	0.770	0.770	0.770	0.770
Population (work)	0.375	0.375	0.375	0.375	0.375	0.375	0.375
Population (ret)	0.395	0.395	0.395	0.395	0.395	0.395	0.395

Note: "Return Ratio" is the present value ratio of benefits to contributions using the domestic interest rate as the discount rate. "Pension" only considers the National Pension, "Gross" considers government the fiscal sector as well, and "(beta)" takes uses the discount rate $1/\beta-1$ to calculate the present value; Normalized to per capita figures. Here, "(work)" denotes working age and "(ret)" denotes retirement age. Except for the Gini coefficients and population, variables in (work) and (ret) are normalized using their respective populations; "Univ. 30%," for example, means that 30% of the DB system's deficit amount of government transfer is used in the universal pension case.

TABLE 9. 2070 DC+UNIVERSAL PENSION, 18% CONTRIBUTION RATE

	DB	DC	DC Univ. 20%	DC Univ. 30%	DC Univ. 40%	DC Univ. 50%	DC Univ. 60%
Gross Product	0.658	0.750	0.742	0.735	0.728	0.721	0.714
Capital (demand)	2.342	3.376	3.270	3.188	3.105	3.022	2.943
Capital (household)	2.342	2.513	2.353	2.273	2.191	2.110	2.032
Consumption	0.352	0.402	0.399	0.397	0.394	0.392	0.390
Disposable Income	0.488	0.488	0.496	0.499	0.503	0.506	0.510
After-tax Income	0.326	0.368	0.367	0.366	0.365	0.364	0.363
Labor	0.597	0.597	0.597	0.597	0.597	0.597	0.597
K/N	3.921	5.651	5.473	5.336	5.197	5.059	4.927
Interest Rate	0.021	0.000	0.002	0.003	0.004	0.006	0.007
Wage Rate	0.705	0.804	0.795	0.787	0.780	0.772	0.765
Income Tax	0.038	0.043	0.043	0.042	0.042	0.042	0.041
Consumption Tax	0.161	0.120	0.129	0.133	0.137	0.142	0.147
Capital Tax	0.020	0.000	0.002	0.004	0.005	0.007	0.009
Death Tax	0.008	0.008	0.007	0.007	0.006	0.006	0.006
Government Spending	0.117	0.117	0.117	0.117	0.117	0.117	0.117
Pension Spending	0.092	0.070	0.071	0.071	0.071	0.072	0.072
Pension Contribution	0.034	0.039	0.038	0.038	0.037	0.037	0.037
Pension Fund	0.000	1.860	1.857	1.854	1.851	1.849	1.846
Basic Pension	0.017	0.020	0.017	0.017	0.016	0.016	0.015
Universal Pension	0.000	0.000	0.012	0.017	0.023	0.029	0.035
Income Replacement Rate	0.142	0.095	0.113	0.122	0.132	0.142	0.152
Pension Return Ratio (beta)	0.494	0.332	0.337	0.342	0.347	0.352	0.358
Gross Return Ratio (beta)	0.105	0.097	0.104	0.108	0.113	0.117	0.122
Pension Return Ratio	0.960	1.000	0.983	0.969	0.955	0.940	0.926
Gross Return Ratio	0.192	0.272	0.281	0.284	0.287	0.289	0.291
Gini Consumption	0.248	0.280	0.276	0.273	0.270	0.266	0.262
Gini Disposable	0.390	0.456	0.437	0.426	0.414	0.403	0.391
Gini Asset	0.570	0.585	0.591	0.594	0.598	0.602	0.607
Consumption (work)	0.415	0.514	0.506	0.500	0.494	0.487	0.481
Disposable (work)	0.750	0.818	0.812	0.806	0.801	0.795	0.789
After-tax (work)	0.559	0.665	0.648	0.639	0.629	0.619	0.608
Asset (work)	2.542	2.755	2.617	2.546	2.472	2.400	2.328
Income Tax (work)	0.078	0.089	0.088	0.087	0.086	0.085	0.084
Consumption Tax (work)	0.191	0.154	0.163	0.168	0.172	0.177	0.181
Gini Consumption (work)	0.215	0.220	0.221	0.221	0.221	0.221	0.220
Gini Disposable (work)	0.293	0.295	0.295	0.294	0.294	0.294	0.294
Gini Capital (work)	0.594	0.607	0.607	0.608	0.608	0.609	0.611
Consumption (ret)	0.292	0.296	0.298	0.299	0.300	0.302	0.303
Disposable (ret)	0.239	0.175	0.196	0.208	0.220	0.233	0.245
After-tax (ret)	0.106	0.086	0.100	0.107	0.115	0.123	0.131
Asset (ret)	2.153	2.283	2.103	2.014	1.925	1.835	1.751
Income Tax (ret)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Consumption Tax (ret)	0.134	0.088	0.096	0.100	0.105	0.109	0.114
Gini Consumption (ret)	0.240	0.253	0.250	0.247	0.244	0.241	0.237
Gini Disposable (ret)	0.153	0.104	0.115	0.118	0.120	0.119	0.117
Gini Asset (ret)	0.532	0.547	0.557	0.563	0.570	0.579	0.587
Population	0.770	0.770	0.770	0.770	0.770	0.770	0.770
Population (work)	0.375	0.375	0.375	0.375	0.375	0.375	0.375
Population (ret)	0.395	0.395	0.395	0.395	0.395	0.395	0.395

Note: "Return Ratio" is the present value ratio of benefits to contributions using the domestic interest rate as the discount rate. "Pension" only considers the National Pension, "Gross" considers government fiscal sector as well, and "(beta)" takes uses discount rate $1/\beta-1$ to calculate the present value; Normalized to per capita figures. Here, "(work)" denotes working age and "(ret)" denotes retirement age. Except for the Gini coefficients and population, variables in (work) and (ret) are normalized using their respective populations; "Univ. 30%," for example, means that 30% of the DB system's deficit amount of government transfer is used in the universal pension case.

VI. Conclusion

This study examines the challenges of continuing the DB pension system in the 2070 demographic environment and the effects of reforming to a DC pension system using a stationary general equilibrium model with overlapping generations. In so doing, we confine our analysis to long-term effects, abstracting from the transition path analysis of the DC reform.

First, if the DB system continues with the aging demographics projected for 2070, it will require 11.3% of GDP in government fiscal support each year at a 9% contribution rate and 8.8% of GDP if the contribution rate rises to 18%. Under the same demographic conditions in 2070, replacing the DB system with a DC system and assuming no net foreign income, would improve the gross product and the average living standard of the working-age group. However, it would also deteriorate the living standard of the elderly, leading to a widening gap between age groups compared to the DB system. If the DC system is supplemented by a universal pension, the average living standards of both working- and retirement-age groups, as well as inequality indicators within the retirement-age group, can be improved by using only a fraction of the financial support required for the DB pension system. Additionally, the DC pension could potentially improve further if there is positive net foreign income.

This study does not aim to identify the optimal pension system. Instead, we focus on demonstrating that parametric reforms that merely maintain the current DB pension system and double the contribution rate are fiscally inefficient in the long run. We propose a policy combining a DC system with a universal pension as a comparison. We do not discuss what contribution rates are optimal for the DC system, which could be an interesting topic for future research.

There may also be policies that are superior to the combination of DC and a universal pension within the stationary equilibrium framework. For example, exploring the effects of reducing the current DB pension system and replacing it with a universal pension could be an interesting research topic. Adding automatic stabilizers to the current DB pension system or incorporating a PAYGO flavor into the DC pension system through a notional defined contribution (NDC) system are also worthy of further study.

However, reality deviates significantly from stationary equilibrium, and a stationary equilibrium analysis alone does not capture the dynamic responses to population shocks. For example, along a transition path to stationary equilibrium, unexpected fertility declines or longevity shocks may deteriorate the return ratio of a PAYGO pension benefit, leaving some generations disproportionately worse off than others. The optimal pension system cannot be fully discussed without considering this dynamic perspective.

Even from this dynamic point of view, extreme DB systems like that of Korea have serious problems: they are not financially resilient to various shocks, and PAYGO pension systems without adequate funding cannot avoid lower pension return ratios. Conversely, even in a country with one of the lowest fertility rates in the world, DC pension systems ensure financial stability and a stable pension return ratio because reserves always exist. While the risk to old-age income in DC systems mainly comes from the fund rate of return, in reality, unlike in our model, the proportion of foreign investment is determined endogenously, which makes it possible to hedge against domestic shocks. Therefore, the analysis within this study's equilibrium framework may underestimate the benefits of the DC pension system.

Appendix

Assuming a fixed mortality rate, the budget constraint for the DC pension fund with growth adjusted for population and wage growth looks like

$$\alpha_t Ex_t + (1+g_z)(1+g_z)S_{t+1} = (1+r)S_t + \mathrm{Re}\,v_t \ .$$

t : year

g_z : wage growth rate

g_μ : population growth rate

r : fund rate of return

Ex_t : DC yearly expenditure per capita (when the return ratio is 1)

$\mathrm{Re}\,v_t$: DC yearly contribution per capita

S_t : DC fund per capita

α_t : return ratio factor (in DC, by definition, $\alpha_t = 1$)

In this context, adjusting the growth rate means that the following equations hold in long-run equilibrium:

$$Ex_t = Ex_0 \times [(1+g_z)(1+g_\mu)]^t ,$$

$$\mathrm{Re}\,v_t = \mathrm{Re}\,v_0 \times [(1+g_z)(1+g_\mu)]^t ,$$

$$S_t = S_0 \times [(1+g_z)(1+g_\mu)]^t .$$

The long-run equilibrium equation without t is

$$\alpha Ex - \mathrm{Re}\,v = S[(1+r) - (1+g_z)(1+g_\mu)] \approx S(r - g_z - g_\mu) .$$

The pension fiscal deficit (left) is equal to the "real" interest rate (right) expressed as the difference between the fund rate of return (r) and the nominal growth rate $(g_z + g_\mu)$. Assuming that the contribution rate Is fixed and that $\mathrm{Re}\,v$ is fixed as well, the equation leads to the following conclusions.

Proposition 1. If $r > g_z + g_\mu$, the DC benefit is higher than in a fully unfunded PAYGO system; i.e., in DC plan $S > 0$, $\alpha Ex - \mathrm{Re}\,v > 0$, and $\alpha = 1$, whereas in an unfunded system, $\hat{S} = 0$ and $\hat{\alpha} = \dfrac{\mathrm{Re}\,v}{Ex} < 1$.

Proposition 2. If $r > g_z + g_\mu$, a larger $r - g_z - g_\mu$ means a larger the gap in pension benefits between the DC and the PAYGO system. We refer to this as the "real interest rate effect."

Finally, one aspect that is not obvious from the equations above is that as the aggregate fertility rate falls, not only does g_μ go down, generating the real interest rate effect, but the population structure ages as well, widening the pension benefit gap between the DC system and the PAYGO system. We refer to the latter as the "population structure effect."

TABLE A1. DC BENEFIT CALCULATION PROCEDURE

i	F_i (beginning of year fund)	$\tilde{F}_i$ (year-end account by cohort)
1	0	v_1
2	$\tilde{F}_1(1+g_z)^{-1}\mu_2/(1-\gamma_1)$	$v_1(1+\tilde{r})/(1-\gamma_1)+v_2$
3	$\tilde{F}_2(1+g_z)^{-1}\mu_3/(1-\gamma_2)$	$v_1(1+\tilde{r})^2/[(1-\gamma_1)(1-\gamma_2)]+v_2(1+\tilde{r})/(1-\gamma_2)+v_3$
⋮	⋮	⋮
i_R-1	⋮	$\bar{B}\equiv v_1(1+\tilde{r})^{n-1}/[(1-\gamma_1)\cdots(1-\gamma_{n-1})]+\cdots+v_{i_R-1}$
i_R	$\tilde{F}_{i_R-1}(1+g_z)^{-1}\mu_{i_R}/(1-\gamma_{i_R-1})$ $=\bar{B}(1+g_z)^{-1}\mu_{i_R}/(1-\gamma_{i_R-1})$	$\bar{B}(1+\tilde{r})/(1-\gamma_{i_R-1})-\xi=\tilde{B}-\xi$
i_R+1	⋮	$\tilde{B}(1+\tilde{r})^{I-i_R}/[(1-\gamma_{i_R})\cdots(1-\gamma_{I-1})]-\xi(1+\tilde{r})^{I-i_R}/[(1-\gamma_{i_R})$ $\cdots(1-\gamma_{I-1})]-\cdots-\xi$
⋮	⋮	⋮
I	…	$\tilde{B}(1+\tilde{r})^{I-i_R}/[(1-\gamma_{i_R})\cdots(1-\gamma_{I-1})]-\xi(1+\tilde{r})^{I-i_R}/[(1-\gamma_{i_R})$ $\cdots(1-\gamma_{I-1})]-\cdots-\xi$

Note: v_i refers to the average contribution of age i; $\xi=\xi(\bar{B})$, $1+\tilde{r}=(1+\hat{r})/(1+g_z)$.

TABLE A2. INITIAL DISTRIBUTION OF LABOR HOURS

	$l=1$	$l=2$	$l=3$
Density	0.992	0.004	0.004

TABLE A3. TRANSITION FUNCTION FOR HOURS WORKED FOR AGES 20-34

	Future $l'=1$	Future $l'=2$	Future $l'=3$
Current $l=1$	0.842	0.132	0.026
Current $l=2$	0.041	0.513	0.446
Current $l=3$	0.121	0.042	0.837

TABLE A4. TRANSITION FUNCTION FOR HOURS WORKED FOR AGES 35-49

	Future $l'=1$	Future $l'=2$	Future $l'=3$
Current $l=1$	0.917	0.031	0.052
Current $l=2$	0.424	0.167	0.408
Current $l=3$	0.010	0.014	0.976

TABLE A5. TRANSITION FUNCTION FOR HOURS WORKED FOR AGES 50-64

	Future $l'=1$	Future $l'=2$	Future $l'=3$
Current $l=1$	0.927	0.058	0.015
Current $l=2$	0.627	0.254	0.118
Current $l=3$	0.024	0.044	0.933

TABLE A6. CALIBRATION RESULTS

	Variables	Value	Rationale
μ_i	Population density by age	-	National Statistics Future Population Projections (2021)
γ_i	Mortality rate by age	-	National Statistics Future Population Projections (2021)
β	Time discount rate	0.97	$K/Y=3$ (Lee *et al.*, 2019)
σ_u	CRRA factor	1.5	Literature Hong *et al.* (2016) Lee *et al.* (2019)
ρ_x	Autoregressive coefficients of AR(1) heterogeneous labor productivity shocks	0.92	Chang *et al.* (2018) Lee *et al.* (2019)
σ_x	Variance of AR(1) heterogeneous labor productivity shocks	0.05	Lee *et al.* (2019)
ε_i	Average labor productivity by age	-	Wages and working hours by age from the Korean Labor Panel (2019)
Λ^{20-34} Λ^{35-49} Λ^{50-64}	Labor time transition matrix	-	National Pension Enrollment Period Data (2022) by age provided by the Ministry of Health and Welfare; Working hours according to the Korea Labor Panel (2019)
θ	Capital gains share	0.36	Hong *et al.* (2016)
δ	Depreciation rate	0.08	Hong *et al.* (2016)
τ_l	Income tax progressivity	0.0365	Seok and You (2018)
λ_l	Income tax level factor	0.915	Tax revenue as a percentage of GDP in 2022 (5.96%)
τ_k	Corporate tax	0.399	Tax revenue as a percentage of GDP in 2022 (4.79%)
τ_c	VAT	0.068	Tax revenue as a percentage of GDP in 2022 (3.78%)
$\widehat{\tau_{ss}}$	Contribution rate for 2022	0.050	Contribution as a percentage of GDP in 2022 (2.59%)
k	Income Cap Constant	1.519	Capped contributors (13.5%)
α	Pension Income Replacement Coefficient	0.672	$1.2\times\widehat{\tau_{ss}}/0.09$
$\overline{\varphi}$	Basic Pension standard	0.053	Spending as a percentage of GDP in 2022 (0.75%)
z	Total Factor Productivity	0.673	$Y=1$
$\overline{g}$	Government spending as relative to population	0.152	Government budget constraint in the model

TABLE A7. NATIONAL PENSION FUND ALTERNATIVE INVESTMENT PORTFOLIO

Portfolio	Private Equity	Real Estate	Infrastructure	Total
Total (trillion won) End of Q2 ’23	65	49.5	39.4	153.9
International (%) Late ’22	78	86.5	79	-.
International Total (trillion won)	50.7	42.8	31.1	124.6 (13.0%)

Source: Author’s derivation of the percentage of international investments by referring to publicly available data at https://fund.nps.or.kr/.

TABLE A8. NATIONAL PENSION FUND PORTFOLIO

Portfolio	International				Domestic		
	Stocks	Bonds	Alternative Investment		Alternative Investment	Other	
Ratio	30.4%	7.2%	13.0%	50.6%	3.1%	46.3%	49.4%

Source: Author’s derivation of the percentage of foreign investments by referring to publicly available data at https://fund.nps.or.kr/.

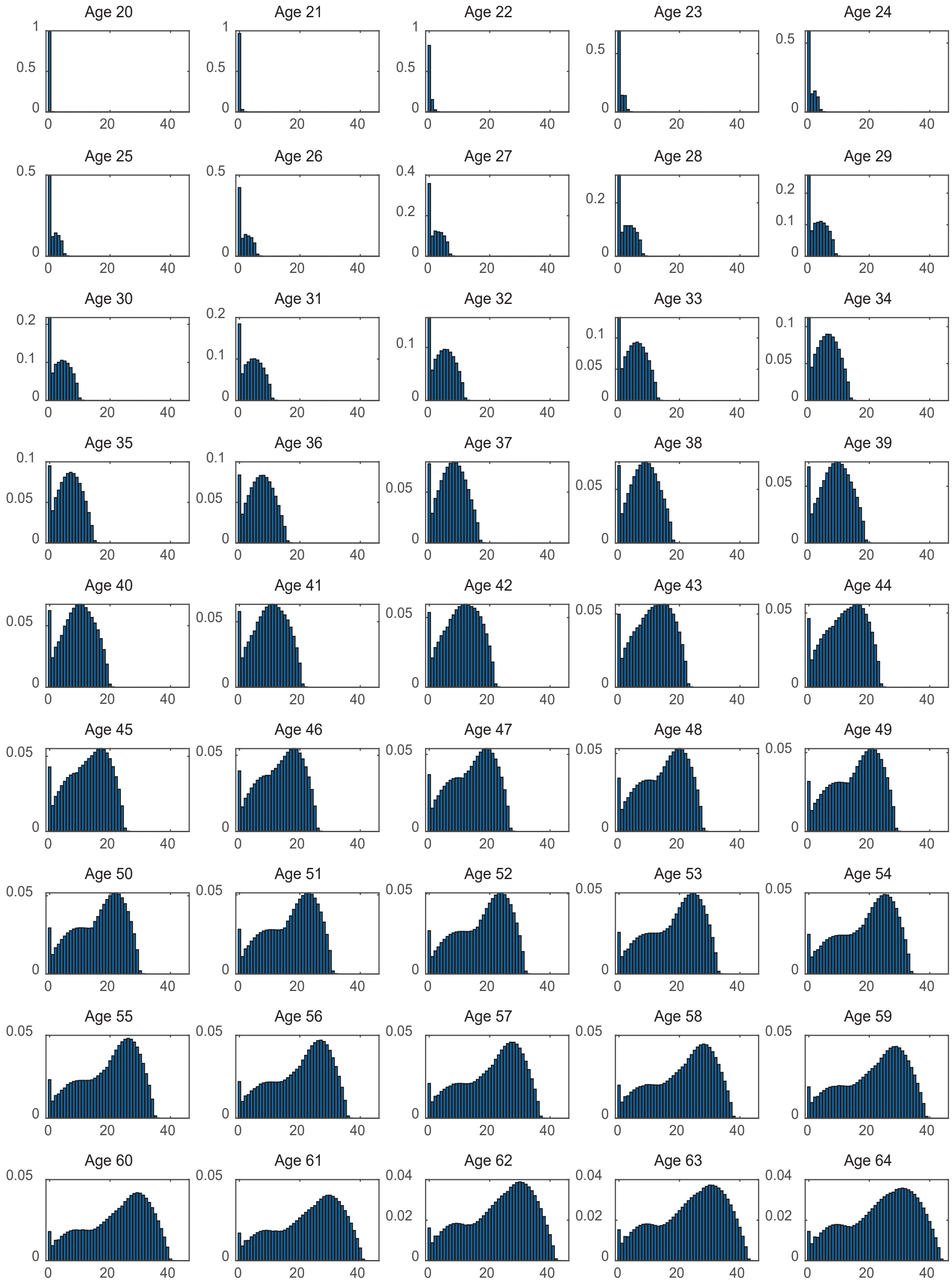

FIGURE A1. CONTRIBUTION PERIOD DENSITY OF THE MODEL

Note: The x-axis in all panels represents the contribution period.

(Unit: population)

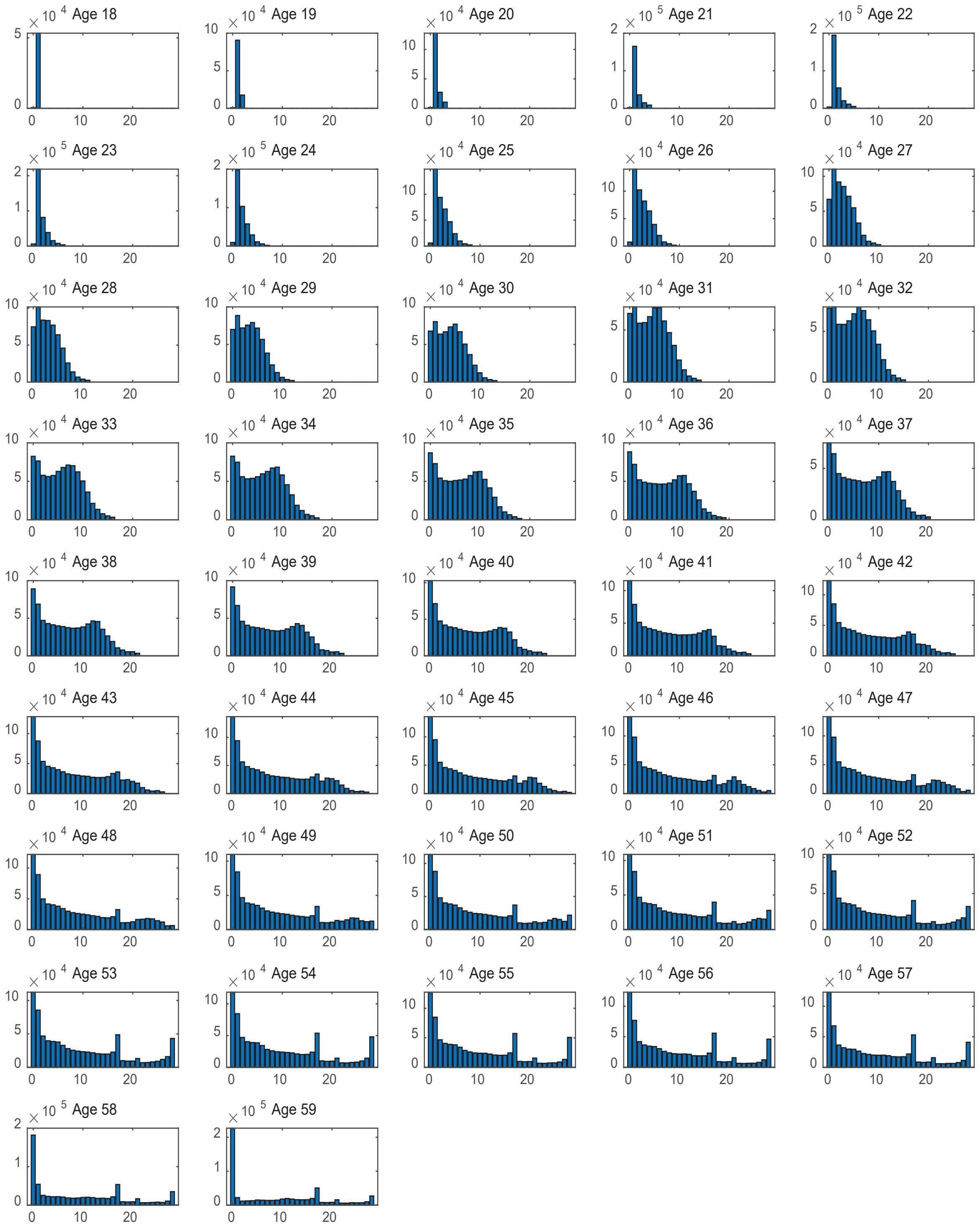

FIGURE A2. POPULATION BY AGE×ENROLLMENT PERIOD IN 2022

Note: The x-axis in all panels represents the contribution period in years.

Source: Author's calculations using 2022 data provided by the Ministry of Health and Welfare.

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Post-closure Career Paths of Self-Employed Workers†

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This study documents self-employed workers' characteristics associated with their career paths after a business closure in order to improve employment insurance for such workers. Utilizing work history data from the Korean Labor & Income Panel Survey, a competing-risks regression model is adopted in order to study how self-employed workers' career paths after unemployment (i.e., business closure) vary according to their characteristics. The findings suggest that the post-closure career paths of self-employed workers are associated with (i) their revenue and income, (ii) the individuals' demographic characteristics, and (iii) the industry in which they operate. Several policy implications for employment insurance that better caters to the needs of self-employed workers are derived from the empirical results.

Key Word: Self-Employment, Unemployment,
Employment Insurance, Career Path
JEL Code: J64, J65, J68

I. Introduction

The economic shock triggered by COVID-19 has underscored the necessity of enhancing employment insurance for self-employed workers. In response, both domestic and international considerations to reinforce social safety nets for self-employed workers are underway (Lee *et al*., 2021; ILO and OECD, 2020; Schoukens

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and Weber, 2020). The Korean government has initiated discussions on expanding employment insurance for self-employed workers, including the announcement of the "National Employment Insurance Roadmap" in December of 2020. Likewise, the OECD continues to recommend the provision of mandatory employment insurance for self-employed workers as a means to address gaps in employment insurance coverage in South Korea (OECD, 2018; 2022).

Although policy discussions on the topic of providing employment insurance for self-employed workers have intensified, economic research to support such discussions is severely lacking. Existing employment insurance policies have already been shown to be limited with regard to their scope and coverage. In South Korea, the number of self-employed workers has reached approximately 5.51 million, representing about 20.2% of the total workforce,[1] but only 0.56% of them are enrolled in employment insurance.[2] Unlike employed workers, self-employed workers are highly heterogeneous in terms of their economic and demographic characteristics. Nevertheless, current employment insurance policies fail to account for such diversity, rendering the system unattractive and thereby ineffective.

In this context, the importance offering carefully designed employment insurance policies that cater to the needs of diverse beneficiaries looms large for policymakers. Existing employment insurance mainly focuses on a single post-unemployment track, which is finding a new job as an employee; however, self-employed workers have shown to take multiple career paths after a business closure. It is therefore crucial to analyze how the probability of a business closure and job transition paths can vary depending on the specific characteristics of self-employed workers.

In order to provide policy implications for employment insurance, this study conducts an empirical analysis of how the probability of a business closure and career transition paths can vary according to the characteristics of self-employed workers. To explore self-employed workers' characteristics and how they are related to their business closure and subsequent career transition paths, I estimate a competing risks model that considers various career transition paths after a business closure. Unlike conventional survival analysis models that consider only one event of interest (i.e., business closure), my model accounts for three post-unemployment job paths as mutually exclusive competing events: (1) restarting a new business after closure, (2) transitioning to wage employment, or (3) transitioning to unemployment or economic inactivity.

The data used in this paper are from the "Korean Labor & Income Panel Survey (KLIPS)," a nationally representative longitudinal survey of individuals residing in urban areas. Annually tracking respondents for over 20 years, the KLIPS provides comprehensive information on individuals' demographic characteristics and labor market outcomes. Another strong point of this survey is its detailed information on the work history of each individual, enabling the tracking of every job transition. Utilizing the work history data, individual-job level data are compiled, consisting of 2,928 observations for self-employed individuals who started a business in 2000 or later.

The empirical findings suggest that the post-closure career paths of self-employed

[1]Statistics Korea, The Economically Active Population Survey.

[2]According to the Ministry of Employment and Labor, there were 30,629 self-employed workers enrolled in employment insurance in 2020. See Section II for more details.

workers are associated with their economic characteristics, demographic characteristics, and the industry in which they operate. First, in terms of economic characteristics, revenue and income are associated in different ways with the probabilities of the post-closure career paths of the self-employed. Specifically, revenue is negatively correlated with the probability of becoming an employee, whereas income shows a stronger negative correlation with both the probability of transitioning to wage employment and the likelihood of unemployment or economic inactivity. The number of employees is another critical economic characteristic: self-employed workers with one or two employees have a lower probability of becoming unemployed or leaving the labor force compared to solo self-employed workers.

Next, among the demographic characteristics of self-employed workers, gender, marital status, and age are significant factors associated with their post-closure career paths. Compared to their male counterparts, female self-employed workers have a lower probability of transitioning to wage employment and a much higher probability of becoming unemployed or economically inactive after closure. Additionally, self-employed individuals with a spouse are less likely to participate in the labor market following a business closure. Age also plays a crucial role in that the probabilities of restarting a business and becoming an employee decrease at a greater age.

Furthermore, the post-closure career paths of the self-employed vary by industry. The probability of restarting a business is relatively high in the wholesale & retail trade, accommodation & food services, finance, real estate activities, and arts/sports/recreation services, compared to the manufacturing sector. Conversely, the probability of transitioning to wage employment after a business closure is relatively low in the transportation & storage industry. Finally, the likelihood of being unemployed or economically inactive post closure is relatively high in the accommodation & food services, real estate activities, and educational services sectors.

From the perspective of policymakers overseeing employment insurance, a potential limitation of this study is the inability of the study to identify the deliberateness of closures, as only insured workers who close their businesses for involuntary reasons are eligible for unemployment benefits. To alleviate this concern, I implement two additional analyses. First, I consider the starting of a new business post closure as a continuation of running a business, and I estimate a model with only two competing risks: (1) transitioning to wage employment and (2) transitioning to unemployment or economic inactivity. Second, based on the assumption that closures due to economic reasons (e.g., bankruptcy, low sales or income, lack of work to be done) are arguably more involuntary than those due to non-economic reasons, I estimate a competing risks regression model considering only closures due to economic reasons as events. The results do not change significantly in a qualitative sense, except for the importance of business income: the association between income and the post-closure career path becomes stronger for closures due to economic reasons, which are presumably more involuntary, as mentioned above.

This paper proceeds as follows. Section II discusses the institutional backgrounds and existing literature on this subject. Section III provides descriptive statistics for the analysis, and Section IV describes the econometrical model used to estimate competing risks related to business closures by self-employed workers. Section V presents empirical results, and Section VI concludes by providing policy implications on the topic of employment insurance for self-employed workers.

II. Institutional Background and Literature Review

A. *Institutional Background*

Among developed nations, South Korea's high proportion of self-employed workers stands out as a characteristic of its labor market composition. This is illustrated in Figure 1, which shows the proportion of the self-employed relative to the total employed population among OECD member countries. As of 2019, the share of the self-employed in total employment stands at 24.6% in South Korea, ranking it the sixth highest among OECD countries.

Since the 2000s, South Korea has witnessed a continuous decrease in the proportion of the self-employed relative to total employment due to a steady increase in the number of employees. This phenomenon, in which wage employment increases and the proportion of the self-employed decreases as the economy grows, is commonly observed in OECD countries (Lee *et al.*, 2020). However, as shown in Figure 2, it is important to note that there has not been much change to the overall number of self-employed workers in South Korea. As of 2021, there are approximately 5.51 million self-employed workers, with no significant changes observed since the 2010s. Furthermore, it should be noted that both the number and proportion of solo self-employees, i.e., self-employed workers without any employees, have increased rapidly since the pandemic. Generally, solo self-employed workers operate small businesses, have higher closure rates, and tend to have lower educational levels, making them economically and socially vulnerable. There are approximately 4.21 million solo self-employed—their number being three times larger than that of self-employed workers with employees, which stands at 1.31 million.

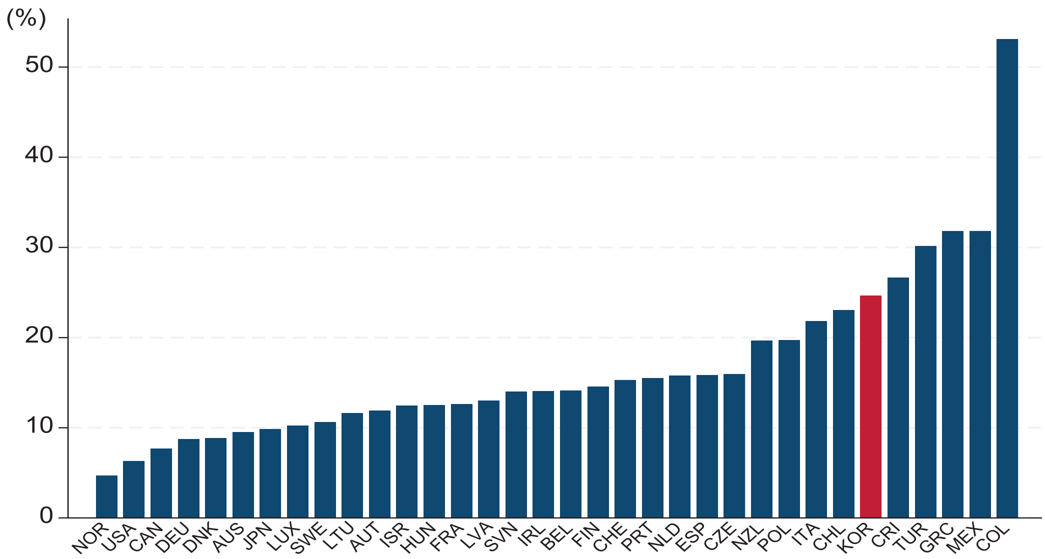

FIGURE 1. SELF-EMPLOYMENT RATES IN OECD COUNTRIES

Note: The self-employment rate is the ratio of self-employed workers to the total employed population. Note that the OECD's definition of self-employment includes unpaid family workers.

Source: Organization for Economic Co-operation and Development (OECD).

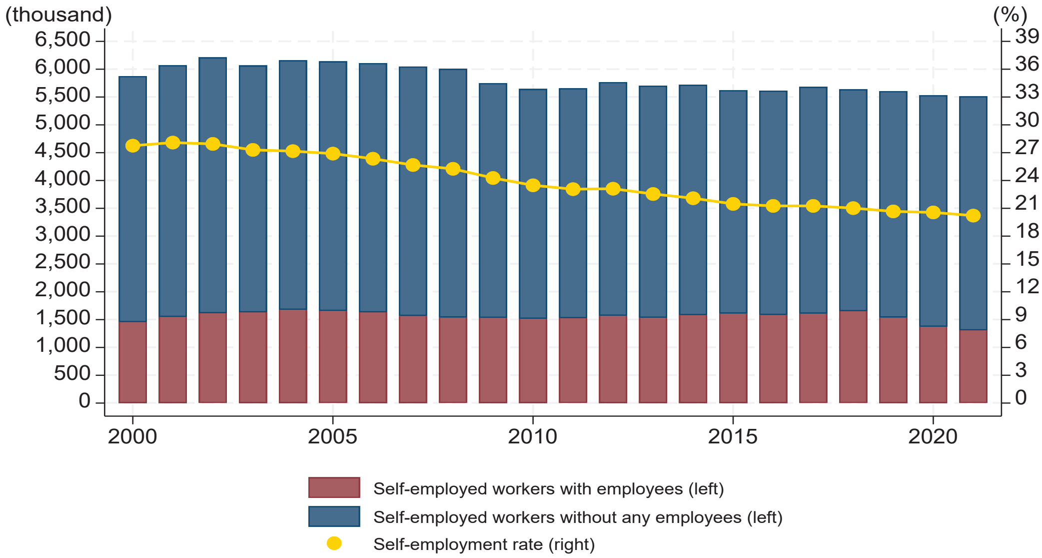

FIGURE 2. SELF-EMPLOYMENT RATE IN THE REPUBLIC OF KOREA OVER TIME

Note: The self-employment rate is the ratio of self-employed workers to the total employed population.

Source: Statistics Korea, The Economically Active Population Survey (EAPS).

TABLE 1—NUMBER OF SELF-EMPLOYED WORKERS COVERED BY EMPLOYMENT INSURANCE

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020
Newly Covered	24,829	5,820	4,918	4,802	5,619	4,245	7,279	10,050	16,251
Total	20,864	17,908	16.985	16,404	16,772	16,455	18,265	22,529	30,629

Source: Ministry of Employment and Labor.

Traditionally, employment insurance has been designed for employees rather than self-employed workers. However, the necessity of employment insurance is not limited to employees. Compared to employees, self-employed workers typically experience more significant income fluctuations due to economic and seasonal variations. This exposes them to constant economic risks such as debt accumulation and business closure, underscoring the need for robust social safety nets. For these reasons, while the South Korean government has been offering employment insurance to them since 2012, employment insurance for the self-employed in its current state is virtually nonexistent, as the enrollment rate is drastically low. As of 2020, only 30,629 self-employed workers were shown to be covered by employment insurance (Table 1), which is a mere 0.56% of the total self-employed population (5.53 million).

There are several reasons for such a low coverage rate. First, unlike employees, self-employed workers are not mandated to enroll in employment insurance. Second, compared to employment insurance for employees, insurance for self-employed workers entails a higher contribution level despite a lower benefit level. The Korean government is endeavoring to promote employment insurance coverage by subsidizing contributions for solo self-employed workers, but the impact remains minimal.

An additional, less highlighted and therefore all the more problematic reason is that current employment insurance fails adequately to take into account the heterogeneity of and among self-employed workers. First, existing employment services provided by employment insurance are tailored to employees, most of whom seek another paid working position after experiencing unemployment. Thus, such services fail to meet the needs of a significant number of self-employed workers who choose to start a new business after a business closure. Second, self-employed workers are a highly heterogeneous group in terms of their demographic and economic characteristics, meaning that their economic risks and their preferences for such risks are also very different. Consequently, insurance premiums, benefit amounts, and incentives such as but not limited to subsidizing insurance premiums need to be differentiated according to their characteristics, which is not the case under the current employment insurance program.

Hence, this study analyzes the various post-closure paths of self-employed workers and thereby highlights the limitations of current employment insurance plans, which fail to consider the heterogeneity of the self-employed workforce. By examining these characteristics of self-employed workers, I explore directions for improving employment insurance for this group, specifically by analyzing how their career paths after unemployment (i.e., business closure) vary according to their characteristics. Based on empirical results, I derive policy implications that better cater to the needs of individual self-employed workers.

B. *Literature Review*

This paper contributes to the body of literature documenting the demographic and economic characteristics of self-employed workers associated with business closures in South Korea. First, Ahn and Sung (2003) conduct an early study analyzing the factors associated with the duration and closure of self-employment ventures in South Korea. Using data from the Korean Labor & Income Panel Survey (KLIPS) spanning from the first year (1998) to the fourth year (2001), they estimate a Cox proportional hazard model. They found that age, education level, marital status, parental self-employment status, industry, revenue, and income are significant variables explaining the business closure risk of self-employed workers. Particularly, public vocational training experience is identified as a positive factor with regard to the duration of self-employment.

Nam (2017) also explores the factors related to self-employment closures in various sectors, including wholesale & retail trade, accommodation & food services, and other personal service industries. he investigates a wide range of variables related to the market environment that could affect the survival of self-employed businesses. Based on data from the Census on Establishments and Cox's proportional hazard model, he finds that certain business characteristics (e.g., tenure and size), economic factors (e.g., regional GDP and the consumer price index), cost factors (e.g., rent, loan interest rates, and fixed labor costs), and regional characteristics (e.g., population, per capita income, and the number of similar businesses in the area) are significantly related to self-employed business closure.

Choi (2018) investigates the factors affecting self-employment closures among middle-aged and elderly individuals (aged 45 and above) using data from the Korean

Longitudinal Study of Aging (KLoSA), ranging from the first survey in 2006 to the fifth survey in 2014. Similar to previous studies, Choi (2018) employs Cox's proportional hazard model, finding that gender, age, education level, industry, and job satisfaction are correlated with the risk of business closure for self-employed workers.

Moon and Park (2020) also focus on middle-aged and elderly self-employed workers, utilizing the KLoSA data from the first survey in 2006 to the sixth survey in 2016. Unlike previous studies, their study employs a competing risks regression model to distinguish between reasons for exiting self-employment, specifically managerial difficulties versus other reasons. Their results suggest that exits from self-employment among middle-aged and elderly self-employed workers are associated with gender, age, the presence of children, education level, net income, and employment status. However, regarding exits due to managerial difficulties, tenure in the same industry is related more strongly to a lower exit risk level compared to other factors such as gender, age, and education. Furthermore, middle-aged and elderly individuals who leave self-employment due to managerial difficulties are less likely to re-enter the labor market.

Lim and Kim (2021) use extensive administrative data primarily sourced from the Statistical Business Registers (SBR). Employing a time-dependent Cox model, their study investigates factors linked to the risk of business closure. Their findings indicate that the risk of closure is negatively associated with having a joint venture partner, owning a franchise outlet, employing a larger number of workers, and generating higher revenue.

The aforementioned studies generally focus on exploring factors related to the duration of self-employment and the occurrence of a closure. However, considering policymakers aiming to implement employment insurance for self-employed workers, it is necessary to analyze not only closures but also various career paths *after* the closures (such as restarting a business, transitioning to wage employment, unemployment, or remaining out of the labor force). Therefore, in this analysis, I aim to document how post-closure career transition states vary according to the characteristics of self-employed workers ultimately to derive policy implications for providing self-employed workers with an employment safety net.

III. Data and Descriptive Statistics

In this paper, I utilize data from the Korean Labor & Income Panel Survey (KLIPS) to document the career transitions of self-employed workers after their businesses close. The KLIPS is a nationally representative longitudinal survey of individuals aged 15 and older residing in urban areas. It has been tracking respondents annually since its inception in 1998, enabling researchers to construct individual-level panel data spanning over 20 years. Furthermore, the survey offers comprehensive information on individuals' (and households') demographic characteristics and labor market outcomes, such as their employment, work status, income (and revenue for self-employed workers), and industry characteristics.

Another benefit of the KLIPS is that it provides the work history of each individual in the survey, enabling the tracking of job transitions. Exploiting work history data combined with individual data and household data from the first to the twenty-third waves (which correspond to the years 1998 to 2020), I construct individual-job level data for self-employed workers aged 15 to 64 who were self-employed in a business in 2000 or later. Employers with 50 or more employees are excluded because the main interest of this paper is small businesses. Given that individuals may hold multiple jobs simultaneously, only the primary job reported at least once by the respondent is included in the analysis data. Therefore, in cases where two or more primary jobs are observed simultaneously, all primary jobs are included in the sample.[3] Given the need here to identify self-employed workers' career transitions in subsequent years after their businesses close, the most recent observations in the survey year 2020 are excluded from the analysis. See Table A1 for details pertaining to the sample construction process.

The descriptive statistics of the sample are presented in Table 2. The dataset comprises a total of 2,928 individual-job observations. When self-employed workers are grouped according to whether they have any employees, 1,981 are categorized as solo self-employed workers (i.e., having 0 employees) and 947 as employers with 1 or more employees. Both the annual revenue and monthly income of self-employed workers are positively correlated with having any employees; while the average annual revenue for the entire sample is approximately 89.3 million won, the revenue of solo self-employed workers averages about half of this, at approximately 49.3 million won. Regarding average monthly income, solo self-employed workers and employers have figures of 1.92 million won and 3.23 million, respectively.

When considering the demographic characteristics of self-employed workers, the proportion of women is 39% and the overall average age is 44. It appears that self-employed workers with a spouse or more family members are more likely to hire employees. In terms of education level, the proportion of those with a high school diploma or less is larger among solo self-employed workers (60%) than employers (46%). Conversely, the proportion of those with at least a college degree is smaller for those without any employees.

Regarding the distribution of industries, wholesale & retail trade (22%) and accommodation & food service activities (17%) account for the largest proportions, followed by education (9%), transportation & storage (8%) and manufacturing (7%). Compared to employers, solo self-employed workers take up a higher proportion in agriculture & forestry, wholesale & retail trade, transportation & storage, finance, as well as education. Conversely, among employers, there is a higher proportion in manufacturing, accommodation & food service activities, business services, and health & social welfare services compared to solo self-employed workers.

In the sample, there are 1,430 observations whose closures are observed once during the period of analysis. In the KLIPS work history questionnaire, respondents for which a job status change was observed were asked why they left/quit their jobs. Using this information, Table 3 summarizes the reasons behind the business closures of the self-employed workers in the sample according to their post-closure career

[3]There are relatively few individuals with multiple primary jobs; only seven individuals are observed in the sample here, which includes 2,928 individual-job observations.

TABLE 2—DESCRIPTIVE STATISTICS ACCORDING TO THE NUMBER OF EMPLOYEES

Variables	0 Employees		1 or More Employees		Total	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Annual Revenue (million won)	49.3	(110.1)	172.9	(349.5)	89.3	(225.9)
Monthly Income (million won)	1.92	(1.84)	3.23	(3.67)	2.34	(2.65)
Number of Employees	0.00	(0.00)	3.24	(4.45)	1.05	(2.95)
Female	0.42	(0.49)	0.34	(0.47)	0.39	(0.49)
Age	44.14	(10.36)	42.76	(9.10)	43.69	(9.99)
Spouse	0.76	(0.42)	0.82	(0.38)	0.78	(0.41)
Number of Family Members	3.29	(1.25)	3.49	(1.19)	3.36	(1.24)
Education Level						
high school diploma or less	0.60	(0.49)	0.46	(0.50)	0.56	(0.50)
associate degree	0.17	(0.38)	0.16	(0.37)	0.17	(0.38)
bachelor degree	0.20	(0.40)	0.35	(0.48)	0.25	(0.43)
master's degree or more	0.02	(0.15)	0.03	(0.16)	0.02	(0.15)
Industry						
manufacturing	0.05	(0.22)	0.10	(0.30)	0.07	(0.25)
agriculture & forestry	0.08	(0.27)	0.01	(0.12)	0.06	(0.23)
fishing	0.01	(0.08)	0.00	(0.05)	0.01	(0.07)
construction	0.05	(0.21)	0.05	(0.22)	0.05	(0.22)
wholesale & retail trade	0.23	(0.42)	0.18	(0.39)	0.22	(0.41)
accommodation & food services	0.13	(0.33)	0.27	(0.44)	0.17	(0.38)
transportation & storage	0.10	(0.30)	0.03	(0.16)	0.08	(0.26)
information & communication	0.01	(0.09)	0.01	(0.09)	0.01	(0.09)
finance	0.05	(0.21)	0.01	(0.10)	0.03	(0.18)
real estate activities	0.04	(0.20)	0.03	(0.18)	0.04	(0.19)
business services	0.04	(0.19)	0.07	(0.26)	0.05	(0.22)
education	0.10	(0.31)	0.06	(0.23)	0.09	(0.28)
health & social work activities	0.00	(0.06)	0.04	(0.20)	0.02	(0.13)
arts/sports/recreation services	0.03	(0.18)	0.05	(0.22)	0.04	(0.19)
other personal services	0.09	(0.28)	0.08	(0.27)	0.08	(0.28)
Observations	1,981		947		2,928	

Note: Standard deviations (S.D.) in parentheses. The sample is from the Korean Labor & Income Panel Survey (KLIPS). It includes self-employed workers who are aged 19 to 64 and run a business for a specific period between 2001 and 2019. There are 2,928 individual-job observations.

paths, revealing that these closures are mainly due to economic reasons: 59.09% result from a bankruptcy, low sales, low income, or a lack of work to be done. Family-related or personal reasons (17.2%) and searching for a better job (15.87%) are correspondingly the second and third most commonly cited reasons.

The reasons for closures are distributed differently across post-closure career paths. First, the share of the self-employed who close their original businesses to start a new business is largest among those who *actually* restart a business post closure (22.86%). This implies that a significant portion of closures could be voluntary, and this is more the case for those who restart new businesses after closing their old business. Second, the percentage citing economic reasons is greater for those who become an employee post closure than those on other career paths. This suggests that the decision to be an employee post closure is less likely to be voluntary.

TABLE 3—REASONS FOR BUSINESS CLOSURES

Reason for Leaving/Quitting Job	Post-closure Career Paths: Restarting a Business	Employee	Unemployment or Economic Inactivity	Total
Economic Reasons				
Bankruptcy, closing, or shutdown of the workplace	18 (4.52)	66 (11.58)	26 (5.63)	110 (7.69)
Lack of work to be done	53 (13.32)	101 (17.72)	46 (9.96)	200 (13.99)
Low sales	106 (26.63)	169 (29.65)	114 (24.68)	389 (27.20)
Low income	37 (9.30)	60 (10.53)	49 (10.61)	146 (10.21)
Searching for a Better Job				
To start a new business	91 (22.86)	16 (2.81)	13 (2.81)	120 (8.39)
Left for a better job	41 (10.30)	58 (10.18)	8 (1.73)	107 (7.48)
Working Conditions, Skill Match, or Future Prospect				
Temporary work/no future prospect	3 (0.75)	18 (3.16)	6 (1.30)	27 (1.89)
Not matched with ability, knowledge, or skill	2 (0.50)	10 (1.75)	4 (0.87)	16 (1.12)
Undesirable work hours or working conditions	7 (1.76)	8 (1.40)	7 (1.52)	22 (1.54)
Family-Related or Personal Reasons				
Family-related reasons such as marriage, nursing for family members, etc.	8 (2.01)	20 (3.51)	66 (14.29)	94 (6.57)
Health problems or old age	21 (5.28)	20 (3.51)	86 (18.61)	127 (8.88)
To study	1 (0.25)	8 (1.40)	13 (2.81)	22 (1.54)
Military service	1 (0.25)	1 (0.18)	1 (0.22)	3 (0.21)
Other Reasons	9 (2.26)	15 (2.63)	23 (4.98)	47 (3.29)
Total	398 (100.00)	570 (100.00)	462 (100.00)	1,430 (100.00)

Note: Frequencies and percentages (in parentheses) of each reason for closing a business. The sample comes from the Korean Labor & Income Panel Survey (KLIPS). Among the 2,928 individual-job observations in the sample of this study (see Table 2), 1,430 observations were found to have ever closed their business.

Last, the share of closures due to family-related or personal reasons is larger for those who become unemployed or economically inactive after the closure compared to those who restart a business or become an employee.

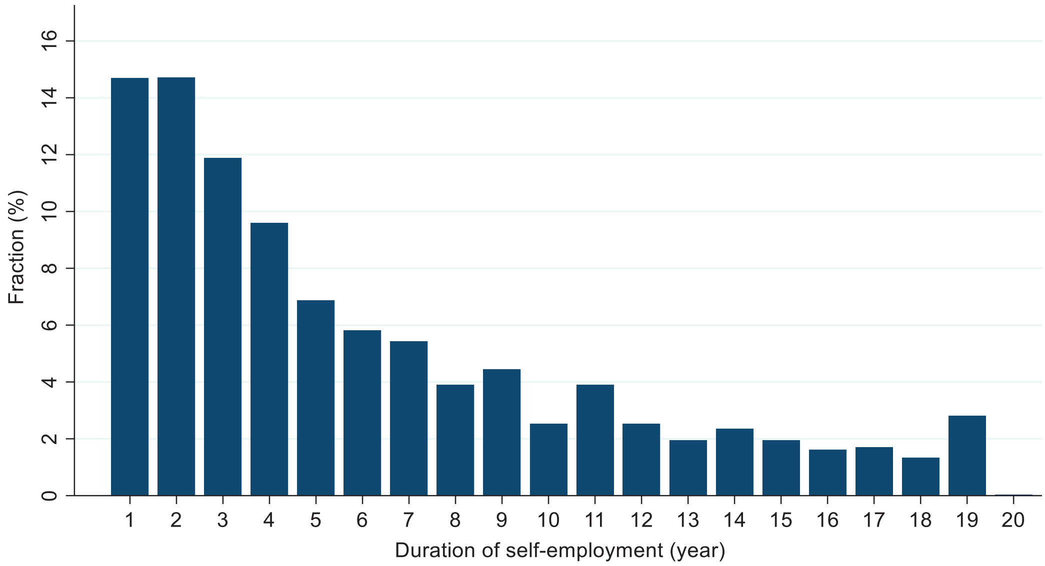

FIGURE 3 DISTRIBUTION OF SELF-EMPLOYMENT DURATIONS

Figure 3 illustrates the distribution of the duration of self-employed businesses in the sample. As is well known, the distribution is right-skewed: the duration for half of the self-employed workers (50.89%) is equal to or less than four years. This reflects the fact that many self-employed workers become unemployed within several years after starting a new business. However, it should be noted that the sample is not limited to self-employed workers who have ever closed their business but also includes those whose businesses are not yet closed: 51.16% of the sample (1,498 observations) is right-censored. Therefore, the results in Figure 3 should not be interpreted as the survival rate of self-employed businesses. Given the right-censored sample, I thus deploy a survival analysis model, as introduced in the next section.

IV. Estimation Model

In this analysis, I estimate a competing risks regression model, which simultaneously considers various post-closure career transition paths, in order to explore factors associated with closures and subsequent career transitions among self-employed workers. Unlike simple survival analysis models that focus solely on the business closure as the sole event of interest, this analysis considers three mutually exclusive post-unemployment job states—restarting a business, transitioning to wage employment, and unemployment or remaining out of the labor force—as pairwise disjoint competing events. Here I denote the duration of self-employment as a random variable T. Additionally, I represent the post-unemployment job state using a random variable, J, with possible values (events of interest) denoted as $j \in$ {restarting a business, wage employment, unemployment or remaining out of the labor force}. The hazard of the sub-distribution for an individual competing event is defined as follows (Fine and Gray, 1999):

$$\lambda_j(t) \equiv \lim_{dt \to 0} \frac{P\{t \le T < t + dt,\ J = j \mid T \ge t\ or\ (T < t\ and\ J \ne j)\}}{dt}$$

In other words, the sub-distribution hazard for an event of interest j at time t is the probability that event j occurs at time t for self-employed workers who have either continued their self-employment business up to time t or experienced another competitive event before time t.

Using the sub-distribution hazard defined above, the cumulative sub-hazard $\Lambda_j(t)$, the survival function $S_j(t)$, and the cumulative incidence estimator $CIF_j(t)$ for a specific event j can be derived as follows:

$$\Lambda_j(t) = \int_0^t \lambda_j(u)du$$

$$S_j(t) = e^{-\Lambda_j(t)}$$

$$CIF_j(t) = 1 - S_j(t)$$

The competing risks regression model to be estimated assumes the sub-hazard of a specific event as a function of both the baseline sub-hazard $\lambda_{0,j}(t, X_i)$ and the observable characteristics of self-employed workers:

$$\lambda_j(t, X_i) = \lambda_{0,j}(t)\exp(X_i\beta) = \lambda_{0,j}(t)\exp(\beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_K x_{Ki}),$$

where the baseline sub-hazard $\lambda_{0,j}(t)$ refers to the value that the sub-hazard takes when all characteristics of self-employed workers have a value of 0. Because the sub-hazard of a specific event of interest j is the product of the baseline sub-hazard and the exponential function $e^{X_i\beta}$, the value of the sub-hazard increases as the values of self-employed workers' characteristics increase.

To estimate the model, I exploit the semi-parametric approach proposed by Cox (1972), which does not parametrize the specific form of the baseline sub-hazard rate. While the parameters targeted for estimation are the coefficients of observable characteristics (β), I report the sub-hazard ratios (SHR), which are exponentiated coefficients, for ease of interpretation:

$$SHR_{k,j} \equiv \frac{\lambda_j(t, X_i \mid x_{ki} = \overline{x}_{ki} + 1)}{\lambda_j(t, X_i \mid x_{ki} = \overline{x}_{ki})} = \exp(\beta_k)$$

Given certain values of the characteristics of self-employed workers $\overline{X}_i = (\overline{x}_{1i}, \overline{x}_{2i}, \cdots, \overline{x}_{Ki})$, the sub-hazard ratio of a characteristic for a specific event is defined as the ratio of the sub-distribution hazard when the value of that characteristic increases by one unit to the original sub-distribution hazard. Therefore, if the sub-hazard ratio is greater than 1, it indicates a positive correlation between that characteristic and the probability of the event. If it is less than 1, it indicates a negative correlation.

It should be noted that the sub-hazard ratio is not for comparisons between different competing events. For example, if the sub-hazard ratio $SHR_{k,j}$ takes a value of 1.05, it means that the probability that event j occurs increases by 5% when characteristic x_k increases by one unit. This does not mean that the probability of event j increases (or decreases) compared to the other competing events.

V. Empirical Results

A. *Main Results*

Figure 4 displays the cumulative incidence of each competing risk: being an employee, starting a new business, and being unemployed or remaining out of the labor force. For each post-closure career path, the cumulative probability that a self-employed worker will close his/her business increases steadily over the age of the business, but this rate slows down over time. Among the post-closure career paths, self-employed workers are more likely to choose to be an employee than take one of the other paths; the probability of closing the business and then becoming an employee within five company years is about 12.07%. The probabilities are similar between the other two competing risks; the probabilities of starting a new business and being unemployed or economically inactive are approximately 7.43% and 8.33%, respectively.

Table 4 presents the estimated results of the competing risks regression model. The first two rows examine the sizes of self-employed businesses in terms of their annual revenue and monthly income, respectively. When the annual revenue increases by one million won, the probability of closing an existing business and

FIGURE 4. CUMULATIVE INCIDENCES OF CAREER PATHS OF SELF-EMPLOYED WORKERS POST-CLOSURE

Note: Cumulative incidence of each competing risk (i.e., career paths after closure) of self-employed workers.

TABLE 4—COMPETING RISKS REGRESSIONS BY POST-CLOSURE CAREER PATH

Variables	Post-Closure Career Paths					
	Restarting a Business		Employee		Unemployment or Economic Inactivity	
	SHR	(S.E.)	SHR	(S.E.)	SHR	(S.E.)
Annual Revenue (million won)	1.002	(0.002)	0.991**	(0.004)	1.000	(0.003)
Monthly Income (million won)	1.010	(0.044)	0.954***	(0.014)	0.958**	(0.017)
Number of Employees						
one or two employees	1.199	(0.152)	0.933	(0.103)	0.653***	(0.083)
three or more employees	1.217	(0.222)	0.829	(0.125)	0.838	(0.144)
Female	0.893	(0.111)	0.784**	(0.077)	2.364***	(0.270)
Age	0.982***	(0.006)	0.973***	(0.005)	1.009	(0.006)
Spouse	0.870	(0.129)	0.759***	(0.079)	1.052	(0.138)
Number of Family Members	1.042	(0.046)	0.981	(0.035)	1.022	(0.043)
Education Level						
associate's degree	0.885	(0.144)	1.159	(0.143)	1.003	(0.157)
bachelor's degree	1.225	(0.169)	1.067	(0.128)	1.143	(0.160)
master's degree or more	0.779	(0.363)	1.231	(0.344)	1.500	(0.422)
Industry						
agriculture & forestry	1.090	(0.415)	0.600	(0.192)	1.375	(0.455)
fishing	0.728	(0.765)	1.434	(0.798)	0.476	(0.512)
construction	1.593	(0.521)	1.305	(0.320)	1.014	(0.375)
wholesale & retail trade	1.987**	(0.527)	1.168	(0.230)	1.461	(0.360)
accommodation & food services	2.362***	(0.636)	1.247	(0.260)	1.809**	(0.451)
transportation & storage	1.557	(0.497)	0.611*	(0.165)	1.219	(0.399)
information & communication	1.381	(0.834)	1.393	(0.508)	1.362	(0.792)
finance	3.699***	(1.218)	1.078	(0.310)	1.070	(0.371)
real estate activities	2.513***	(0.892)	0.718	(0.234)	2.077**	(0.641)
business services	0.697	(0.296)	1.017	(0.268)	1.209	(0.418)
education	0.959	(0.323)	0.909	(0.212)	1.862**	(0.495)
health & social work activities	1.498	(0.721)	1.572	(0.532)	0.596	(0.384)
arts/sports/recreation services	2.268***	(0.702)	1.300	(0.336)	1.623	(0.528)
other personal services	1.549	(0.480)	0.860	(0.206)	1.559	(0.431)
Regional & Year Fixed Effects	Y		Y		Y	
Observations	2,928		2,928		2,928	
Chi-Squared Statistics (D.F.=59)	222.07***		1288.88***		689.30***	

Note: The outcome variable is the duration of a self-employed business. SHR indicates the sub-hazard ratio. Standard errors (S.E.) in parentheses. D.F. indicates degrees of freedom. The sample includes self-employed workers aged 19 to 64 and who run a business for a specific period between 2001 and 2019. There are 2,928 individual-job observations. Number of employees, female, spouse, education level, and industries are indicators. The reference group for the indicators are zero employees, male, no spouse, a high school diploma or less, and manufacturing, respectively. *** p<0.01, ** p<0.05, * p<0.10.

transitioning to wage employment decreases by 0.9%, whereas the probabilities of the other post-closure career paths do not change by statistically significant amounts. These results imply that self-employed workers with larger revenue amounts are less likely to be an employee after an incidence of closure.

Compared to annual revenue, monthly income is a factor more closely associated with post-closure career paths of the self-employed. A one million won increase in monthly income is associated with a 4.6% decrease in the probability of transitioning to becoming an employee and a 4.2% decrease in the probability of remaining unemployed or economically inactive. On the other hand, the post-closure career path to restart a business is not significantly associated with monthly income.

Regarding the workforce size, employers with employees are less likely to become unemployed or economically inactive. Compared to self-employed workers without any employees, the probability of being unemployed or remaining out of the labor force decreases by 34.7% with one or two employees. Although the estimates of the coefficients for the indicators of having any employees are not statistically significant in the case of transitioning to a new business, their large magnitudes suggest that self-employed workers with larger businesses, in terms of the number of employees, are more likely to start another business – even after the closure.

The rows in Table 4 below denote the demographic characteristics of self-employed workers. Compared to male self-employed workers, female self-employed workers have a lower probability of transitioning to wage employment but show a much higher probability of becoming unemployed or economically inactive after a closure: the probability of being unemployed or economically inactive after a closure is 2.36 times higher for female self-employed workers than for their male counterparts. This may partly stem from the fact that the threshold for finding a job is higher for women, but it is also likely due to them having spouses who engage in income-generating activities. As the estimates show, self-employed workers with spouses are less likely to participate in the labor market after an incidence of closure compared to those without spouses. Age is another significant factor: being one year older is associated with a 1.8% decrease in the probability of restarting a business and a 2.7% decrease in the probability of being an employee. With regard to family size and education level, their associations with post-closure career paths are not statistically significant.

Furthermore, the post-closure career paths of the self-employed vary by industry. First, compared to the manufacturing sector, the probability of restarting a business is higher for those in wholesale & retail trade, accommodation & food services, finance, real estate activities, and arts/sports/recreation services. Next, the probability of choosing wage employment after a closure is significantly lower for those in transportation & storage. Last, the probability of transitioning to unemployment or becoming economically inactive after a closure is relatively high for those engaging in accommodation & food services, real estate activities, and educational services.

B. *Further Analyses*

A potential limitation of this study for policymakers of employment insurance for self-employed workers is that it does not identify the deliberateness of the closures observed in the data (i.e., whether a closure was due to voluntary or involuntary reasons). As insured workers are eligible for unemployment benefits only if they lose their jobs due to involuntary reasons (e.g. being dismissed), it would be more informative for policymakers if involuntary closures (unemployment) were observed.

To alleviate this concern, I implement two additional analyses. First, I re-estimate the competing risks regression model regarding the starting of a new business as a continuation of running a business so that there are only two competing risks:

(i) wage employment and (ii) unemployment or remaining out of the labor force. Arguably, the transition to starting a new business is more likely to be a voluntary decision compared to the transition to wage employment or to being unemployed. The reasons for closures in the sample (Table 3) support this assumption.

The results reported in Table 5 are quantitatively and qualitatively similar to the estimates in Table 4. Although the magnitudes of most estimates are quite similar, several significant differences are observed in industry dummies. Compared to their counterparts in manufacturing, self-employed workers in accommodation & food services are more likely to become an employee after closing their business. Similarly, self-employed workers engaged in wholesale & retail trade, arts/sports /recreation services, and other personal services are more likely to become unemployed or economically inactive. The cumulative incidences of competing risks displayed in Figure A1 are also quite similar to those in Figure 4.

Second, I document quitting self-employment due to economic reasons to proxy an involuntary closure. More specifically, only closures resulting from economic reasons (in Table 3) are regarded as an event (i.e., failure), while other closures due to non-economic reasons (which are arguably more voluntary closures) are regarded as survived cases. There are two justifications for this: first, in reality, a closure due to economic reasons is highly likely to be involuntary, and second, for self-employed workers, economic reasons such as significant declines in revenue are a core eligibility requirement for receiving unemployment benefits. Although closures due to economic reasons in the data are not an exact measure of eligibility requirements for unemployment benefit, documenting such closures would help to clarify which self-employed workers could be covered by employment insurance.

Figure A2 illustrates the cumulative incidences of career paths after a closure due to economic reasons. Compared to the results in Figure 4, the probability of a closure is lower for every career path, but this is much more the case for the paths of starting a new business and being unemployed or remaining out of the labor force, which suggests that the share of closures due to non-economic reasons is larger for these two paths than for the path of becoming an employee (Table 3).

Despite such a stark difference in the cumulative incidences, the estimation results shown in Table 6 are not much different from the main results in Table 4 in a qualitative sense. The only economically significant difference is found in monthly income. While it is not a significant factor in the path to restart a business after a closure in Table 4, it becomes significantly correlated with the probability of the career path when only closures due to economic reasons are considered: a one million won increase in monthly income is associated with a 4.4% decrease in the probability of starting a new business after a closure. This result implies that income is a factor closely associated with involuntary closures due to economic reasons.

TABLE 5—COMPETING RISKS REGRESSIONS BY POST-CLOSURE CAREER PATH WITHOUT RESTARTING A BUSINESS

Variables	Post-Closure Career Paths			
	Employee		Unemployment or Economic Inactivity	
	SHR	(S.E.)	SHR	(S.E.)
Annual Revenue (million won)	0.992**	(0.003)	1.001	(0.003)
Monthly Income (million won)	0.936***	(0.014)	0.936***	(0.017)
Number of Employees				
one or two employees	0.926	(0.102)	0.666***	(0.084)
three or more employees	0.844	(0.128)	0.845	(0.145)
Female	0.778**	(0.076)	2.398***	(0.274)
Age	0.971***	(0.005)	1.007	(0.006)
Spouse	0.750***	(0.079)	1.052	(0.139)
Number of Family Members	0.981	(0.034)	1.016	(0.043)
Education Level				
associate's degree	1.168	(0.145)	0.990	(0.156)
bachelor's degree	1.112	(0.131)	1.169	(0.162)
master's degree or more	1.185	(0.332)	1.425	(0.408)
Industry				
agriculture & forestry	0.613	(0.198)	1.374	(0.458)
fishing	1.430	(0.793)	0.469	(0.505)
construction	1.408	(0.347)	1.092	(0.405)
wholesale & retail trade	1.278	(0.254)	1.596*	(0.396)
accommodation & food services	1.427*	(0.300)	2.070***	(0.519)
transportation & storage	0.651	(0.177)	1.291	(0.426)
information & communication	1.541	(0.556)	1.440	(0.833)
finance	1.321	(0.375)	1.240	(0.433)
real estate activities	0.832	(0.263)	2.561***	(0.799)
business services	1.004	(0.267)	1.205	(0.421)
education	0.917	(0.216)	1.899**	(0.511)
health & social work activities	1.705	(0.579)	0.637	(0.411)
arts/sports/recreation services	1.430	(0.374)	1.813*	(0.589)
other personal services	0.911	(0.218)	1.622*	(0.451)
Regional & Year Fixed Effects	Y		Y	
Observations	2,928		2,928	
Chi-Squared Statistics (D.F.=59)	987.05***		612.79***	

Note: The outcome variable is the duration of a self-employed business. SHR indicates the sub-hazard ratio. Standard errors (S.E.) in parentheses. D.F. indicates degrees of freedom. The sample includes self-employed workers aged 19 to 64 and who run a business for a specific period between 2001 and 2019. There are 2,928 individual-job observations. Number of employees, female, spouse, education level, and industries are indicators. The reference group for the indicators are zero employees, male, no spouse, a high school diploma or less, and manufacturing, respectively. *** p<0.01, ** p<0.05, * p<0.10.

TABLE 6—COMPETING RISKS REGRESSIONS BY POST-CLOSURE CAREER PATH FOR CLOSURES DUE TO ECONOMIC REASONS

Variables	Post-closure Career Paths: Restarting a Business SHR	(S.E.)	Employee SHR	(S.E.)	Unemployment or Economic Inactivity SHR	(S.E.)
Annual Revenue (million won)	1.000	(0.003)	0.993*	(0.004)	0.997	(0.006)
Monthly Income (million won)	0.956**	(0.018)	0.945***	(0.015)	0.955**	(0.020)
Number of Employees						
one or two employees	1.117	(0.211)	0.982	(0.128)	0.651**	(0.118)
three or more employees	1.271	(0.306)	0.749	(0.136)	0.770	(0.200)
Female	0.867	(0.140)	0.689***	(0.086)	1.681***	(0.249)
Age	0.985*	(0.009)	0.980***	(0.006)	1.016*	(0.008)
Spouse	0.740	(0.152)	0.779*	(0.102)	0.786	(0.147)
Number of Family Members	1.015	(0.063)	0.980	(0.042)	1.082	(0.065)
Education Level						
associate's degree	0.833	(0.191)	1.119	(0.170)	0.952	(0.219)
bachelor's degree	0.941	(0.184)	1.029	(0.148)	1.031	(0.200)
master's degree or more	0.840	(0.498)	0.955	(0.396)	1.940	(0.793)
Industry						
agriculture & forestry	1.220	(0.628)	0.274***	(0.119)	0.697	(0.326)
construction	1.648	(0.751)	1.213	(0.318)	0.685	(0.326)
wholesale & retail trade	1.910*	(0.696)	1.006	(0.211)	1.422	(0.419)
accommodation & food services	2.281**	(0.835)	1.050	(0.238)	1.621	(0.499)
transportation & storage	0.987	(0.482)	0.436***	(0.133)	0.295**	(0.172)
finance	1.911	(0.945)	0.940	(0.313)	0.888	(0.420)
real estate activities	3.048**	(1.338)	0.674	(0.239)	2.392**	(0.879)
business services	0.310	(0.240)	0.953	(0.273)	0.687	(0.344)
education	0.749	(0.378)	0.589*	(0.176)	0.860	(0.322)
arts/sports/recreation services	2.180*	(0.956)	1.063	(0.306)	1.133	(0.485)
other personal services	1.426	(0.615)	0.534**	(0.151)	0.958	(0.355)
Regional & Year Fixed Effects	Y		Y		Y	
Observations	2,928		2,928		2,928	
Chi-Squared Statistics (D.F.=59)	7662.25***		1071.31***		12034.20***	

Note: The outcome variable is the duration of a self-employed business. SHR indicates the sub-hazard ratio. Standard errors (S.E.) in parentheses. D.F. indicates degrees of freedom. The sample includes self-employed workers aged 19 to 64 and who run a business for a specific period between 2001 and 2019. There are 2,928 individual-job observations. Number of employees, female, spouse, education level, and industries are indicators. The reference group for the indicators are zero employees, male, no spouse, a high school diploma or less, and manufacturing, respectively. Estimates for the following industries with few observations are not reported: fishing, information & communication, and health & social work activities. *** p<0.01, ** p<0.05, * p<0.10.

C. *Heterogeneity by Business Size*

Because the economic and demographic characteristics of self-employed workers vary depending on whether or not they have employees (as shown in Table 2), it is important to examine whether the associations between these characteristics and their post-closure career paths also differ based on whether they have any employees. The competing risks regression analysis presented in Table 4 is replicated for self-employed workers without any employees (Table 7) and for those with employees (Table 8).

TABLE 7—COMPETING RISKS REGRESSIONS BY POST-CLOSURE CAREER PATH, SOLO SELF-EMPLOYMENT

Variables	Post-closure Career Paths					
	Restarting a Business		Wage Employment		Unemployment or Economic Inactivity	
	SHR	(S.E.)	SHR	(S.E.)	SHR	(S.E.)
Annual Revenue (million won)	1.007***	(0.002)	0.992	(0.005)	0.999	(0.010)
Monthly Income (million won)	1.006	(0.037)	0.902**	(0.039)	0.843***	(0.041)
Female	0.914	(0.138)	0.749**	(0.092)	2.229***	(0.306)
Age	0.973***	(0.008)	0.971***	(0.006)	1.006	(0.007)
Spouse	0.823	(0.152)	0.843	(0.106)	1.053	(0.157)
Number of Family Members	1.083	(0.061)	0.977	(0.041)	1.042	(0.051)
Education Level						
associate's degree	0.848	(0.168)	1.236	(0.179)	0.892	(0.159)
bachelor's degree	1.171	(0.195)	1.124	(0.167)	1.048	(0.176)
master's degree or more	0.421	(0.304)	0.864	(0.312)	1.549	(0.476)
Industry						
agriculture & forestry	1.036	(0.466)	0.495*	(0.178)	1.162	(0.425)
fishing	0.727	(0.819)	1.148	(0.681)	0.419	(0.459)
construction	1.469	(0.618)	0.927	(0.290)	0.847	(0.382)
wholesale & retail trade	1.587	(0.545)	1.109	(0.266)	1.292	(0.372)
accommodation & food services	2.066*	(0.771)	1.256	(0.328)	1.506	(0.457)
transportation & storage	1.133	(0.441)	0.603	(0.187)	1.125	(0.413)
information & communication	0.971	(0.721)	1.452	(0.640)	0.971	(0.670)
finance	2.641**	(1.020)	1.145	(0.372)	0.938	(0.364)
real estate activities	2.018	(0.909)	0.855	(0.313)	2.588***	(0.903)
business services	0.249*	(0.185)	0.998	(0.341)	1.058	(0.471)
education	0.594	(0.264)	0.971	(0.270)	1.694*	(0.522)
health & social work activities	2.618	(2.757)	2.027	(1.082)	1.706	(1.717)
arts/sports/recreation services	1.925	(0.828)	0.900	(0.331)	1.089	(0.476)
other personal services	1.082	(0.443)	0.873	(0.247)	1.291	(0.425)
Regional & Year Fixed Effects	Y		Y		Y	
Observations	1,981		1,981		1,981	
Chi-Squared Statistics (degree of freedom=57)	796.33***		805.69***		2045.71***	

Note: The outcome variable is the duration of a self-employed business. SHR indicates the sub-hazard ratio. Standard errors (S.E.) in parentheses. D.F. indicates degrees of freedom. The sample includes solo self-employed workers aged 19 to 64 and who run a business for a specific period between 2001 and 2019. There are 1,981 individual-job observations. Number of employees, female, spouse, education level, and industries are indicators. The reference group for the indicators are zero employees, male, no spouse, a high school diploma or less, and manufacturing, respectively. *** p<0.01, ** p<0.05, * p<0.10.

A comparison between the estimates in the two tables reveals that the results are qualitatively similar between the two groups, both in terms of economic and demographic characteristics. Although some estimates are not precise enough to be statistically significant, their magnitudes imply that higher revenue levels or incomes are positively correlated with restarting a business but negatively correlated with being an employee or being unemployed or remaining out of the labor force. Such correlations are stronger for solo self-employed workers than for employers. Demographic characteristics are also significant factors. Female or older self-employed workers are less likely to restart a business or to be an employee but more

TABLE 8—COMPETING RISKS REGRESSIONS BY POST-CLOSURE CAREER PATH, SELF-EMPLOYMENT WITH EMPLOYEES

Variables	Post-closure Career Paths					
	Restarting a Business		Wage Employment		Unemployment or Economic Inactivity	
	SHR	(S.E.)	SHR	(S.E.)	SHR	(S.E.)
Annual Revenue (million won)	1.000	(0.004)	0.991**	(0.004)	1.001	(0.002)
Monthly Income (million won)	1.011	(0.075)	0.957**	(0.018)	0.965	(0.022)
Three or More Employees	1.032	(0.200)	0.844	(0.151)	1.368	(0.304)
Female	0.818	(0.172)	0.697*	(0.133)	2.211***	(0.528)
Age	0.997	(0.010)	0.981*	(0.011)	1.012	(0.014)
Spouse	0.973	(0.265)	0.657**	(0.134)	1.165	(0.344)
Number of Family Members	0.991	(0.072)	0.945	(0.067)	0.945	(0.082)
Education Level						
associate's degree	0.869	(0.267)	0.902	(0.225)	1.156	(0.429)
bachelor's degree	1.280	(0.291)	0.966	(0.195)	1.357	(0.352)
master's degree or more	1.805	(1.051)	1.619	(0.656)	1.445	(0.946)
Industry						
construction	1.751	(1.057)	2.758**	(1.116)	1.325	(0.883)
wholesale & retail trade	2.380*	(1.074)	1.378	(0.479)	2.130	(1.056)
accommodation & food services	2.904**	(1.220)	1.473	(0.524)	2.608**	(1.157)
transportation & storage	3.852**	(2.131)	0.587	(0.465)	0.898	(1.028)
information & communication	2.094	(2.117)	2.360	(1.692)	1.952	(2.380)
finance	4.278*	(3.451)	0.577	(0.586)	1.528	(1.539)
real estate activities	2.448	(1.571)	0.598	(0.428)	0.804	(0.822)
business services	1.208	(0.697)	1.129	(0.485)	1.701	(1.029)
education	1.845	(1.019)	0.603	(0.320)	1.793	(1.021)
health & social work activities	1.800	(1.155)	2.070	(1.023)	0.619	(0.546)
arts/sports/recreation services	2.277	(1.172)	2.334**	(0.911)	3.434**	(1.807)
other personal services	2.629*	(1.334)	0.735	(0.352)	2.075	(1.103)
Regional & Year Fixed Effects	Y		Y		Y	
Observations	947		947		947	
Chi-Squared statistics (degree of freedom=58)	6694.67***		1639.79***		5417.81***	

Note: The outcome variable is the duration of a self-employed business. SHR indicates the sub-hazard ratio. Standard errors (S.E.) in parentheses. D.F. indicates degrees of freedom. The sample includes self-employed workers (who have one or more employees) aged 19 to 64 and who run a business for a specific period between 2001 and 2019. There are 947 individual-job observations. Number of employees, female, spouse, education level, and industries are indicators. The reference group for the indicators are zero employees, male, no spouse, a high school diploma or less, and manufacturing, respectively. Estimates for the following industries with few observations are not reported: agriculture & forestry, and fishing. *** p<0.01, ** p<0.05, * p<0.10.

likely to be unemployed or economically inactive after a closure. Family size and education levels are statistically significant factors for neither solo self-employed workers nor employers.

On the other hand, several differences are observed between the two groups with regard to industry. For self-employed workers engaged in wholesale & retail trade, transportation & storage, and other personal services, the probability of starting a new business after a closure is much higher for employers, but this is not the case for those without any employees. While employers in construction or in arts/sports

/recreation services are positively associated with the post-closure path of entering wage employment, industry is not a significant factor for solo self-employed workers. Finally, the probability of unemployment or economic inactivity is significantly associated with real estate activities or education for solo self-employed workers, but for employers, this probability is more associated with accommodation & food services or arts/sports/recreation services.

VI. Conclusion

In this study, I explore the factors associated with business closures by self-employed workers and the subsequent job transition paths of such individuals, using data from the Korean Labor Panel & Income Survey. The empirical results reveal that the risk of closure and the subsequent career paths for self-employed workers are correlated with various factors, including the business size in terms of revenue and income, as well as demographic factors such as gender and age, and industry.

The empirical findings of this study provide several policy implications. First, it is necessary to use income to determine eligibility for unemployment benefits for the self-employed. In the current employment insurance system for self-employed workers, revenue is used to determine the inevitability of unemployment (business closure) because there is no administrative system in place to assess the business income of self-employed workers accurately. My results suggest that the factor most closely associated with closure and post-closure career paths of the self-employed is income rather than revenue (Table 4). This is more the case for closures due to economic reasons (therefore arguably more involuntary) and for solo self-employed workers (Tables 6 and 7), whose business size is generally small.

Next, with reference to the characteristics of self-employed workers, the elderly are relatively less likely to close their businesses. This suggests that they have a high tendency to maintain their business for livelihood purposes. Consequently, it appears to be feasible to set support targets based on demographic characteristics and consider complementary policy support methods, such as but not limited to providing subsidies for employment insurance premiums.

Last, this study finds that post-closure transition paths also vary by industry. Industries such as wholesale & retail trade, accommodation & food services, finance, real estate activities, and arts/sports/recreation-related services have relatively higher closure risk levels. If a phased expansion of employment insurance for the self-employed is considered by policymakers, the aforementioned industries could be prioritized, given their strong demand for an employment safety net.

APPENDIX

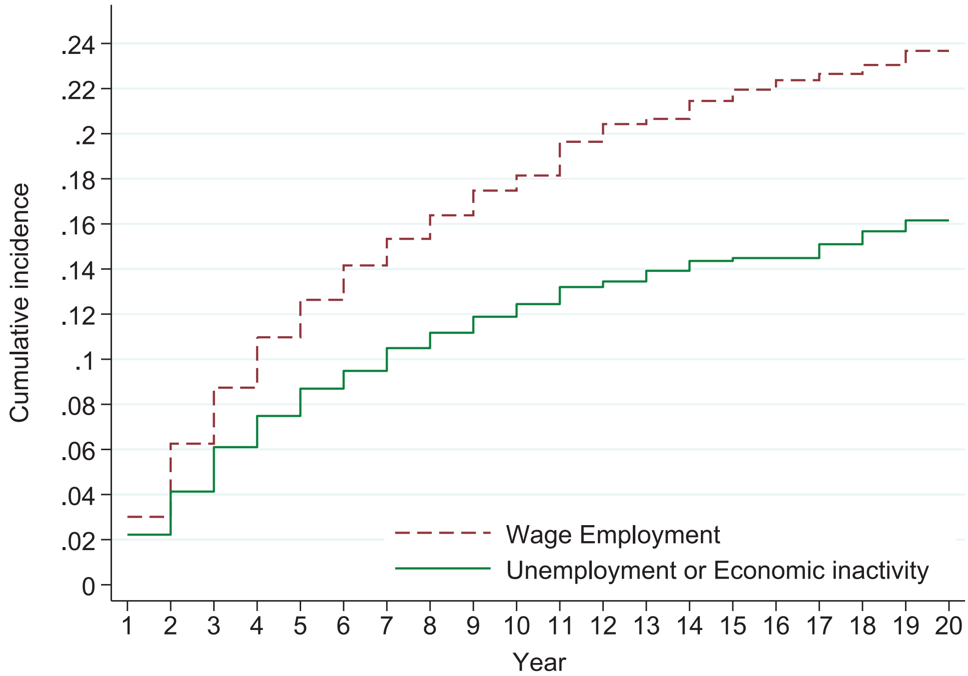

FIGURE A1. CUMULATIVE INCIDENCES OF CAREER PATHS OF SELF-EMPLOYED WORKERS AFTER A CLOSURE WITHOUT RESTARTING A BUSINESS

Note: Cumulative incidence of each competing risk (i.e., career paths after closure) of self-employed workers.

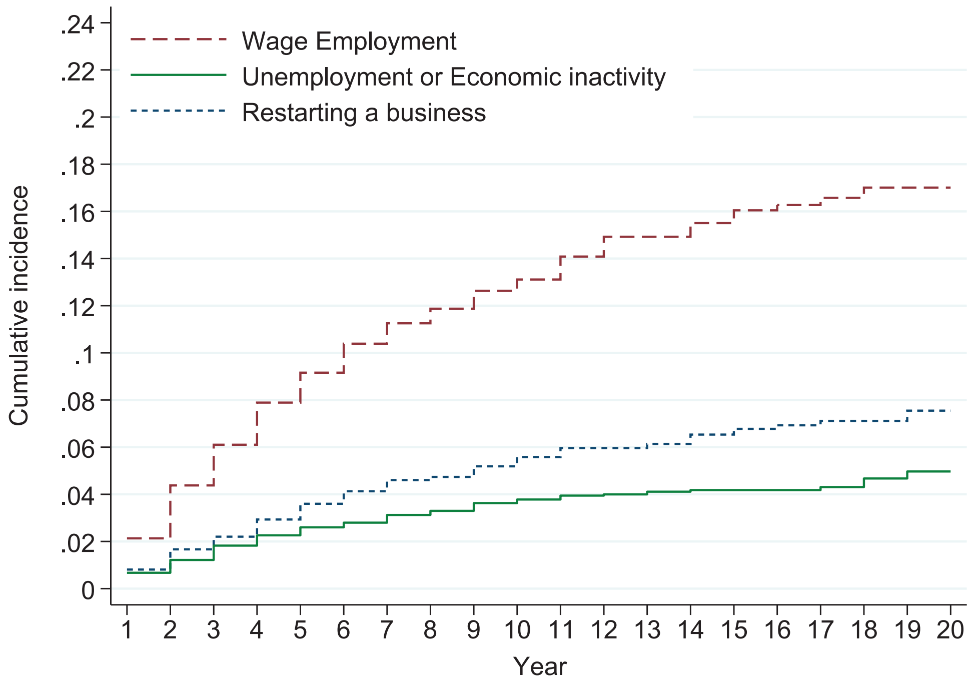

FIGURE A2. CUMULATIVE INCIDENCES OF CAREER PATHS OF SELF-EMPLOYED WORKERS AFTER A CLOSURE DUE TO ECONOMIC REASONS

Note: Cumulative incidence of each competing risk (i.e., career paths after closure) of self-employed workers.

TABLE A1—SAMPLE SELECTION CRITERIA AND SAMPLE SIZE

Step	Description	Remaining Observations
1. Raw data	· Use the twenty-third wave (year 2020) of the KLIPS work history data: 28,230 individuals, 244,560 observations. · The work history data are merged with the individual data and household data from the first to the twenty-third waves (1998-2020).	244,560
2. Individual-job-year level panel data	· Remove observations from retrospective responses. · Remove persons with missing values in variables, such as but not limited to status in employment and start/end year of a job. · Include only primary jobs: jobs reported as a primary job at least once.	149,667
3. Sample selection	· Include only jobs started later than 1999 and earlier than 2020. · Remove observations with missing values in annual revenue, monthly income, or industry. · Remove observations with industries with a small sample size: (1) electricity, gas, steam and air conditioning supply; (2) goods-and services-producing activities of private households for their own use. · Include self-employers aged 15 to 64 who have 50 or fewer employees, with a business survived at least one year.	11,971
4. Individual-job level data aligns with the estimation model	· Include only the initial observation of each individual-job pair so that the sample aligns with the competing risks regression model in Section IV where observable characteristics are time-invariant.	2,928

Note: The variables from the work history data include the start/end year, status in employment, industry, annual revenue, monthly income, and the number of employees (if any). The variables from the individual data include gender, age, education level, marriage, region of residence, and region of business. The variable from the household data is the number of household members.

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신품목 도입 시 개척자와 추종자의 신규 공장 설립 의사결정에 대한 실증분석 및 학습파급효과에 대한 시사점†

한진희*

본 연구는 1990~96년 우리나라 제조업의 연도별 기업-사업체-품목 자료를 이용하여 어떤 품목을 경제 최초로 생산한 개척자와 이 품목을 뒤이어 생산한 추종자 간 해당 품목 생산 방식(기존 공장 활용 vs 신규 공장 생산)의 선택에 있어서 차이점이 있는지 여부를 분석하였다. 그 결과 추종자는 개척자에 비하여 신규 생산 품목을 기존 공장보다는 신규 공장에서 생산하는 경향이 강하다는 점을 발견하였다. 또한 투자 회귀분석을 통하여 신품목 생산을 위해 신규 공장을 설립하는 의사결정이 기존 공장을 활용하는 대안 대비 더 큰 투자를 수반한다는 결과도 얻을 수 있었다. 이러한 결과들은 개척자로부터 추종자로 흐르는 학습파급효과(learning spillovers)의 존재와 부합하며, 학습파급효과의 내용은 신품목의 미래 수익성에 대한 불확실성 감소일 가능성을 시사한다.

Key Word: 개척자, 추종자, 학습파급효과, 불확실성, 투자
JEL Code: O11, O14, O31, O47

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I. 서 론

새로운 품목이 낡은 품목을 끊임없이 대체해 나가는 슘페터적 창조적파괴(Schumpeterian creative destruction) 과정이 자본주의 경제의 성장 및 신산업의 발전에 있어서 핵심적 요소라는 것은 거의 모든 경제학자에 의해 받아들여지고 있다고 보인다. 그런데 신품목을 경제 내에서 처음으로 생산하는 기업, 즉 개척자(pioneer)의 신품목 혹은 신시장 개척을 위한 노력은 신품목의 미래 수익성에 대한 정보를 창출할 것이며, 이러한 정보 중 적어도 일부는 추종자(follower)에게 다양한 경로로 흘러갈 개연성이 있다. 즉, 개척자로부터 추종자로의 학습파급효과(learning spillovers)가 존재할 수 있다. 이러한 학습파급효과의 존재 여부는 자유방임적 시장경제가 신품목 개척에 대한 적절한 유인을 제공하는지를 판단하는 데 핵심적인 이슈 중 하나이다. 그럼에도 불구하고 개척자로부터 추종자로의 학습파급효과에 대한 기존 실증분석 문헌은 의외로 많지 않다.

본 고는 1990~96년 한국 제조업의 연도별 기업–사업체–품목 자료를 이용하여 기업 관점에서 새로운 품목을 생산 시작하는 시점에, 그 기업이 해당 품목에 대한 개척자인지 아니면 추종자인지에 따라 과연 동 품목 생산 방식(기존 공장 활용 vs 신규 공장 생산)에 차이점이 존재하는지를 분석한다. 이와 같이 본고가 개척자와 추종자 간 신품목 생산 방식의 차이에 주목하는 이유는, 이에 대한 실증분석 결과가 개척자로부터 추종자로 학습파급효과의 존재 여부에 대한 하나의 실증적 증거를 제공할 수 있기 때문이다. 이에 대한 설명은 이하 제II장에서 이루어진다. 신품목 생산 시 신규 공장 설립이라는 기업의 투자의사 결정에 대한 분석은 아마도 그 자체로 기존 연구에서 찾아보기 어려운 것이라 생각된다. 그러나 무엇보다도 기존 연구 대비 본 고의 새로운 점은 개척자에서 추종자로의 학습파급효과를 신품목 생산 개시 시점의 신규 공장 설립 여부라는 측면에서 파악하고자 시도하였다는 점이다.

본 고의 주된 실증분석 결과는 다음과 같다. 추종자는 개척자에 비하여 신규 생산 품목을 기존 공장보다 신규 공장에서 생산하는 경향이 강하다는 점을 발견하였다. 이러한 결과는 개척자로부터 추종자로 흐르는 신품목의 미래 수익성에 대한 학습파급효과의 존재와 부합한다. 신품목 생산을 위해 신규 공장을 설립하는 의사결정이 기존 공장을 활용하는 대안 대비 비가역적 성격의 투자를 많이 요구한다는 전제하에서, 이러한 학습파급효과의 구체적 내용이 '신품목의 미래 수익성에 대한 불확실성 감소'라는 추측도 해볼 수 있을 것이다. 한편 개척자 대비 추종자가 신품목의 신규 공장 생산 경향이 강한 정도는 다품목생산기업(multiprf)일수록 낮았다. 이에 대한 한 가지 가능한 설명은 다품목생산기업의 경우 신품목이 기존 생산 품목을 대체하는 '제살깎기(cannibalization)'형일 가능성이 높기 때문이라는 것이다.

본 고와 연관성이 높은 기존 문헌은 다음과 같다.[1] 먼저 Hausmann and Rodrik(2003)은, 특히 개도국의 경제발전에 있어 자신이 어떤 품목에 잠재적 비교우위가 있는가를 학습해 나가는 것, 즉 '자기 개척(self-discovery)'이 중요한데, 이러한 자기 개척에는 비용이 수

[1]기업 간 학습파급효과와 직간접적으로 관련된 기존 문헌은 수없이 많고, 이 문헌들을 모두 서베이하는 것은 하지 않는다.

반되는 반면 추종자(follower)들에 의해 쉽게 모방되기 때문에 사회적 최적 수준에 미달하는 자기 개척 투자가 이루어지는 경향이 있음을 이론적으로 보여주었다.[2] 그리고 이들은 Evenson and Westphal(1995), Yonekawa(1982), Dahlman *et al.*(1985), Kim(1993) 등 기존 문헌들의 여러 일화적 증거(anecdotal evidence)를 인용하며 선도자(first-comer)로부터 후발 모방자(late imitator)들로 학습파급효과의 증거들이 광범위하게 존재함을 설명하였다. 한편 Iacovone and Javorcik(2010), Freund and Pierola(2010), Artopoulos *et al.*(2013) 등은 기술적 분석(descriptive analysis), 사례연구 방법을 이용하여 각각 멕시코, 페루 및 아르헨티나의 수출 신산업의 출현에 있어서 수출 개척자(export pioneer)의 역할이 중요했다는 점을 보여주었다. 본 연구는 수출이 아닌 "생산"을 기준으로 정의된 개척자와 추종자 간 신품목 생산방식의 차이를 엄밀한 계량경제학적 방법을 이용하여 실증적으로 보여주었다는 점에서 이들 논문과 차이가 있다.

다음으로 Aitken *et al.*(1997), Alvarez *et al.*(2008), Swenson(2008), Koenig *et al.*(2010), Fernandes and Tang(2014) 등은 기존 수출기업 혹은 다국적 기업으로부터 신규 수출기업으로의 수출 파급효과(export spillovers)가 존재하는지를 엄밀한 계량경제학적 방법으로 실증분석 한 논문들이다. 공통으로 이들 논문은 어떤 품목에 있어서 기존 지리적으로 가까운 수출기업의 '존재(existence)' 혹은 그 '광범위성(prevalence)'이 후발 기업의 수출시장 진입을 촉진하는 데 영향을 미친다는 결과들을 보여준다. 그러나 이들 논문이 어떤 품목의 경제 최초 생산자, 즉 개척자(pioneer)에 초점을 맞추어 개척자-추종자 학습파급효과를 분석한 것은 아니다. 한편 한국 제조업에 대해 개척자에 초점을 맞추어 개척자-추종자 학습파급효과를 분석한 논문은 한진희(2018) 및 Hahn(2019)을 들 수 있는데, 이 논문들은 기본적으로 위 Fernandes and Tang(2014) 등의 방법론을 따라 분석한 것으로서, 개척자의 존재가 (지리적으로 인접한) 잠재적 추종 수출자의 추종 수출을 촉진시킴을 보여준다. 본 고가 이 논문들과 다른 점은 본 고는 수출이 아닌 "생산"을 기준으로 개척자와 추종자를 파악하고, 개척자와 추종자 간 신품목 생산방식에 대한 선택을 분석함으로써 개척자-추종자 학습파급효과에 대한 시사점을 얻으려 했다는 점이다.[3]

본 고의 구성은 다음과 같다. 제II장에서는 실증분석의 이론적 프레임워크를 간단히 설명한다. 제III장은 자료 및 회귀분석모형을 설명한다. 제IV장은 실증분석 결과를 논의한다. 마지막 장은 본 고를 요약하고 마무리한다.

[2]한편 Wei *et al.*(2017)은 학습파급효과의 존재만으로 시장 실패의 존재를 단정지을 수 없음을 이론적으로 보여준다. 이들은 시장 실패가 존재하기 위해서는 개척 비용(discovery cost)이 매우 크거나 매우 작지 않아야 하는데, 이러한 두 조건이 실제로 모두 충족되기는 쉽지 않음을 실증적으로 보여준다. 한편 개척자와 추종자 간 학습파급효과라는 주제는 경영학 문헌에서 논의되는 '선발자의 이익 및 불이익(first mover advantages and disadvantages)'과도 일맥상통하는데, 이에 대한 논의는 Lieberman and Montgomery(1988)를 참조하기를 바란다.

[3]한편, 본 고와 같이 신품목 도입 기업의 신규 공장 설립 여부 의사결정에 관한 기존 문헌은 찾아보기 어려웠다. 마지막으로 본 고는 제II장에서 논의되는 바와 같이 신품목의 미래 수익성에 대한 학습파급효과가 존재할 때 개척자와 추종자가 당면한 미래 수익성 불확실성의 차이가 신규 공장 설립 의사결정에 영향을 미칠 수 있다는 프레임워크를 토대로 한 분석이므로 본 고는 간접적으로 '불확실성과 투자(uncertainty and investment)' 관련 방대한 문헌과도 연관되어 있을 수 있다. 관련 이론 및 실증 문헌에 대한 서베이는 Campello and Kankanhalli(2022)를 참조하기를 바란다.

Ⅱ. 분석의 프레임워크

본 연구는 개척자(pioneer)와 추종자(follower) 간 신제품 생산방식의 차이가 존재하는지에 대한 실증분석에 그 일차적 관심이 있다. 그러나 본 연구의 보다 근본적인 관심은 과연 이러한 생산방식의 차이가 개척자로부터 추종자로 흐르는 신제품에 대한 일종의 학습효과 혹은 학습파급효과(learning spillovers)를 반영하는지 여부, 그리고 그 학습효과의 구체적 내용이 무엇인가에 있다. 결론부터 이야기하면 본고는 개척자와 추종자 간 신제품 생산방식의 차이를 살펴봄으로써 학습파급효과의 존재 여부 및 그 내용에 대한 유추가 가능하다고 본다.

어떤 제품의 경제 최초 생산자, 즉 개척자는 개척자이기 때문에 그 제품의 미래 수익성에 대해 커다란 불확실성(uncertainty)에 직면해 있을 것이다. 미래 수익성의 불확실성은 시장 수요뿐 아니라 제품의 질(quality), 개척자 자신의 생산 비용(production cost) 등의 불확실성 등에 기인할 것이다. 이러한 큰 불확실성 아래에서 개척자는 처음부터 대규모 투자를 통해 거대한 생산시설을 구축하기보다는 소규모 투자에 기초한 실험(experiment)을 통해 미래 수익성을 결정하는 모수(parameter)들에 대해 학습해 나가는 방식을 택할 가능성이 높을 것이라 추론해 볼 수 있다. 그리고 이러한 추론은 불확실성이 투자(investment)를 감소시킨다는 많은 이론 및 실증연구 결과와도 부합하는 것이다. 기업이 신제품을 생산하는 방법은 기존 공장을 활용하는 방법 및 신규 공장을 통한 방법 등 두 가지가 있을 수 있는데, 기존 공장 활용 시보다 공장 신축 시 비가역성(irreversibility)이 높은 투자가 필요하다고 하자. 이때 큰 불확실성에 직면한 개척자는 신제품 생산을 위해 기존 공장을 활용하는 방법을 택할 유인을 가지고 있을 것이라고 추론해 볼 수 있겠다.

한편 추종자는 자신의 입장에서 신제품의 미래 수익성에 대하여 개척자에 비해 작은 불확실성을 당면할 수도 있다. 추종자는 개척자의 경험을 관찰할 수 있는 기회를 가질 수 있고, 그 기회를 통하여 미래 수익성을 결정하는 모수들에 대해 간접적으로 정보를 얻을 수 있을 것이기 때문이다. 따라서 추종자는 개척자 대비, 다른 조건이 동일하다면, 신제품 생산을 위해 공장 신축 방법을 선호할 수 있을 것이라고 예상된다.[4] 소위 '선발자의 이득(first mover advantage: FMA)'이 존재할 수 있고, 이러한 상황에서 만일 추종자가 개척자의 경험으로부터 아무것도 배울 수 없다면, 추종자는 개척자 대비 공장 신축을 더욱 선호할 유인이 없거나 오히려 그 유인이 작을 것으로 예상해 볼 수 있다. 따라서 본 연구는 만일 추종자가 개척자 대비 공장 신축을 선호한다는 결과를 얻게 된다면 이를 학습파급효과(learning spillovers)의 존재와 부합하는 증거로 볼 수 있다.

[4]추종자가 개척자의 경험을 토대로 미래 수익성 분포의 상위에 위치한 품목을 선택적으로 추종할 개연성도 있을 것이다. 이러한 요인도 추종자가 개척자에 비해 공장 신축 방법을 택할 가능성을 높이는 방향으로 작용할 수 있을 것이다.

Ⅲ. 자료 및 회귀분석 모형

1. 자료

본 연구에 사용된 데이터세트는 다음 두 가지이다.[5] 그 첫째는 1990년에서 1996년까지 기간에 대한 통계청의 「광업・제조업조사」의 연도별 사업체 수준(plant-level) 미시자료이다(이하 사업체 자료). 이 자료는 광업 및 제조업 부문의 종업원 5인 이상 모든 사업체에 대한 센서스 자료로서 불균형 패널 데이터세트이다. 본 연구에서는 제조업 부문에 대한 자료만을 사용하였다. 자료에 포함된 사업체 수는 약 68,000개에서 약 97,000개 사이로, 연도에 따라 다르다. 이 자료는 기본적으로 생산액, 출하액, 유형고정자산, 종업원 수 등 사업체의 생산구조에 관한 정보뿐 아니라 연구개발비 등 일부 사업활동 관련 정보도 제공한다.

두 번째 데이터세트는 1990~96년 기간에 대한 연도별 사업체－품목 자료이다. 이 자료는 사업체 코드를 통하여 위의 사업체 자료와 연계될 수 있다. 이 자료는 연도별 사업체가 생산하는 각 품목에 대한 생산액, 출하액, 수출액 등에 대한 정보를 가지고 있다. 사업체－품목 자료는 사업체 자료의 대부분을 포괄한다. 사업체－품목 자료는 사업체 수 기준 사업체 자료의 약 70~80%를, 출하액 기준 약 84% 이상을, 그리고 수출액 기준 거의 100%를 커버한다. 한편 '품목'은 품목코드에 의해 정의된다. 품목코드는 8자리(eight-digit) 수로서 매우 상세하다고 할 수 있다. 분석기간 중 연도별 품목 수(또는 품목코드 수)는 대략 2,500개에서 3,200개 정도이다. 품목코드는 분석기간 중 일관성을 가진다.

본 연구의 핵심 질문인 경제 전체 관점 신품목의 최초 생산 기업과 추종 생산 기업 간 생산방법의 차이를 살펴보기 위해서는 기업－사업체－품목 자료가 구축되어야 한다. 이를 위해서 1992~96년 기간 각 연도에 대한 사업체－기업 매칭코드를 이용하여 기업－사업체－품목 자료를 구축하였다.[6] 사업체－품목 자료에 존재한 사업체 중 기업코드가 매치된 사업체의 비율은 연도별로 5~8% 정도이다. 그리고 기업코드가 매치된 사업체는 그렇지 않은 사업체에 비해 출하액이 연도별로 평균 10배에서 13배 정도 큰 사업체이다. 한편 사업체를 기업에 매칭할 때 사용한 데이터세트는 사업체 자료가 아니라 사업체－품목 자료이다. 사업체－품목 자료의 사업체 수가 사업체 자료에 비해 적음에도 불구하고 이러한 방식을 택한 것은 품목 정보가 없는 사업체는 어차피 분석에 사용될 수 없기 때문이다.

[5]본 고의 자료는 저자가 한국개발연구원에 재직할 당시 통계청으로부터 제공받았던 것이다. 이에 저자는 통계청에 감사를 표한다.

[6]사업체－기업 매칭코드는 결함이 없는 완전한 상태는 아니었다. 동일 사업체가 한 연도에 두 개의 기업코드에 매치된 경우가 사업체 수 기준 극히 일부 있었는데, 이 경우 분석기간에 다수 연도에 매치된 기업코드를 사용하였다. 또한 100개 정도의 사업체는 분석기간에 기업코드가 한 번 변경된 경우였는데, 이러한 사업체에 대해서는 아무런 조치도 취하지 않았다. 마지막으로 적지 않은 수의 사업체가 분석기간에 단 한 가지의 기업코드가 매치되어 있으면서 동시에 일부 연도에 대해서 기업코드가 누락되어 있는 경우가 있었다. 이에 대해 아무런 조치를 취하지 않을 경우 실제 연속적으로 존재한 사업체가 새로이 출현 혹은 소멸한 것으로 간주되는 오류가 발생할 수 있으므로, 이 경우 해당 사업체는 분석기간에 동일한 기업에 소속되어 있는 것으로 간주하였다.

2. 주요 변수의 정의: 개척자, 추종자, 신규 공장 생산, 기존 공장 생산 등

본 고의 초점은 어떤 품목을 경제 최초로 생산한 기업 혹은 개척자(pioneer)와 그 품목의 개척자를 추종하여 생산한 기업, 즉 추종자(follower)가 그 품목을 기존 공장에서 생산을 개시하느냐 아니면 신규 공장에서 생산을 개시하느냐 하는 선택에 있어서 어떠한 차이점을 보이는가 하는 데 있다. 이를 위해서는 경제최초생산품목, 개척자, 추종자, 기존 공장 생산, 신규 공장 생산 등에 대한 정의가 필요하다. 경제최초생산품목은 해당 8 자릿수 품목코드가 1990~91년 기간 중 존재하지 않던 품목이 1992년 이후 출현하였다면 그 품목을 경제최초생산품목이라고 정의한다. 개척자는 경제최초생산품목의 생산 시작 연도에 생산을 시작한 기업이다. 추종자는 경제최초생산품목을 개척자보다 늦은 연도에 생산을 시작한 기업이다. 이에 따라 추종자는 개척자가 경제 최초로 도입한 품목(product)에 대한 또 다른 품목 버라이어티(product variety)를 시차를 두고 도입한 기업이라고 볼 수 있다.[7]

한편 개척자 및 추종자의 해당 품목 생산 시작이 기존 공장 혹은 신규 공장 중 어디에서 이루어졌느냐 하는 것은 사업체(공장) 코드가 분석기간 중 일관성이 있다는 점을 이용하여 파악할 수 있다.[8] 본 고에서는 해당 품목 생산 시작 연도가 t라고 하면, 그 품목을 t년도에 생산한 사업체가 $t-1$년도에도 존재하였던 사업체면 기존 공장이라고 보고, $t-1$년도에는 존재하지 않았던 사업체면 신규 공장이라고 본다. 본 연구에서 구축된 기업–사업체(공장)–품목 자료는 위 모든 개념에 대한 식별을 가능케 한다.[9,10]

Table 1은 위의 정의에 따라 식별된 경제최초생산품목, 개척자, 추종자의 수를 보여주고 있다. 먼저 1992~96년 기간 중 위의 정의에 따라 품목 자료 전체에서 식별된 경제최초생산품목(pioneered product)의 수는 총 562개이다. 본 고에서 사용될 기업코드가 매칭된 기업–사업체–품목 자료에서 식별된 경제최초생산품목의 수는 같은 기간 중 251개로, 제조업 전체 562개의 약 45% 정도에 해당한다. 경제최초생산품목을 도입한 개척자의 수는 1993~96년 기간 중 819개이다.[11] 한편 경제최초생산품목 수보다 개척자의 수가 많은 것은

[7]본고는 연간 자료를 사용하였기 때문에 개척자와 추종자 간 추종 시차가 짧을 경우에는 실제로는 추종자임에도 불구하고 본 고의 정의에 의하여 개척자로 분류되는 일이 발생할 수 있다. 이러한 문제는 연간 자료를 이용하는 한 해결되기 어려운 문제로 보인다.

[8]사업체 코드는 통계청이 시계열적 일관성 확보에 가장 중점을 두는 코드이다. 이는 본 자료가 기본적으로 사업체를 대상으로 조사한 자료이기 때문이다.

[9]자료에서 사업체가 신규로 생산한 품목이 생산 첫 연도에 두 개 이상의 공장에서 생산되는 경우도 존재한다. 이 경우 그 어느 한 공장이라도 신규 공장이면 그 품목은 신규 공장에서 생산 개시된 것으로 간주하였다.

[10]한편 ‘기존 공장 생산’과 ‘신규 공장 생산’이 내용상으로 그리 분명히 구분되기 어려운 측면이 있을 수 있어 분석 결과 해석에 다소 신중을 기할 필요가 있다고 판단된다. 본 연구에서 기존 공장 생산으로 식별된 경우에도 만일 생산설비 등을 사실상 공장을 새로 짓는 수준으로 교체하는 경우에는 신규 공장 생산과 실질적 차이가 크지 않을 수도 있을 것이다. 또한 기존 공장으로 식별된 경우에서도 기존 생산설비를 교체하여 신규 생산설비를 설치하는 경우와 기존 생산설비를 그대로 놔두면서 신규 생산설비를 설치하는 경우도 혼재할 수 있을 것이다. 이러한 점을 지적해 주신 익명의 검토자께 감사드린다.

[11]1992년 107개의 경제최초생산품목을 도입한 개척자의 수는 313개이다. 이 숫자를 괄호 안에 표기한 이유는 사업체–기업 매칭코드가 1992년부터 이용할 수 가능하기 때문에 1992년 개척자의 경우 이들이 경제 최초 생산한 품목이 기업 관점에서 신규 공장에서 생산 개시되었는지 혹은 기존 공장에서 생산 개시되었는지를 파악할 수 없고, 따라서 이하의 분석에 사용될 수 없기 때문이다.

Table 1. Number of Pioneered Products, Pioneers, and Followers

	All Sample	Sample with Matched Firm Code		
Year	Number of Pioneered Products	Number of Pioneered Products	Number of Pioneers	Number of Followers
1992	178	(107)	(313)	-
1993	180	134	437	185
1994	76	43	111	282
1995	84	47	102	353
1996	44	27	169	334
Total	562	251	819	1,154

Note: The number of followers in each year are for those products pioneered in the preceding years.
Source: Author's own calculation.

동일 연도에 여러 기업이 동일한 품목을 경제 최초로 생산할 수 있기 때문이다. Table 1의 마지막 열은 1992~95년 기간 중 경제최초생산품목을 개척자를 추종하여 생산하기 시작한 추종자(follower)의 수가 1,154개임을 보여주고 있다. 본 고의 회귀분석에서 사용될 분석 표본은 개척자(819개)와 추종자(1,154개)의 신품목 생산 첫 연도 관측치 1,973개이다.

Figure 1은 품목 자료 전체 및 기업코드가 매칭된 기업－사업체－품목 자료에서의 각 562개 및 251개의 경제최초생산품목의 KSIC 2 자릿수 산업별 분포를 보여준다. 먼저 두 자료에서 경제최초생산품목의 산업별 분포는 매우 유사한 모습을 보여준다. 그리고 두 자료에서 모두 화학산업 및 기계장치(전자, 컴퓨터, 일반기계 등) 산업에서 경제최초생산품목이 많은 것으로 나타난다. 기업코드가 매치된 자료에서의 경제최초생산품목이 품목 자료 전체에서의 그것에 비해 일부 산업에 편중되어 있다고 보이지는 않는다. 한편 Table A1은 사무·계산 및 회계용 기계 제조업(computing machinery, KSIC 30) 및 영상·음향 및 통신장비 제조업(communication equipment, KSIC 32)에서 8 자릿수 품목 단위에서 정의된 경제최초생산품목의 명칭을 참고용으로 제시한다.

Table 2는 개척자와 추종자의 신규 생산 품목의 신규 공장 생산 여부에 따른 분포를 보여준다. 개척자는 총 819개 중 90개인 11% 정도가 신품목을 신규 공장에서 생산하였고, 나머지 89%가량은 기존 공장에서 생산하였다. 반면 추종자는 개척자의 경제최초생산품목을 추종하여 생산할 때 총 1,154개 중 256개, 약 22% 정도가 신품목을 신규 공장에서 생산하는 방식을 택한 것으로 나타난다. 추종자의 신품목 신규 공장 생산 비율이 개척자의 두 배 정도 된다는 사실은 분명 매우 흥미로운 것이다. 이하에서는 보다 엄밀한 분석을 통하여 개척자와 추종자의 신품목 생산방식의 차이가 존재하는가를 살펴본다.

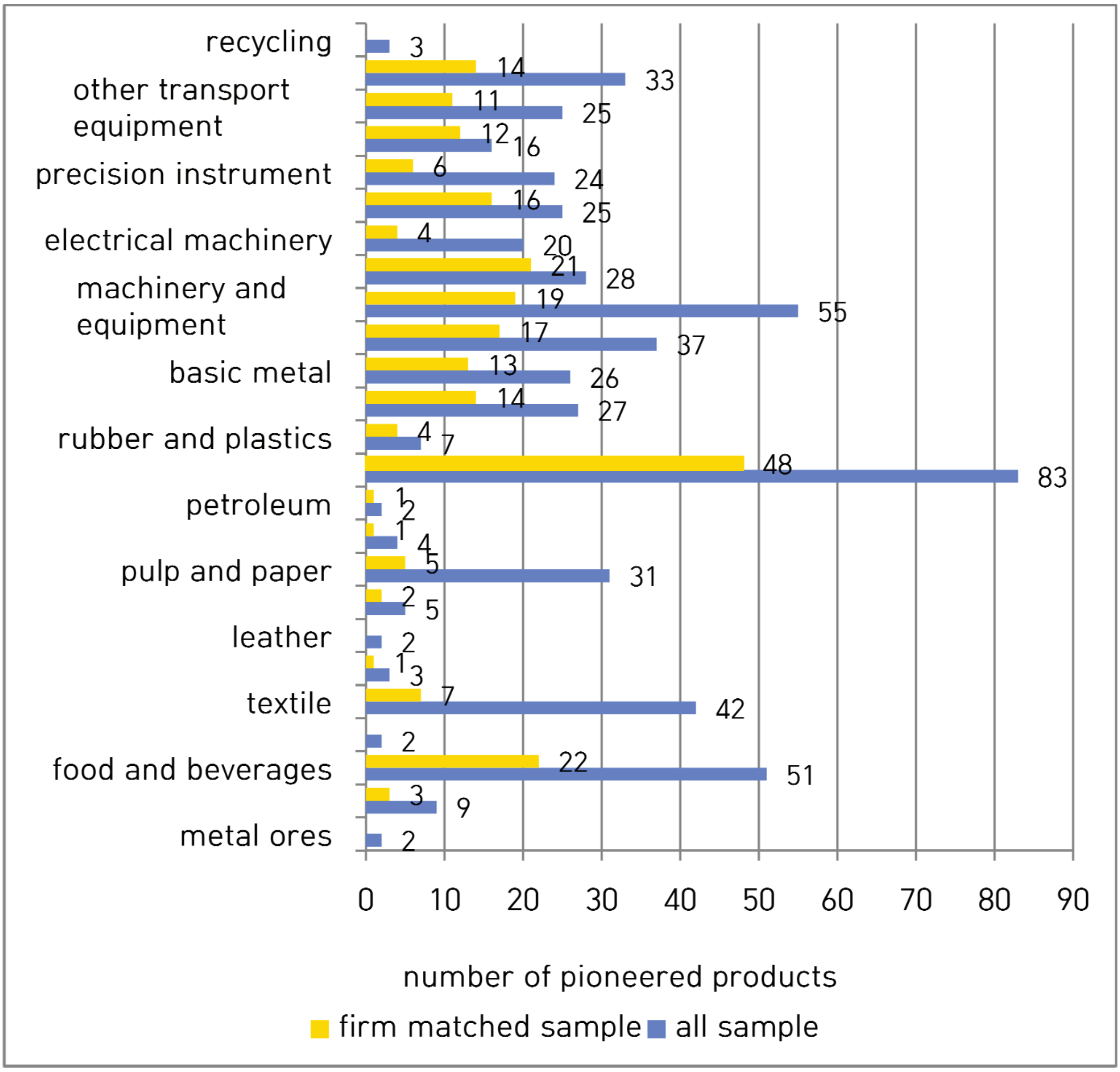

Figure 1. Industry Distribution of Pioneered Products

Source: Author's own calculation.

Table 2. Where the New Products is Produced?: New vs Existing Plant

		Where the New Product is Produced?		Total
		Existing Plant	New Plant	
Follower	Number	898	256	1154
	(row percent)	(77.8)	(22.2)	(100)
Pioneer	Number	729	90	819
	(row percent)	(89.0)	(11.0)	(100)
Total	Number	1627	346	1973

Source: Author's own calculation.

3. 회귀분석 모형

본 고에서는 아래의 비관측효과(unobserved effects) 패널데이터 모형을 선형확률모형(linear probability model)을 이용하여 추정함으로써 개척자와 추종자 간 해당 품목의 신규 생산 시 신규 공장 생산방법을 선택할 확률에 있어서 차이를 보이는가를 분석해 본다.

(1) $$nplant_{pjt} = \alpha + \beta \cdot follower_{pjt} + Z_{pjt}\gamma + \delta_p + \delta_t + \epsilon_{pjt}$$

여기에서 $nplant_{pjt}$는 기업 j가 t연도에 품목 p를 기업 관점에서 신규 생산하였을 때 신규 공장에서 생산하였으면 1의 값을 갖고, 기존 공장에서 생산하였으면 0의 값을 갖는 이항 종속변수이다. 설명변수 $follower_{pjt}$는 품목 p를 t연도에 신규 생산한 기업이 추종자이면 1의 값을 갖고, 그렇지 않고 개척자이면 0의 값을 갖는다. Z_{pjt}는 기업 특성(firm characteristics) 벡터로서, 기업 특성 변수로는 종업원 수(로그값)로 측정한 기업규모(lnworker), 다품목생산기업 더미변수(multiprf), 다공장기업 더미변수(multiplf), 수출기업 더미변수(exporter) 등을 고려하였다. δ_p 는 품목 p의 비관측효과(unobserved effect)를 나타내며, 따라서 본 분석에서 품목 p는 통상적 패널데이터 모형에서의 횡단면 관측 단위에 해당된다. δ_t는 연도 더미변수이다.[12] 본 고에서 주된 관심을 갖는 계수는 β이다. 만일 β값이 양수로 추정된다면 이를 학습효과 등으로 인해 추종자가 개척자에 비해 신규 생산 품목의 미래 수익성에 대해 더 작은 불확실성을 당면함에 따른 것으로 해석해 볼 수 있을 것이다. Table 3은 회귀분석에 사용된 변수의 기초통계량을 보여준다.

Table 3. Basic Statistics

Variable	No. Obs.	Mean	S.D.	Sum	Min	Max
Nplant	1973	0.175	0.380	346	0	1
Follower	1973	0.585	0.493	1154	0	1
Worker	1973	1,403	4,935	2,767,913	5	39,377
Exporter	1973	0.574	0.495	1132	0	1
Multiprf	1973	0.763	0.425	1505	0	1
Multiplf	1973	0.428	0.495	845	0	1

Source: Author's own calculation.

[12] 본고는 연도 더미로 금리, 환율, 성장률 등 거시경제 변수의 영향을 통제하고자 하였으나 여전히 통제되지 못하는 거시경제 변수의 영향이 존재할 수 있고, 이것이 분석 결과에 편향을 초래할 수 있을 것이다. 이에 대한 추가 분석은 추후 연구로 미룬다.

Ⅳ. 실증분석 결과

통상적으로 비관측효과 패널데이터 모형에서는 비관측효과가 설명변수와 체계적 상관관계를 가지느냐 여부에 따라 고정효과(fixed effect) 혹은 확률효과(random effect) 모형이 더 적합한 모형이라고 여겨진다. 이에 따라 아래의 Table 4, Table 5 및 Table 6의 모든 회귀모형에 대하여 Hausman 검증을 실시하여 보았다. 그 결과 모든 회귀식에서 고정효과 모형의 추정계수와 확률효과 모형의 추정계수가 같다는 귀무가설을 기각할 수 없었다. Wooldridge(2015)는 Hausman 검증에서 귀무가설을 기각하지 못하는 경우는 고정효과 모형의 추정치가 확률효과 모형의 추정치가 충분히 가깝다는(sufficiently close) 것을 의미하며, 따라서 이 경우 두 모형 중 어느 모형을 사용하더라도 무방하다고 설명한다. 이에 따라 본 고에서는 기본적으로 고정효과 모형으로 추정된 결과를 제시하였다. 단, 가장 주된 회귀모형이라고 할 수 있는 Table 4의 모형 [4]에 대해서만 확률효과 모형으로 추정된 결과를 함께 보여준다.

먼저 Table 4를 보면, 예상한 바와 같이, 추종자(follower)의 계수는 1% 수준에서 유의한 양수로 추정되었으며, 이 결과는 기업 관점에서 어떤 품목을 신규 생산할 때 추종자가 개척자 대비 신규 공장에서 생산할 가능성이 높음을 의미한다. 다른 말로 하면, 개척자가 추종자 대비 어떤 품목을 신규 생산할 때 기존 공장에서 생산할 가능성이 높다는 것이다. 신품목 생산 시 개척자와 추종자 간 생산방식(신규 공장 vs 기존 공장) 선택에 있어서 위와 같은 차이는, 위 제Ⅲ장에서 설명하였듯, 개척자로부터 추종자로 흐르는 학습파급효과(learnings pillovers)의 존재와 일맥상통한다. 예를 들어 개척자는 신품목의 미래 수익성에 대한 큰

Table 4. Main Regression Results

	[1]	[2]	[3]	[4]	
				Fixed Effect	Random Effect
Follower	0.110***	0.105**	0.105***	0.106***	0.101***
	(0.042)	(0.041)	(0.040)	(0.040)	(0.018)
Lnworker		-0.060***	-0.047***	-0.043***	-0.037***
		(0.006)	(0.006)	(0.007)	(0.005)
Exporter			-0.094***	-0.090***	-0.095***
			(0.021)	(0.021)	(0.018)
Multiprf				-0.107***	-0.095***
				(0.027)	(0.025)
Multiplf				0.047**	0.041**
				(0.021)	(0.019)
Observations	1,973	1,973	1,973	1,973	1,973
R-Squared	0.034	0.110	0.120	0.130	0.130

Note: Asterisks ***, **, and * indicate that the coefficient is significant at 1, 5, and 10 percent level. Product and year dummy variables are included. Constants are not reported.
Source: Author's own calculation.

불확실성에 당면하여 신규 공장을 설립하기보다는 기존 공장을 활용한 실험(experiment)을 통해 미래 수익성을 파악하는 접근 방식을 택할 가능성이 높은 반면, 추종자는 학습효과로 인한 축소된 불확실성 아래에서 신규 공장 설립이라는 비가역성(irreversible)이 큰 투자를 선택할 가능성이 높을 수 있을 것이다.

한편 기업규모 변수 lnworker의 계수는 유의한 음수로 추정되어 기업규모가 작은 기업일수록 신품목 도입이 신규 공장 설립으로 이어지는 경향이 강한 것으로 나타났다.[13] 수출기업(exporter) 변수의 계수도 유의한 음수로 추정되었다. 만일 어떤 기업이 수출하고자 할 때 주요 항구에 인접한 공장을 가지고 있는 것이 유리하고, 또한 기업이 미래 수출 가능성을 염두에 두고 신품목을 생산한다고 하면, 비수출기업이 신품목 생산 시 주요 항구에 인접한 신규 공장을 설립할 가능성이 높을 수 있을 것이라 추측해 볼 수 있을 것이다. 다품목생산기업(multiprf) 더미변수의 계수도 유의한 음수로 추정되었는데, 이에 대한 한 가지 가능한 설명은 다품목생산기업의 경우 신품목이 '제살깎기(cannibalization)'형일 가능성이 높

Table 5. Additional Regressions with Interaction Terms

	[1]	[2]	[3]	[4]	[5]
Follower	0.280***	0.184***	0.215***	0.140***	0.303***
	(0.067)	(0.051)	(0.057)	(0.043)	(0.072)
x Lnworker	-0.033***				-0.017
	(0.009)				(0.012)
x Exporter		-0.125***			-0.080**
		(0.037)			(0.040)
x Multiprf			-0.139***		-0.093*
			(0.050)		(0.053)
x Multiplf				-0.072**	0.031
				(0.032)	(0.039)
Lnworker	-0.024***	-0.044***	-0.043***	-0.043***	-0.034***
	(0.009)	(0.007)	(0.007)	(0.007)	(0.009)
Exporter	-0.089***	-0.016	-0.088***	-0.089***	-0.041
	(0.021)	(0.027)	(0.021)	(0.021)	(0.028)
Multiprf	-0.105***	-0.104***	-0.018	-0.107***	-0.044
	(0.027)	(0.027)	(0.037)	(0.027)	(0.039)
Multiplf	0.050**	0.050**	0.044**	0.088***	0.031
	(0.022)	(0.022)	(0.021)	(0.023)	(0.022)
Observations	1,973	1,973	1,973	1,973	1,973
R-Squared	0.136	0.136	0.136	0.132	0.140

Note: Asterisks ***, **, and * indicate that the coefficient is significant at 1, 5, and 10 percent level. Product and year dummy variables are included. Constants are not reported.
Source: Author's own calculation.

[13]구체적인 이유를 밝혀내는 일은 본 고의 범위를 다소 벗어나는 일이라 판단된다. 그럼에도 불구하고 설명할 수 있는 한 가지 추측은, 대규모 사업장은 본래 생산품목에 큰 차질을 빚지 않으면서 신품목을 생산할 수 있는 여력이 있을 수 있지만 작은 사업장은 그럴 여력이 없어 새로운 공장을 짓는 것이라는 것이다. 이러한 해석을 제시해 준 익명의 검토자께 감사드린다.

기 때문이라는 것이다. 마지막으로 다공장기업 더미변수(multiplf)의 계수는 양수로 추정되었으나 그 유의성은 높지 않았다.

추종자가 개척자 대비 신품목을 신규 공장에서 생산할 가능성이 높은 정도는 기업 특성에 따라 달라질 수 있음을 고려하여 추종자(follower) 변수와 기업 특성 변수 간의 상호작용 항을 추가하여 추정하여 보았다. Table 5는 그 결과를 보여준다. 각 기업 특성 변수의 상호작용 항을 하나씩 추가하였을 때는 모든 상호작용 항이 유의한 음수로 추정되었다. 그러나 모든 상호작용 항을 포함해 추정하였을 때는 수출기업(exporter) 더미변수 및 다품목생산기업 더미변수의 상호작용 항만 각각 5% 및 10% 수준에서 유의한 음수로 추정되었다.

마지막으로 Table 6은 Table 4 및 Table 5의 추정 결과에 대한 견고성 검증 차원에서 수행한 추가적 분석 결과를 보여준다. 견고성 검증은 두 가지 측면에서 수행하였다. 그 첫째는 개척자(pioneer)의 정의에 대한 것이다. 여태까지 개척자는 1990~91년 기간 중 존재하지 않던 품목이 1992년 이후 경제 전체 관점에서 새로이 출현하였을 때 그 품목을 최초 출현 연도에 생산하기 시작한 기업이라고 정의하였다. 1990~91년이라는 2개년만을 기준으로 경제최초생산품목 및 개척자를 정의하였던 것은 기본적으로 품목코드가 일관성이 있는 자료의 시계열이 충분히 길지 못하기 때문이지만, 과연 2개년이라는 기간이 개척자를 식별하기 충분한 기간인지 아닌지는 다소 불확실하다. 예를 들어 1990~91년 기간 중 존재하지 않았던 품목이 1992년에 새로이 출현하였다고 하더라도 1989년에 이 품목이 존재하였을 수도 있다는 것이다. 이 경우 실제로는 경제최초생산품목이 아님에도 불구하고 경제최초생산품목으로 식별될 것이고, 추종자를 개척자로 잘못 분류하게 될 것이다. 만일 위 회귀분석 결과가 보여주는 바와 같이 추종자가 개척자 대비 신품목 도입 시 신규 공장에서 생산하는 경향이 실제로 존재한다면, 개척자를 충분히 까다로운 기준으로 식별하지 않아 추종자를 개척자로 식별할 경우 Table 4 및 Table 5의 추종자(follower)의 추정 계수는 하향 편의를 가질 것이다. 이에 따라 이하의 견고성 검증에서는 1990~92년 3개년 기간 중 존재하지 않았던 품목이 1993년 이후 출현하였을 때 이를 경제최초생산품목이라고 하고, 이 품목을 최초 생산한 기업을 개척자, 추종 생산한 기업을 추종자라고 정의한 후 위와 동일한 회귀식을 추정하여 보았다. 추정된 회귀식은 Table 4 및 Table 5의 마지막 열의 회귀식으로서, 추정 결과는 Table 6의 첫 두 열에 제시되어 있다.

두 번째 견고성 검증은 분석 표본에 대한 것이다. Table 4 및 Table 5의 추정에 사용된 표본의 관측치 수는 1,973개로, 이는 1992년 이후 경제최초생산품목을 최초로 생산했거나 이를 추종하여 생산한 기업–품목 관측치의 생산 첫 연도 관측치 수이다. 이 가운데 개척자는 819개이고, 추종자는 1,154개이다. 그런데 어떤 기업이 경제최초생산품목의 개척자 혹은 추종자로서 기업 관점에서 새로운 품목의 생산을 시작한 당해 연도에 반드시 한 개의 품목 버라이어티만을 신규 생산하는 것은 아니고 두 개 이상의 품목 버라이어티를 신규 생산할 수 있다. 본 연구의 분석 표본 1,973개 관측치 가운데 약 72%는 해당 기업이 새로운 품목 생산 당해 연도에 단 한 개의 품목 버라이어티만을 신규 생산한 경우이지만, 나머지 28% 정도는 해당 기업이 두 개 이상(2~12개)의 품목 버라이어티를 동일한 연도에 신규 생산한 경우이다.[14] 개척자 혹은 추종자가 해당 품목 신규 생산 연도에 여러 개의 품목 버라이

어티를 동시에 신규 생산하는 경우는 해당 품목 하나만을 신규 생산할 경우와 비교하여 신규 공장 설립 여부에 대한 의사결정이 달라질 수 있을 것으로 생각해 볼 수 있다. 따라서 Table 6에서는 개척자든 추종자든 해당 기업이 해당 연도에 한 개의 품목 버리이어티만을 신규 생산하는 관측치(1,415개)만을 추출한 표본에 대하여 위와 동일한 회귀식을 추정한 결과도 보여준다. 추정된 회귀식은 Table 6의 3열 및 4열에 제시되어 있다. Table 6의 마지막 두 열은 개척자의 정의도 보다 까다롭게 하고 한 연도에 한 개의 품목 버라이어티만 신규 생산한 개척자 및 이에 대한 추종자만을 추출한 표본(1,054개 관측치)에 대한 추정 결과를 보여준다.

Table 6의 추정 결과는 Table 4 및 Table 5에 제시된 본 고의 주요 추정 결과와 질적으로 거의 동일하였다. 즉, 추종자(follower)의 계수는 여전히 유의한 양수로 추정되었다. 또한 추종자와 다품목생산기업 더미변수(multiprf)의 상호작용 항은 여전히 유의한 음수로 추정되었다. 개척자를 보다 까다롭게 정의하여 1993년 이후의 개척자 및 이에 대한 추종자만

Table 6. Robustness Check

	Pioneer ≧ 1993		1 New Product Variety		Pioneer ≧ 1993 1 New Product Variety	
	[1]	[2]	[3]	[4]	[5]	[6]
Follower	0.132**	0.338***	0.113**	0.329***	0.142**	0.358***
	(0.055)	(0.096)	(0.054)	(0.100)	(0.071)	(0.126)
x Lnworker		-0.016		-0.020		-0.016
		(0.014)		(0.019)		(0.020)
x Exporter		-0.064		-0.071		-0.050
		(0.045)		(0.053)		(0.058)
x Multiprf		-0.102*		-0.147***		-0.177***
		(0.059)		(0.055)		(0.063)
x Multiplf		-0.008		0.035		0.006
		(0.054)		(0.052)		(0.065)
Lnworker	-0.042***	-0.035***	-0.061***	-0.048***	-0.058***	-0.048***
	(0.008)	(0.009)	(0.011)	(0.017)	(0.013)	(0.017)
Exporter	-0.074***	-0.039	-0.089***	-0.041	-0.067**	-0.035
	(0.020)	(0.029)	(0.026)	(0.042)	(0.027)	(0.042)
Multiprf	-0.100***	-0.044	-0.105***	-0.007	-0.103***	-0.008
	(0.029)	(0.038)	(0.027)	(0.042)	(0.030)	(0.041)
Multiplf	0.028	0.032	0.092***	0.067*	0.076**	0.065*
	(0.025)	(0.022)	(0.027)	(0.038)	(0.031)	(0.038)
Observations	1,501	1,501	1,415	1,415	1,054	1,054
R-Squared	0.127	0.140	0.154	0.168	0.143	0.162

Note: Asterisks ***, **, and * indicate that the coefficient is significant at 1, 5, and 10 percent level. Product and year dummy variables are included. Constants are not reported.
Source: Author's own calculation.

[14]해당 기업이 동일 연도에 3개 이하의 품목 버리이어티를 신규 생산한 경우는 총관측치 수 1,973개의 약 93.4%이다.

Table 7. Probit and Logit Model Estimation Results

	LPM (fixed effect)	Probit	Logit
Follower	0.106***	0.107***	0.105***
	(0.040)	(0.018)	(0.019)
Lnworker	-0.043***	-0.047***	-0.049***
	(0.007)	(0.007)	(0.007)
Exporter	-0.090***	-0.0728***	-0.074***
	(0.021)	(0.018)	(0.018)
Multiprf	-0.107***	-0.056***	-0.053***
	(0.027)	(0.020)	(0.019)
Multiplf	0.047**	0.043**	0.046**
	(0.021)	(0.022)	(0.023)
Observations	1,973	1,973	1,973
Log Likelihood		-763.26	-761.22
Pseudo R^2		0.167	0.169
R-Squared	0.130		

Note: Asterisks ***, **, and * indicate that the coefficient is significant at 1, 5, and 10 percent level. The figures for probit and logit models are average marginal effects.
Source: Author's own calculation.

을 표본으로 한 경우 추종자(follower)의 계수는 Table 4 및 Table 5에 비해 다소 크게 추정되었는데, 이는 예상한 바와 부합한다.

Table 7은 Table 4의 모형 [4]를 probit 모형과 logit 모형을 이용하여 추정한 결과를 위의 선형확률모형(linear probability model: LPM)을 이용한 추정 결과와 비교하여 보여준다. 이 경우 품목 더미변수는 포함하지 않았다. 그 결과 probit 혹은 logit 모형을 이용한 평균한계효과(average marginal effect)의 추정 결과는 Table 4의 선형확률모형을 이용한 추정 결과와 정성적 측면뿐 아니라 정량적 측면에서도 큰 차이가 없었다. Probit 모형 추정 결과를 토대로 볼 때, 경제최초생산품목의 추종자는 개척자에 비해 약 0.1 정도 높은 확률로 신규 공장 설립을 선택하는 것으로 나타났다.

마지막 회귀분석에서는 신품목을 생산 첫 연도에 신규 공장에서 생산한 기업이 기존 공장에서 생산한 기업에 비해 투자 규모가 큰지 여부를 살펴보았다. 이를 위해 기업의 신품목 생산 첫 연도 투자액 변수를 종속변수로 하고, 신규 공장 생산 여부 더미변수 *nplant*를 설명변수로 하는 회귀식을 추정하여 보았다. 통제변수로는 기업규모 등 위 회귀분석과 동일한 변수들을 고려하여 보았다. 또한 위 회귀분석과 마찬가지로 품목 및 연도 고정효과를 고려하였다. 표본도 위의 회귀분석과 동일하다.

Table 8의 회귀식 [1]에서 *nplant*의 계수는 유의한 음수로 추정되었다. 그러나 기업규모 변수(lnworker)를 추가한 회귀식 [2]~[4]에서 *nplant*의 추정 계수는 매우 유의한 양수로 나타났다. 즉, 일단 기업규모를 통제하면 신품목을 신규 공장에서 생산한 기업이 기존 공장에서 생산한 기업에 비해 생산 첫 연도에 더욱 큰 규모의 투자를 하였다는 것이다. 이러한 결과는 수출기업 더미변수(exporter), 다품목생산기업 더미변수(multiprf), 다공장기업 더미

Table 8. Investments: New vs Existing Plants

	[1]	[2]	[3]	[4]
Nplant	-0.907***	0.917***	0.949***	0.973***
	(0.161)	(0.111)	(0.111)	(0.114)
Lnworker		1.252***	1.227***	1.278***
		(0.024)	(0.027)	(0.028)
Exporter			0.218**	0.232**
			(0.091)	(0.091)
Multiprf				0.035
				(0.107)
Multiplf				-0.334***
				(0.103)
Observations	1,655	1,655	1,655	1,655
R-Squared	0.020	0.683	0.684	0.687

Note: Numbers in parenthesis are robust standard errors. Asterisks ***, **, and * indicate that the coefficient is significant at 1, 5, and 10 percent level. Product and year dummy variables are included. Constants are not reported.
Source: Author's own calculation.

변수(multiplf) 등을 통제변수로 추가에 거의 영향을 받지 않았다. 전반적으로 Table 4 및 Table 8의 회귀분석 결과는 추종자가 개척자 대비 신품목 생산을 기존 공장보다 더 큰규모의 투자가 필요한 신규 공장에서 생산하는 경향이 있음을 말해준다. 그리고 이러한 분석 결과는 추종자가 개척자의 경험으로부터 얻는 학습파급효과로 인해 개척자에 비해 작은 신품목 미래 수익성의 불확실성을 당면하게 된다는 해석을 가능케 한다.

V. 요약 및 맺음말

본고는 1990~96년 우리나라 제조업의 연도별 기업－사업체－품목 자료를 이용하여 어떤 품목을 경제 최초로 생산한 개척자와 이 품목을 뒤이어 생산한 추종자 간 해당 품목 생산 방식(기존 공장 활용 vs. 신규 공장 생산)의 선택에 있어서 차이점이 있는지를 분석하였다. 그 결과 추종자는 개척자에 비하여 신규 생산 품목을 기존 공장보다는 신규 공장에서 생산하는 경향이 강하다는 점을 발견하였다. 이러한 결과는 개척자로부터 추종자로 흐르는 신품목의 미래 수익성에 대한 학습파급효과(learning spillovers)의 존재와 부합하는 것으로 판단된다. 또한 신품목 생산을 위해 신규 공장을 설립하는 의사결정이 기존 공장을 활용하는 대안 대비 더 큰 투자를 수반한다는 결과도 얻을 수 있었다. 이러한 분석 결과들은 학습파급효과의 내용이 신품목의 미래 수익성에 대한 불확실성 감소라는 가설과 부합한다고 판단된다.

본 고는 다음과 같은 몇 가지를 포함한 여러 가지 한계점을 갖는다. 먼저 본 연구가 최근

한국경제의 여건과 차이가 있을 수 있는 1990년대 자료를 사용하였다는 점이다. 1990년대 자료를 사용할 수밖에 없었던 이유는 자료의 가용성 문제 때문이다. 특히 본 고에 필수적인 사업체－기업 매칭 테이블은 통계청에서 공식적 절차를 통해 제공하는 자료 목록에서 찾아볼 수 없었다. 통계청의 「광업・제조업조사」가 기본적으로 사업체를 조사 대상으로 하는 자료이기는 하지만, 만일 통계청이 사업체－기업 매칭 정보를 가지고 있고, 또한 이러한 정보를 어떠한 방식으로든 연구자에게 제공할 수 있다면 좋을 것으로 생각된다. 또 다른 한계는 본 연구가 기업의 신품목 생산 시 신규 공장 설립 여부 의사결정에 대한 엄밀하고도 정치한 이론이 뒷받침되지 않은 분석에 머물렀다는 점이다. 이러한 이론은 보다 설득력 있는 실증분석의 틀을 제공해 줄 수 있을 것이다. 마지막으로 본 연구는 분석 결과들이 개척자로부터 추종자로 흐르는 학습파급효과의 존재를 시사하는 것으로 해석하였다. 더 나아가 본 연구는 이러한 학습파급효과의 본질(nature)이 개척자 대비 추종자가 당면한 신품목의 미래 수익성에 대한 불확실성의 감소라고 해석해 보았다. 그러나 이러한 해석이 충분한 설득력을 가지기 위해서는 본 논문에서 관찰된 여러 실증적 증거가 우리나라의 다른 시기 혹은 다른 국가에 대해서도 얻어질 수 있는지, 또한 불확실성 감소가 학습파급효과의 주된 내용인지 여부에 대한 추가적인 연구가 필요하다고 판단된다.

부 록

Table A1. Pioneered Products in Computing Machinery and Communication Equipment Industry

Computing Machinery (KSIC 30)		Communication Equipment (KSIC 32)	
Product Code	Product Name	Product Code	Product Name
30011104*	personal computer	32101106*	other braun (receiver or amplifier valves)
30011105*	notebook, palm-top	32101107	statie tubes
30011106*	digital processing units	32101108*	photo-cathede tubes
30012104*	CD Rom disk drive	32103105*	copperfoil laminated sheet (epoxy type)
30013104*	computer receiver (monitor)	32105105*	variable carbon resistors
30013105*	magnetic head (used computer)	32106106	biopolar
30013201*	key board	32106107	other electronic integrated circuits
30013202	mouse	32106108	M O S microcomponent integrated circuits
30013203	optical character reader	32106111*	M O S memory integrated circuits
30013204	scanner	32106119*	electronic integrated circuits and parts
30013205	bar code reader	32106200*	analog IC and digital-analog mix type
30013209*	others (input device)	32106300*	hybrid integrated circuit
30013301*	laser printer	32201108	voice answering machine
30013302*	dot printer	32300115*	laser disc player
30013303*	ink jet printer	32300116*	TVCR
30013304	data disk	32300117*	Karaoke machine
30013305*	computer receiver cmoniter	32300118*	TV broadcast transmitter
30013309*	others (output device)	32300121*	closed caption TV
30013401*	terminal	32300122*	monitor TV (broadcast)
30013403	audio input, output units	32300123*	VTR for broadcasting
30013409*	others (both input and output)	32300129*	TV component N.E.C
30019100*	others computer and accessories	32300507	magnetic head (used audio)
30022104	ticket-issuing machines	32300508	magnetic head (used video)
30029107*	electronic dictionary and electronic note	32300511	magnetic head (used computer)
30029108*	automatic passbook regulator	32300519	other audio equipment and parts
30029111*	automatic transaction terminal		
30029112*	B.C card inquiry machine		
30029119*	other office and accounting machinery and parts		

Note: This table shows the names of the pioneered products identified from the entire product data. Product codes with are for pioneered products in the sample with matched firm code.
Source: Author's own calculation.

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Product Pioneers and Followers' Choices on New vs Existing Plant to Product New Products: Evidence from Korean Manufacturing and Implications on Learning Spillovers†

By Chin Hee Hahn*

This paper examines whether product pioneers differ from product followers in their decision to establish a new plant to product a new product, utilizing a firm-plant-product dataset for Korean manufacturing from 1990 to 1996. We find that followers are more likely to establish a new plant rather than utilize existing plants to product a product which is new to the plant. We also find that establishing a new plant is accompanied by a larger investment than utilizing existing plants. These results seem consistent with the existence of pioneer-to-follower learning spillovers, possibly in the sense that followers face less uncertainty about the future profitability of the new product.

Key Word: Pioneer, Follower, Learning Spillovers, Uncertainty, Investment
JEL Code: O11, O14, O31, O47

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우리나라 노동시장 상황과 인플레이션 간의 관계 변화†

허준영 · 채민석*

본고는 최근 고물가와 견조한(tight) 고용시장 상황이 나타나면서 미국 등 선진국을 중심으로 논의되고 있는 노동시장과 인플레이션, 그리고 통화정책 간 관계의 시간에 따른 변화를 우리나라 데이터를 통해 연구하고자 한다. 먼저 2009년 7월부터 2023년 6월까지의 데이터를 분석한 결과, 노동시장의 상황을 포착하는 빈일자리율이 인플레이션에 미치는 영향은 시간에 따라 점점 증대되어 온 것으로 나타났다. 또한 인플레이션의 노동시장 상황 변화에 대한 반응도는 인플레이션 수준이 낮은 때보다는 높은 시기에 더욱 증가하는 것으로 도출되었다. 마지막으로 통화정책 변화가 빈일자리율에 미치는 영향은 불황기와 코로나19 팬데믹 이후 기간에 대해 더욱 도드라지는 것으로 나타났다. 이와 같은 결과는 우리나라에서 노동시장과 인플레이션 간의 관계가 볼록성(convexity)을 가질 가능성을 시사한다. 이 경우 인플레이션이 높을 때 금리를 인상하면 빈일자리율의 감소보다 인플레이션의 하락 효과가 상대적으로 클 것이기 때문에 통화정책 운용에 있어 유리한 상황으로 작용할 수 있다.

Key Word: 노동시장, 빈일자리율, 인플레이션, 통화정책
JEL Code: E31, E52, C32

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I. 서 론

거시경제 수준에서 물가와 경기와의 상충관계(trade-off)는 중앙은행의 오랜 관심사였다. 통상적으로 필립스 곡선(Phillips curve)로 요약되는 이러한 상충관계는 통화정책이 인플레이션 및 실물경제에 미치는 영향에 대한 중요한 함의를 갖기 때문이다. 이러한 논의는 물가안정뿐만 아니라 금융안정을 추구하는 한국은행에도 적용된다. 물론 필립스 곡선은 물가와 경기 사이의 관계를 반영하므로 금융안정과 직접적인 관련은 없어 보일 수 있으나, 경기변동이 소득변동을 통해서 금융안정에 영향을 미친다는 점에서 간접효과가 존재할 수 있다는 점에서 더욱 그러하다.

학계나 정책당국에서는 2008~09년 글로벌 금융위기 이후 장기간 실업률이 자연실업률을 상회함에도 물가가 크게 하락하지 않는 현상들이 관측되면서 필립스 곡선의 관계가 유효한지에 대한 논의가 있어 왔다. 특히 최근 들어서는 미국을 중심으로 고물가와 견조(tight)한 고용시장 상황이 나타나면서 노동시장 상황과 인플레이션의 관계에 대한 활발한 연구가 진행중이다.[1]

이러한 물가와 경기의 관계에 있어 특징 중 하나는 경기 국면이나 인플레이션 수준에 따라 해당 관계가 변할 가능성이 높다는 점이다. 특히 글로벌 금융위기 이후에는 위기 전후로 주요국에서 노동시장 상황으로 도출한 경기와 인플레이션 사이의 상충관계가 약화되는 등 경제구조 및 상황에 따라 해당 관계의 정도가 변한다는 견해가 널리 받아들여지고 있다. 예를 들어 IMF(2013)에서는 선진국을 대상으로 인플레이션과 실업률 간의 상충관계가 2008~09년 글로벌 금융위기 이후 약화된 것을 보고하고 있으며, Powell(2018)은 이러한 관계가 인플레이션 수준에 따라 변화되는 것을 강조한 바 있다. 이러한 맥락에서 Gagnon and Collins(2019)는 인플레이션 수준에 따라 해당 관계가 변화함을 실증적으로 보인 바 있다. 한편 Nalewaik(2016)이나 Babb and Detmeister(2017)와 같은 연구에서는 해당 관계의 정도가 실업률 등으로 나타나는 노동시장 상황에 따라 달라짐을 도출하였다.

나아가 최근 기간에 대해서는 코로나19 위기를 거치면서 노동시장과 인플레이션 사이의 관계가 이전 시기와는 달라지고 있는 특성이 관측된다. 예를 들어 2022년 이후 급격한 인플레이션 상승에 대응하기 위해 미국 연준은 기준금리를 빠르게 상승시켰는데, 이후 2023년 1/4분기에서부터 3/4분기까지의 기간 동안 인플레이션은 상당한 속도로 내려오고 있는데 비해 실업률은 전례 없이 낮은 상태로 유지되고 있다. 이러한 최근의 상황은 통화정책적 관점에서 노동시장과 인플레이션 간의 관계가 구조적으로 변하였는지, 또한 이와 같은 관계가 어떤 유휴노동력 지표를 통해 나타나는지 등과 같은 중요한 함의를 지닌다. 노동시장과 인플레이션 간의 구조적인 변화 여부는 통화정책의 실물경제에 대한 유효성 측면에서, 유휴노동력 지표의 반응 여부는 정책 파급경로로서의 노동시장의 유용성 측면에서 의미가 있을 것이기 때문이다.[2]

[1] 필립스 곡선 추정에 관한 최근 미국 대상 문헌 흐름은 Hooper *et al.*(2020)에 잘 정리되어 있다.
[2] 미국을 대상으로 코로나19 팬데믹 이전과 이후 노동시장 상황과 인플레이션 간 관계 변화에 대해 연구한 논문으로는

그러나 이렇게 노동시장과 인플레이션 간의 관계에 대한 다양한 연구가 진전되었던 미국 등 선진국과는 달리 우리나라를 대상으로 한 동 주제의 연구는 제한적인 것이 사실이다. 다만 우리나라 노동시장과 인플레이션 사이의 관계에 대한 연구는 최근 한국은행을 중심으로 이루어져 왔는데, 오삼일 외(2022)는 기존 필립스 곡선 논의에서 주로 사용되었던 변수인 실업률보다 빈일자리율이 노동시장 상황을 더 잘 반영하는 변수임을 보인 Barnichon and Shapiro(2022)에서와 같이 우리나라 빈일자리율 데이터를 사용하였을 때 해당 관계가 더욱 강건하게 도출됨을 보였다. 송상윤・배기원(2022)은 전국 단위 데이터에서는 잘 관측되지 않던 노동시장 상황과 인플레이션 간의 관계가 지역별로 세분화된 자료를 사용하였을 때 더 잘 추정되는 것을 보고하였다.

본고는 미국 등 선진국을 중심으로 논의되고 있는 노동시장과 인플레이션, 그리고 통화정책 간의 시간에 따른 관계 변화를 우리나라 데이터를 통해 연구하고자 한다. 구체적으로 본 연구의 첫 번째 관심사는 노동시장 상황의 변화가 인플레이션에 미치는 영향이 시간에 따라 변화해 왔는지, 그리고 해당 영향이 인플레이션 수준에 따라 달라지는지의 여부이다. 이를 위해 벡터자기회귀(Vector Autoregressive: VAR) 모형을 설정하고 노동시장 상황을 반영하는 변수에의 외생적 충격을 식별하여 인플레이션의 반응을 시산한다. 본 고에서는 기존 국내 연구인 오삼일 외(2022)와 송상윤・배기원(2022)을 따라 빈일자리율을 노동시장 상황을 반영하는 변수로 고려하고, 반응변수인 인플레이션과 함께 인플레이션에 영향을 줄 수 있는 변수인 수입물가 인플레이션과 기대인플레이션으로 구성된 4변수 VAR 모형을 설정한다. 월별 빈일자리율 데이터가 가용한 2009년 7월부터 2023년 6월까지 기간에 대해 노동시장 상황의 변화가 인플레이션에 미치는 영향의 시변패턴을 시산하기 위해 다음이 두 가지 VAR 방식을 원용한다. 첫 번째 접근법은 매기 VAR 모형의 모수가 변할 수 있는 것을 허용하는 시변모수 벡터자기회귀(Time-varying Coefficient VAR: TVC-VAR) 모형을 사용하는 것이며, 두 번째 접근법은 일반적인 고정계수 VAR 모형을 구간이동방식(rolling window)으로 추정하는 방식이다. 한편 이러한 노동시장이 인플레이션에 미치는 영향이 인플레이션 수준에 따라 다른지를 분석하기 위해 전년 동기 대비 인플레이션이 한국은행의 인플레이션 목표(target)보다 높았던 시기와 낮았던 시기를 나누어 고정계수 VAR 모형을 추정하여 충격반응함수를 비교한다.

본고의 두 번째 연구 주제는 통화정책이 노동시장에 미치는 효과의 시간변화 여부이다. 특히 외생적 통화정책 변화에 대한 노동시장에의 파급효과가 경기 팽창기・수축기나 코로나19 팬데믹 이전・이후 등 국면별로 달라지는지를 검증하고자 한다. 이를 위해 VAR 모형을 설정하여 외생적 통화정책 충격을 식별한 후 해당 충격 시퀀스(sequence)를 국소투영법(local projection: LP) 기법에 적용하여 통화정책 충격이 빈일자리율과 실질임금 등 노동시장 변수들에 미치는 영향과 해당 영향이 특정 거시경제 국면별로 어떻게 달라지는지를 시산한다.

실증분석 결과 TVC-VAR 및 rolling window VAR 모형은 노동시장 상황 변화가 인플레이션에 미치는 영향에 대한 일관된 결론을 제시해 주는 것을 확인하였다. 구체적으로 빈

Ball *et al.*(2022)이나 Benigno and Eggertsson(2023) 등이 있다.

일자리율이 상승하면, 즉, 노동시장이 보다 견조해지면 인플레이션은 단기적으로 상승하는데, 이와 같은 반응의 반응도가 2009년 이후 최근 기간까지 지속적으로 증가하면서 2010년대 후반부터는 통계적으로 유의미해진 것으로 나타났다. 이와 같은 결과를 미국과 비교하기 위해 TVC-VAR을 미국 데이터를 이용하여 추정한 결과 분석기간 동안 우리나라와 유사한 시변패턴이 관측되었다. 다만 우리나라의 경우 미국보다 평균적인 반응도가 크게 식별되며, 코로나19 팬데믹 이후 인플레이션의 반응도가 다시 낮아지는 추세를 보였던 미국과는 다르게 팬데믹 이후에도 반응도가 감소하지 않는다는 차이점도 보였다. 한편, 두 국가 모두 2009년 이후 2010년대 중반까지는 반응도가 통계적으로 유의하지 않은 것은, 이준석・장용성・최영두(2022)의 분석에서 1970~2014년 중 인플레이션과 실업률의 관계가 점차 평탄화 되었고 특히 2010~14년 중에는 한국과 미국 모두 그 관계가 통계적으로 유의미하지 않게 나타난 것과 일관되는 결과라고 볼 수 있다.

나아가 이와 같은 우리나라에서의 노동시장 상황 변화에 따른 인플레이션 반응도의 변화는 인플레이션 수준과 관계를 가지고 있는 것으로 나타났다. 빈일자리율 증가에 대한 인플레이션의 반응은 인플레이션(YoY)이 한국은행의 인플레이션 목표를 상회하는 시기가 그렇지 않을 때보다 큰 것으로 추정되었다. 2021년 이후 인플레이션이 중앙은행의 목표를 지속적으로 상회하였다는 점에 비추어 볼 때, 이러한 결과는 TVC-VAR 및 rolling window VAR 모형에서 도출된 것처럼 최근 기간에 대해 노동시장 상황 변화가 인플레이션에 미치는 영향이 증대된 패턴과 부합한다. 또한 IMF(2013)나 Powell(2018)에서 보고된 노동시장과 인플레이션 간의 비선형적 관계가 우리나라 데이터에서도 관측됨을 시사한다.

마지막으로 LP 분석 결과는 외생적 통화정책 변화가 노동시장 변수 가운데 빈일자리율에 미치는 영향이 상태의존적(state dependent)임을 나타낸다. 긴축적 통화정책 충격 발생 시 불황기와 코로나19 팬데믹 이후 기간에 대해서는 빈일자리율이 단기적으로 유의하게 감소한다. 그러나 호황기나 코로나19 팬데믹 이전에 대해서는 해당 충격에 대한 빈일자리율의 반응이 충격 이후 대부분의 시계에 걸쳐 유의하지 않았다. 한편 통화정책 충격에 대한 실질임금의 반응은 모든 국면에 대해 통계적으로 유의하지 않게 도출되었다.

본 고는 크게 5장으로 구성되어 있다. 먼저 Ⅱ장에서는 노동시장 변수로 실업률 대신 빈일자리율을 고려하게 된 배경을 설명한다. Ⅲ장에서는 먼저 TVC-VAR 모형과 해당 분석결과를 제시하고, 이어서 고정계수 VAR 분석을 통해 TVC-VAR 모형 결과의 강건성을 검증한 후, 빈일자리율 변화에 대한 인플레이션 반응이 인플레이션 수준별로 다른지를 검증한다. Ⅳ장에서는 LP 기법을 사용하여 통화정책 충격에 대한 노동시장 변수들의 반응에 비선형성이 있는지 분석한다. 마지막으로 Ⅴ장에서는 연구 결과를 요약하고 정책적 시사점을 도출하였다.

Ⅱ. 노동시장 변수의 선택

일반적으로 노동시장 변수로 실업률이나 실업률 갭(unemployment gap)을 사용하는 것과 달리 본 고에서는 빈일자리율, 즉, '빈일자리수 / (임금근로자수+빈일자리수)'를 대신 사용하는데, 그 이유는 다음과 같다.

우선 Barnichon and Shapiro(2022) 등 여러 연구는 노동시장 상황을 대변하는 변수로 실업률이나 실업률 갭이 최선의 선택이 아닐 수 있음을 보이고 있으며, 특히 우리나라 실업률 지표는 노동시장 상황을 비대칭적으로 반영할 가능성이 크다. 즉 실업률이 하락에 있어서는 별다른 제약을 받지 않는 반면, 상승에 있어서는 상대적으로 강하게 제약을 받을 수 있다. 대표적인 예로 코로나19 팬데믹 기간 중 우리나라와 미국 모두에서 일시휴직의 형태로 노동시장 유휴인력(slack)이 크게 증가하였는데 양국 실업률의 변화는 크게 달랐다. 미국의 경우 일정 기간 후 재고용을 약속받고 퇴직 처리된 일시휴직자를 실업자로 분류하고 실업급여를 제공하기 때문에, Figure 1에서 보듯이 코로나19 팬데믹 기간 중 실업률이 크게 상승하였다. 반면, 우리나라는 일시휴직자를 취업자로 분류함에 따라 동기간 중 실업률의 상승 폭이 크지 않았다. 이를 더 자세히 살펴보기 위해 일시휴직자를 실업자에 포함한 보정 실업률을 산출해 보면, 동기간 중 실업률의 상승 폭이 크게 확대되는 것을 확인할 수 있다. 아울러, 우리나라의 경우 경기수축으로 인한 불황기에 정부가 적극적으로 일자리를 창출함으로써 일자리 감소를 막는 정책을 펼치는 경향이 있는데, 이 또한 실업률의 상승이 제약되는 비대칭성을 초래할 가능성이 있다.

이와 같은 우리나라 실업률 지표의 특성 및 정책 여건은 실업률과 경기 간의 관계를 약화시키는 결과로 이어질 수 있다. 통상적으로 오쿤의 법칙(Okun's law)으로 요약되는 산출

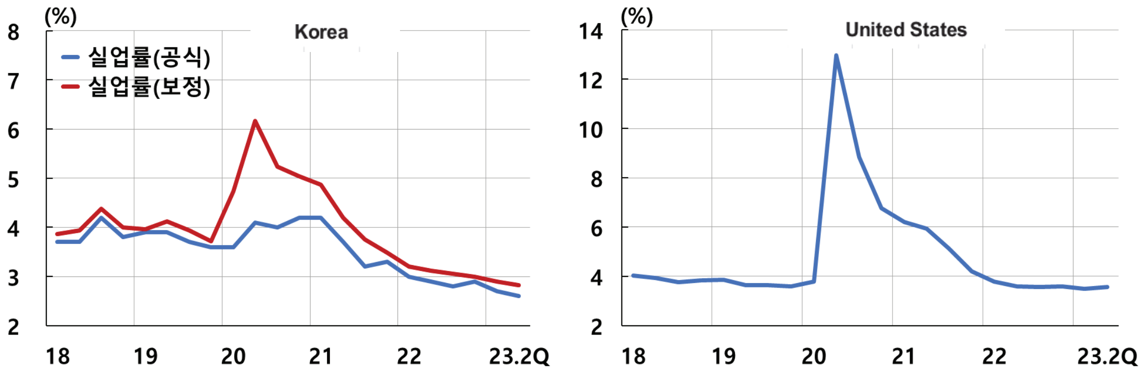

Figure 1. The Unemployment Rates in Korea and the U.S. Before and After the Pandemic

Note: Unemployment rate = Unemployed / Labor force × 100; Adjusted unemployment rate = (Unemployed + Temporarily laid off) / Labor force × 100

Source: Statistics Korea, Labor Force Survey, Author's calculation.

Note: Unemployment rate = (Unemployed, including temporarily laid off) / Labor force × 100

Source: U.S. Bureau of Labor Statistics (BLS), Current Population Survey.

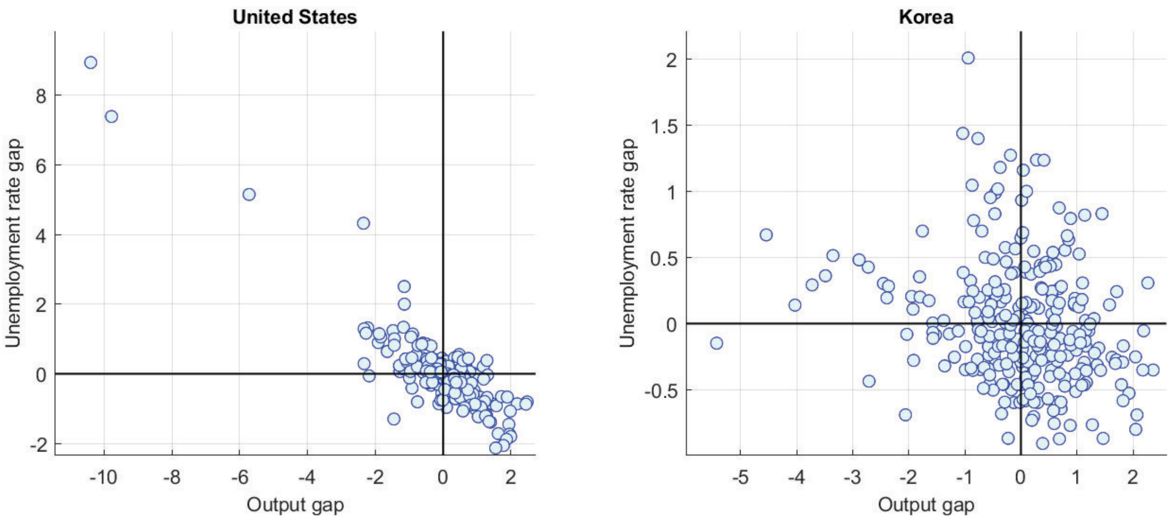

Figure 2. The Relationship Between the Output Gap and the Unemployment Rate Gap in the U.S. and Korea.

Note: The estimation of gap variables (i.e., real GDP growth rate) and the trend of the unemployment rate was performed using the Hodrick-Prescott filter.

Source: Statistics Korea, U.S. Bureau of Labor Statistics (BLS), Author's calculation.

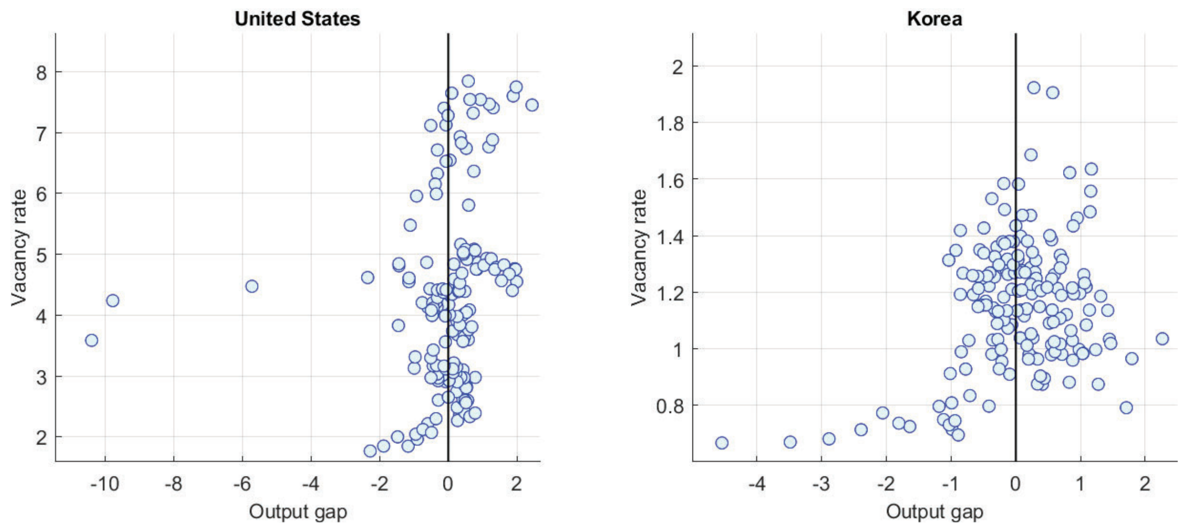

Figure 3. The Relationship Between the Output Gap[1)] in the U.S. and Korea and the Job Vacancy Rate[2)].

Note: 1) The estimation of the output gap (i.e., real GDP growth rate) trend was performed using the Hodrick-Prescott filter; 2) Job vacancy rate = (Number of vacancies / (Number of wage workers + Number of vacancies)) × 100.

Source: Statistics Korea; Ministry of Employment and Labor; U.S. Bureau of Labor Statistics (BLS), Author's calculation.

갭과 실업률 갭 간의 관계를 살펴보기 위해 2009년 7월부터 2023년 6월까지의 월별 데이터를 분석하였다. 갭 변수의 시산을 위해 산출과 실업률의 추세는 Hodrick-Prescott 필터를 이용하여 추정하였다. 이렇게 도출한 미국과 한국의 산출 갭과 실업률 갭 간의 관계는 Figure 2에 제시되어 있다. 이 그림을 통해 알 수 있듯이 미국의 경우 두 변수 사이의 음(-)

의 관계가 강하게 나타나는데 반해 우리나라에서는 미국만큼 강한 관계가 관측되지 않는다. 실제로 분석기간 동안 두 변수 사이의 상관관계는 미국이 −0.87, 한국이 −0.22로 도출되어 이와 같은 사실을 뒷받침한다.

이와 같이 노동시장 상황을 보여주는 데 많은 한계를 가진 실업률이나 실업률 갭에 대한 대안으로 몇 가지 변수들을 고려해 볼 수 있다. 예를 들어 우리나라 통계청은 공식 실업률에 대한 대안 지표로 고용보조지표들을 발표하고 있는데, 김태봉・이한규(2020)는 동 지표들이 공식 실업률 지표에 비해 오쿤의 법칙 또는 필립스 곡선과 같은 통계적 관계에서 그 유효성이 보다 높다는 실증분석 결과를 제시하였다. 그러나 이러한 고용보조지표들은 2015년부터 발표되기 시작하였기 때문에 분석에 사용하기에는 아직 시계열이 짧다는 단점이 있다.

반면, 본 고에서 선택한 빈일자리율의 경우 충분한 시계열이 제공되면서도 노동시장 상황을 잘 나타내는 변수이다. Domash and Summers(2022)는 노동시장과 물가의 관계를 추정함에 있어 빈일자리율이 실업률보다 낫다는 결과를 보였다.[3] 비슷한 맥락에서 우리나라를 대상으로 한 오삼일 외(2022)에서도 빈일자리율이 여타 고용 지표에 비해 노동시장 상황을 잘 나타내는 것으로 나타났다. 또한 Figure 3을 보면 2009년 이후 우리나라의 빈일자리율과 산출 갭 간의 상관계수는 0.31로 Figure 2에서 보았던 실업률과 산출 갭 간의 상관계수보다 다소 높은 것으로 나타났다.

Ⅲ. 노동시장이 물가상승률에 미치는 영향의 시변패턴: VAR 모형 및 추정결과

본 장에서는 위의 Ⅱ장에서 살펴본 데이터를 바탕으로 노동시장 상황 변화가 인플레이션에 미치는 영향을 분석한다. 구체적으로는 VAR 모형을 사용하여 빈일자리율을 외생적으로 상승시키는 충격을 식별하고, 해당 충격에 대한 인플레이션의 반응을 시산함으로써 이와 같은 영향을 파악한다. 이러한 VAR 방법론은 Benati(2015)나 Ascari *et al.*(2023) 등의 기존 문헌에도 동 연구 주제 분석을 위해 사용된 바 있다.

1. 시변계수 VAR 모형 및 충격반응함수

먼저 다음과 같은 축약형 시변계수 VAR 모형을 상정한다.

[3] Barnichon and Shapiro(2022) 등에서 노동 수요 및 공급을 각각 반영한다고 할 수 있는 빈일자리수와 실업자 수 간의 비율을 노동시장 변수로 선택하고 있는 것과 비교하면, 본 고에서 빈일자리만 고려한 것은 실업률이 자연실업률 등 균형 수준에 머물러 있는 경우를 가정한 것이라고 해석할 수 있다. 이는 우리나라 실업률의 수준과 변동성이 미국 등에 비해서는 매우 낮다는 점에서 현실성 있는 가정이라고 볼 수 있으며, 특히 앞서 언급한 바와 같이 실업률이 노동시장 상황을 비대칭적으로 반영할 수 있다는 문제점을 피할 수 있다는 장점이 있다.

(1) $$z_t = c_t + B_{1,t} z_{t-1} + \dots + B_{k,t} z_{t-k} + u_t, \quad E(u_t u_t{}') = \Sigma_{u,t}$$

여기에서 z_t는 n개의 내생변수로 구성된 $n \times 1$ 차원의 내생변수 벡터이다. 식 (1)에 제시된 축약형 시변계수 VAR 모형은 일반적인 고정계수 모형에서 축약형 VAR 모형의 계수인 B 행렬과 축약형 오차의 분산-공분산 행렬인 Σ_u가 시간에 따라 변할 수 있도록 한 것임을—따라서 B_t와 $\Sigma_{u,t}$가 되는 것을—알 수 있다. 분석을 위해 먼저 내생변수 벡터를 $z_t = [v_t, \pi_t]'$와 같이 빈일자리율 v_t와 연율화된 전월 대비 인플레이션율 π_t로 구성된 2변수 모형을 고려하고, VAR 모형의 시차(lag)는 4로 설정하여 $k = 4$가 된다.

위의 축약형 VAR에 구조식별제약을 부과하여 동 축약형 모형에 상응하는 시변모수 구조적 VAR 모형을 설정하면 다음과 같다.

(2) $$A_t z_t = A_t (c_t + B_{1,t} z_{t-1} + \dots + B_{k,t} z_{t-k}) + e_t, \quad E(e_t e_t{}') = \Sigma_{e,t}$$

단, A_t는 당기반응계수 행렬이며, e_t는 $e_t = A_t u_t$인 구조적 충격이 되어 $\Sigma_{e,t}$의 비대각원소(off-diagonal element)들은 0이 된다.

구조적 VAR 모형의 식별을 위해 A_t 행렬을 Primiceri(2005)에서와 같이 내생변수들의 외생성 순서를 가정하여 도출하는 축차적 방식(또는 촐레스키 분해, Cholesky decomposition)을 사용할 수 있다. 이에 대한 자세한 설명을 위해 2변수 축약형 VAR 모형의 분산－공분산 행렬 $\Sigma_{u,t}$을 다음과 같이 나타내어 보자.

(3) $$\Sigma_{u,t} = \begin{bmatrix} \sigma_{1,t}^2 & \sigma_{1,t}\sigma_{2,t}\rho_{12,t} \\ \sigma_{1,t}\sigma_{2,t}\rho_{12,t} & \sigma_{2,t}^2 \end{bmatrix}$$

여기에서 $\sigma_{j,t}^2$는 j번째 축약형 VAR 오차(residual)의 분산을 나타내며, $\rho_{ij,t}$는 i번째와 j번째 축약형 VAR 오차 사이의 상관계수(correlation coefficient)를 의미한다. 이때 해당 행렬의 촐레스키 분해를 통해 구해지는 A_t 행렬은 다음과 같이 나타내어짐이 잘 알려져 있다.

(4) $$A_t = \begin{bmatrix} \sigma_{1,t} & 0 \\ \sigma_{2,t}\rho_{12,t} & \sigma_{2,t}\sqrt{1-\rho_{12,t}^2} \end{bmatrix}^{-1}$$

이때, 모형의 첫 번째 변수인 v_t를 1만큼 증가시키는 다음의 충격을 고려해 보자.

(5)
$$e_{0,t} = \begin{bmatrix} 1/\sigma_{1,t} \\ 0 \end{bmatrix}$$

이러한 충격에 대한 모형의 두 번째 변수인 π_t의 당기(impact period) 충격반응함수는 다음과 같이 나타낼 수 있다.

(6)
$$z_{0,t} = A_t^{-1} e_{0,t} = \begin{bmatrix} 1 \\ \rho_{12,t} \times (\sigma_{2,t}/\sigma_{1,t}) \end{bmatrix} = \begin{bmatrix} 1 \\ cov(u_{1,t}, u_{2,t})/var(u_{1,t}) \end{bmatrix}$$

위 식 (6)에서 $\widetilde{\beta_t} \equiv \rho_{12,t} \dfrac{\sigma_{2,t}}{\sigma_{1,t}} = \dfrac{cov(u_{1,t}, u_{2,t})}{var(u_{1,t})}$로 정의하면 $\widetilde{\beta_t}$는 다음 회귀식의 계수 β_t의 추정치에 상응하게 된다.

(7)
$$\pi_t = c_t + \beta_t v_t + \epsilon_t$$

여기에서 $\widetilde{\beta_t}$는 위 필립스 곡선 식 (7)에서 기울기를 나타내는 항에 해당함을 알 수 있다. 결국, 본 고에서 축차적 방식을 통해 VAR 모형의 충격을 식별한 것은 빈일자리율 충격에 대한 인플레이션의 당기(impact period) 반응이 통상적인 회귀분석을 통한 필립스 곡선 기울기 추정치와 유사(analogous)하게 해석되도록 하기 위함이다.

다만, VAR에서의 충격반응함수는 기본적으로 외생적 충격에 대한 인과관계를 보는 것인 반면, 통상적인 필립스 곡선의 관계는 상관관계에 가깝기 때문에 VAR의 충격반응함수를 필립스 곡선의 기울기로 직접적으로 해석하기에는 무리가 있다.

2. 시변계수 VAR 모형의 충격반응함수 추정 결과

위의 시변계수 VAR 모형을 2009년 7월부터 2023년 6월까지의 미국 데이터를 사용하여 추정하였다. 구체적으로 Primiceri(2005) 및 Galí and Gambetti(2015) 등 기존 문헌에 따라 동 모형의 추정을 위해 베이지안(Bayesian) 방식을 사용하였다.[4] 이렇게 추정된 빈일자리율에 대한 충격 후 인플레이션의 시점별 충격반응함수의 시변패턴은 Figure 4에 제시되어 있다. 중간값 추정치 기준 당기의 충격반응함수는 2009년 이후 2020년 초반까지 지속적으로 상승한 후 이후 약간 감소한 것으로 분석되었다. 이와 같은 결과는 미국의 경우 2009년 이후 최근의 코로나19 기간 이전까지 노동시장 상황 변화가 인플레이션에 미치는 영향이 증가한 것을 시사한다. 한편 68% 밴드 추정치에 근거하면 이와 같은 영향이 2010

[4] 시변계수 VAR 모형 추정에 관한 자세한 설명은 부록에 제시되어 있다.

(Unit: %)

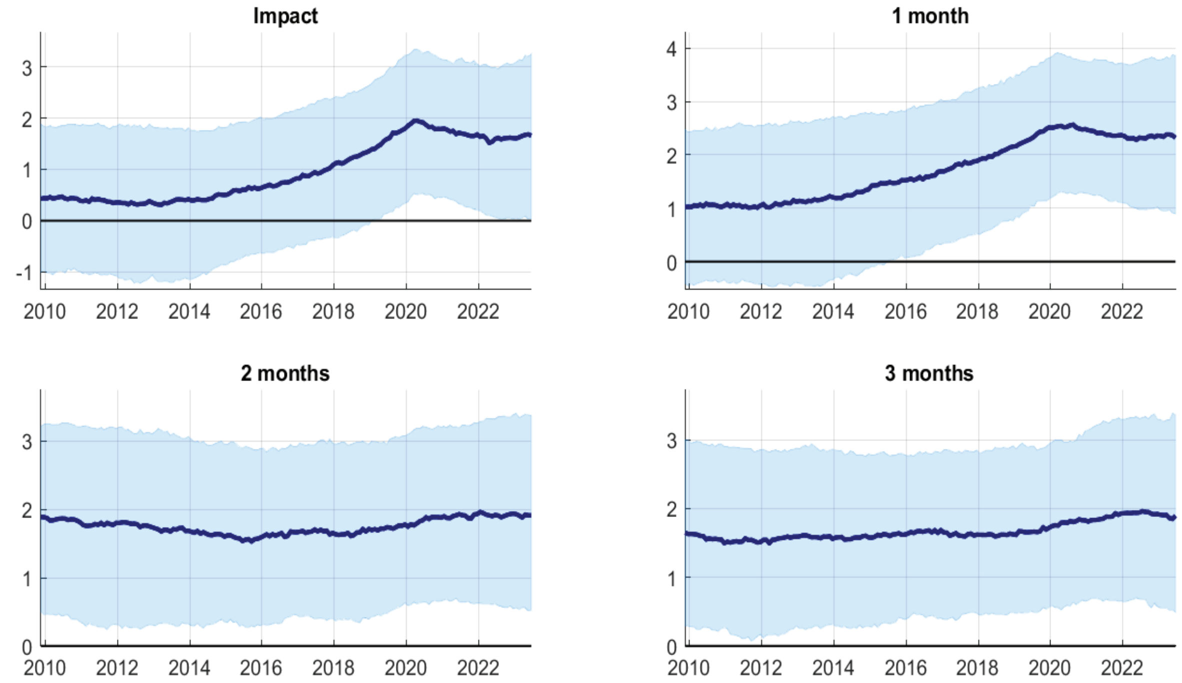

Figure 4. The Impulse Response Function of a Two-Variable Time-Varying Coefficient VAR Model for Inflation After a Shock to the Job Vacancy Rate in the U.S.

Note: In each figure, the solid line and shading represent the median of the posterior distribution and the [16%, 84%] error band estimates.

(Unit: %)

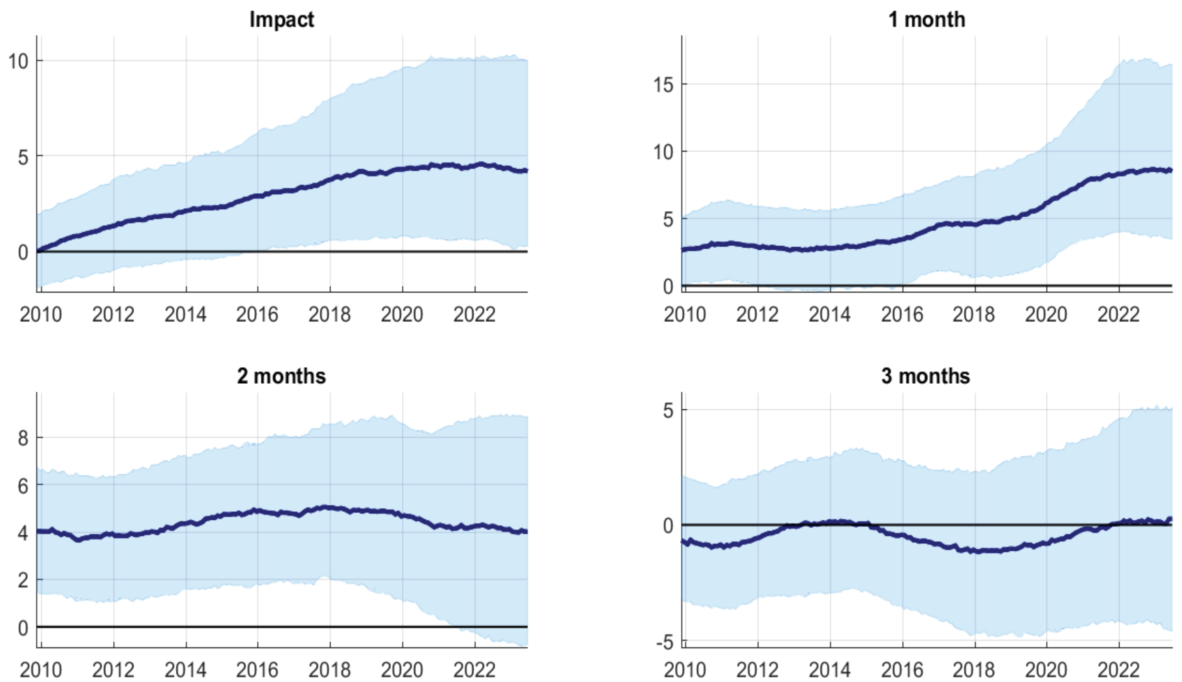

Figure 5. The Impulse Response Function of a Two-Variable Time-Varying Coefficient VAR Model for Inflation After a Shock to the Job Vacancy Rate in Korea

Note: In each figure, the solid line and shading represent the median of the posterior distribution and the [16%, 84%] error band estimates.

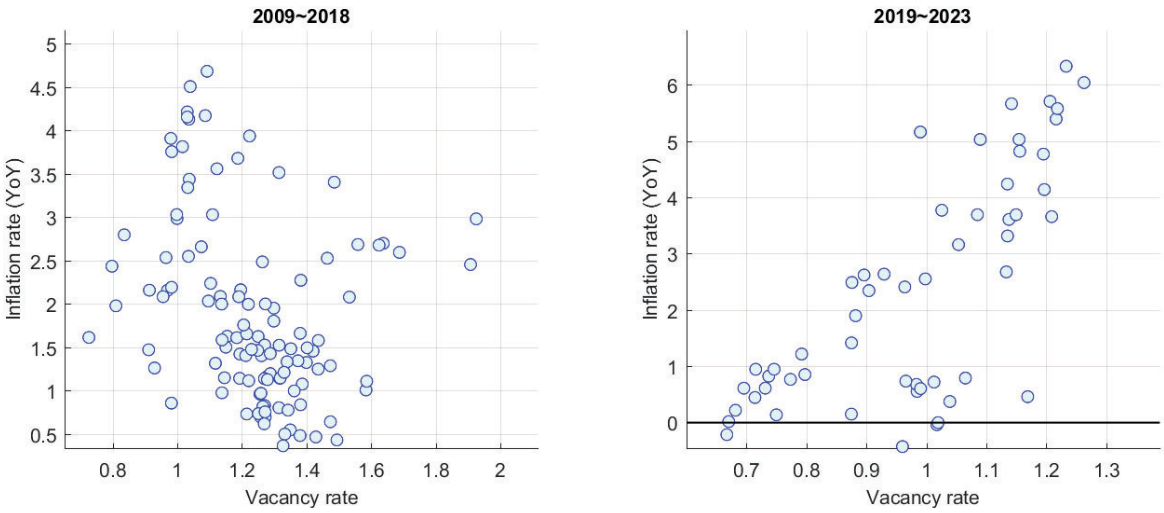

Figure 6. The Relationship Between the Job Vacancy Rate[1] in Korea and Inflation[2] from 2009 to 2018 Compared to 2019 to 2023

Note: 1) Job vacancy rate = (Number of vacancies / (Number of wage workers + Number of vacancies)) × 100; 2) Year-on-year change rate of the consumer price index.

Source: Ministry of Employment and Labor; U.S. Bureau of Labor Statistics (BLS), Author's calculation.

년대 말부터 최근 기간까지에 대해서 통계적으로 0과 다름을 알 수 있다.

해당 그림으로부터 얻을 수 있는 또 하나의 결론은 충격이 있은 당기보다 충격 1개월 이후 인플레이션의 반응이 크다는 점이다. 충격반응함수의 전반적인 시변패턴은 당기와 1개월 이후가 큰 차이가 없으나, 반응도에 있어 충격 1개월 이후가 당기보다 큰 것을 알 수 있다. 이러한 결과는 노동시장의 변화가 인플레이션에 미치는 영향이 시차를 두고 나타날 가능성을 시사한다. 한편 충격 2~3개월 이후 반응은 특별한 시변패턴을 보이지 않으나, 반응 자체는 통계적으로 0과 다른 것으로 도출되었다.

동 모형을 동일한 기간 동안의 우리나라 데이터를 사용하여 추정한 결과는 Figure 5에 나와 있다. 미국과 유사하게 당기의 충격반응함수는 2009년 이후 지속적으로 증가해 온 것으로 나타났으며, 2017년경 이후부터는 통계적으로도 0과 다른 것으로 도출되었다. 다만 충격반응함수의 크기는 미국에 비해 훨씬 크며 2020년 코로나19 팬데믹 이후에도 미국과는 다르게 감소하는 패턴을 보이지 않는다는 차이점도 존재한다. 충격반응함수가 최근 기간으로 올수록 증가하는 모습은 충격 1개월 이후 충격반응함수에서 더 명확하게 관측되는데, 특히 1개월 이후 충격반응의 경우 팬데믹 이후 그 증가 폭이 오히려 확대되는 모습을 보인다. 반면 충격 2개월 이후의 충격반응에서는 특정한 시변패턴이 관측되지 않고 3개월 이후 반응의 경우 2009년 이후 모든 기간에 걸쳐 충격반응함수가 통계적으로 0과 다르지 않은 것을 알 수 있다. 한편, 두 국가 모두 2009년 이후 2010년대 중반까지는 반응도가 통계적으로 유의하지 않은 것은, 이준석・장용성・최영두(2022)의 분석에서 1970~2014년 중 인플레이션과 실업률의 관계가 점차 평탄화되었고 특히 2010~14년 중에는 한국과 미국 모두 그 관계가 통계적으로 유의미하지 않게 나타난 것과 일관되는 결과라고 볼 수 있다.

이와 같은 우리나라 추정 결과는 빈일자리율과 인플레이션 사이의 관계가 최근 기간에

대해 이전보다 더 강해졌을 가능성을 시사한다. 이를 자세히 살펴보기 위해 Figure 6은 우리나라 빈일자리율과 전년 동월대비(YoY) 인플레이션 간의 관계를 2009~18년과 2019~23년에 대해 대비하고 있다. 해당 그림에 나타나듯이 두 변수 사이의 관계는 두 시기에 대해 상당히 다른 양상을 보이고 있다. 2009~18년간에는 두 변수 사이의 상관관계가 음(-)에 가까운데 반해 이후 기간에 대해서는 강한 양(+)의 관계로 전환하는 것을 알 수 있다. 실제로 두 변수 간의 상관계수가 2009~18년과 2019~23년에 대해 각각 −0.29와 0.74로 나타나 이와 같은 변화를 뒷받침해 준다.[5] IMF(2013)은 전세계적으로 경기와 물가 간의 관계인 필립스 곡선의 기울기가 인플레이션이 낮을 때는 관측되지 않다가 인플레이션이 높아질 때 다시 관측되는 경향이 있음을 보고하고 있다. 해당 연구에서는 경기를 반영하는 변수로 실업률 갭을 고려하고 있기 때문에, 이와 같은 결과는 인플레이션이 낮을 때 실업률로 대표되는 노동시장 변수와 인플레이션 간의 관계가 약화되는 것으로 해석할 수 있다. 실제로 우리나라 데이터에서도 2009~18년의 평균적 인플레이션이 1.89%인데 비해 2019~23년에 대해서는 2.33%로 상승하는 경향을 보인다. 다음 절에서는 우리나라를 대상으로 이와 같은 인플레이션 수준에 따라 노동시장 상황과 인플레이션 사이의 관계가 변하는 비선형성을 자세하게 다룬다.

기존의 문헌에서는 노동시장 변수를 통해 반영된 현재 경기 상황과 물가 사이의 상관관계를 포착하는 필립스 곡선의 기울기 추정 시 인플레이션에 영향을 줄 수 있는 노동시장 상황 이외의 다른 변수를 통제한다. 예를 들어 IMF(2013)는 모형에 노동시장 상황 변수 및 인플레이션과 함께 수입물가 인플레이션과 기대인플레이션을 추가적으로 고려하였는데, 노동시장 변수로 빈일자리율을 사용한 송상윤・배기원(2022), 오삼일 외(2022)[6] 등도 이와 유사하게 기대인플레이션율 등을 통제하고 있다. 뉴케인지안(New Keynesian) 필립스 곡선에서는 인플레이션 결정 요인 중 하나로 기대인플레이션이 포함되며, 이를 통해 통화정책의 기조나 방향성과 관련하여 기대경로에 따른 인플레이션의 변화를 통제할 수 있을 것으로 기대된다. 또한, 인플레이션은 단기적으로 원자재 가격의 변동에 의해서도 영향을 받게 되는데, 원자재는 국제적으로 거래되기 때문에 수입물가 인플레이션을 통해 그 영향을 상당부분 통제할 수 있다.

이러한 연구를 따라 본 고에서도 VAR 모형의 내생변수를 $z_t = [v_t, \pi_t^m, \pi_t, \pi_t^e]'$ 4변수로 확장하여 모형을 재추정하였다. 여기서 v_t와 π_t는 앞의 VAR 모형에서와 같이 빈일자리율 및 연율화된 전월 대비 인플레이션율이다. π_t^m은 수입물가 인플레이션율을, π_t^e는 소비자동향조사 중 향후 1년간 기대인플레이션율을 의미하는데 모두 연율화된 전월 대비 변화율을 사용하였다. 일반적인 단일 방정식(single equation) 접근법과 달리 내생변수들의 외생성 순서를 가정하는 축차적 방식 VAR에서는 이 변수들의 순서가 결과에 영향을 줄 수 있다. 본 연구에서는 기대인플레이션이 동기(contemporaneous period)의 다른 세 변수가 먼저 결정된 후 가장 덜 외생적으로 결정된다고 가정하였다.

[5]전년 동월 대비가 아닌 전월 대비(MoM) 인플레이션과의 관계를 보았을 때도 두 시기에 대해 빈일자리율과의 상관계수가 각각 0.05와 0.34로 도출되어 이러한 패턴이 유지된다.

[6]기대인플레이션 외에도 인구증가율, 노동생산성 상승률 등의 변수를 추가로 고려하고 있다.

이렇게 확장된 모형을 미국 데이터를 이용하여 추정한 결과가 Figure 7에 요약되어 있다. Figure 4와 비교해 보면 충격반응함수의 시변패턴 및 반응도가 2변수 및 4변수 모형 간 유사함을 알 수 있다. 이러한 결과는 모형을 확장하더라도 2변수 VAR 모형의 충격반응함수 추정치와 크게 달라지지 않음을 나타낸다.

(Unit: %)

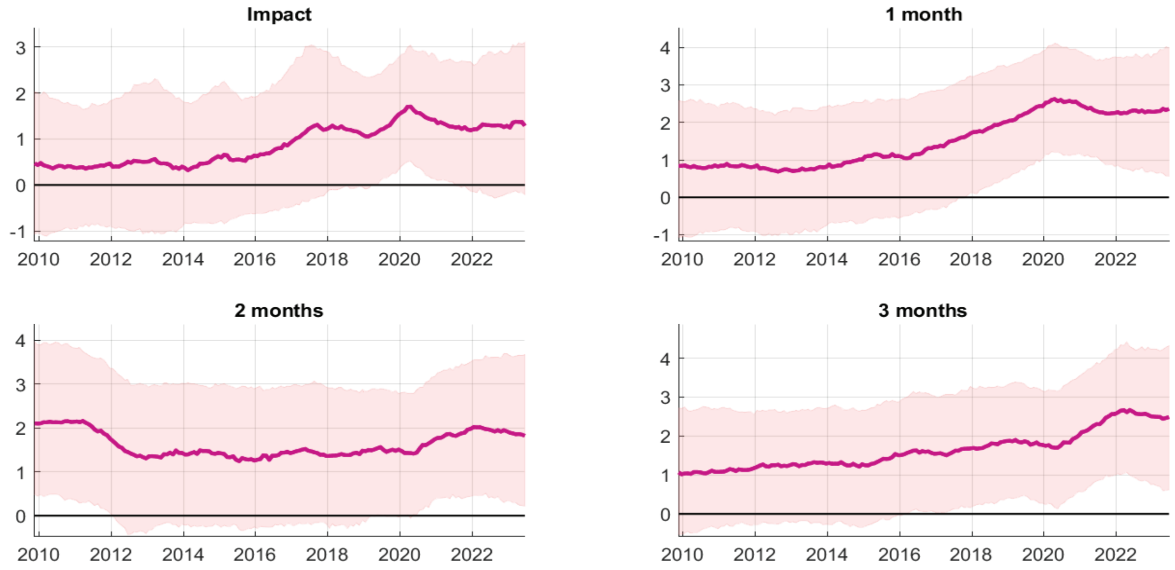

Figure 7. The Impulse Response Function of a Four-Variable Time-Varying Coefficient VAR Model for Inflation Following a Shock to the Job Vacancy Rate in the U.S.

Note: In each figure, the solid line and shading represent the median of the posterior distribution and the [16%, 84%] error band estimates.

(Unit: %)

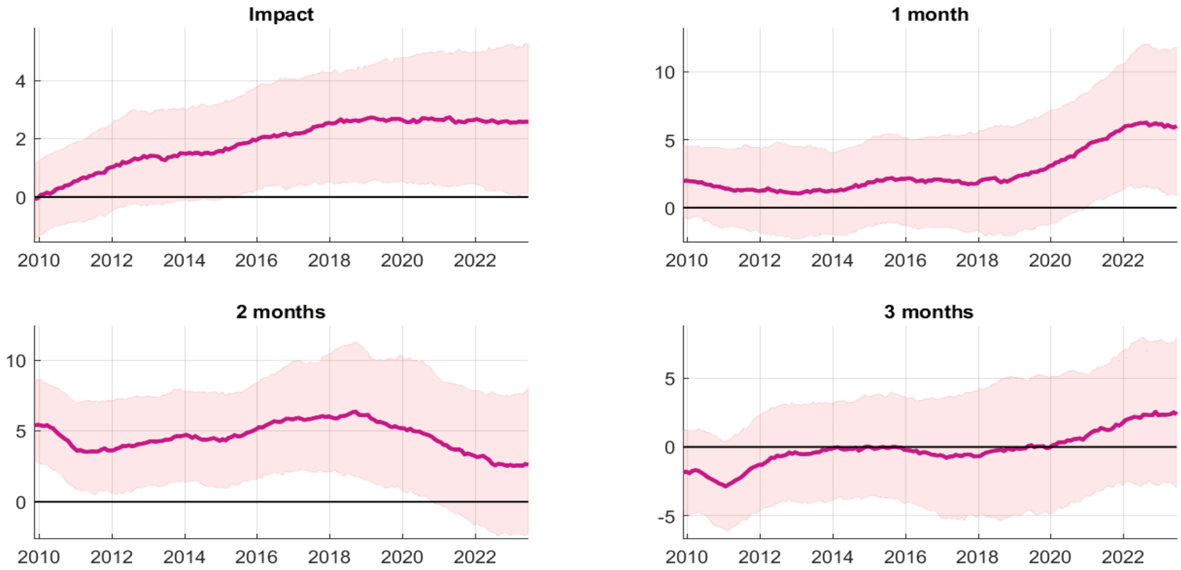

Figure 8. The Impulse Response Function of a Four-Variable Time-Varying Coefficient VAR Model for Inflation Following a Shock to the Job Vacancy Rate in Korea

Note: In each figure, the solid line and shading represent the median of the posterior distribution and the [16%, 84%] error band estimates.

확장된 4변수 시변계수 VAR 모형을 우리나라 데이터를 사용하여 추정한 충격반응함수는 Figure 8에 나와 있다. 전반적으로 충격반응함수의 시변패턴은 두 모형 간 큰 차이는 없으나, 충격 당기와 1개월 이후 반응의 경우 4변수 모형에서 2변수 모형보다 반응도가 훨씬 작아지는 현상이 관측되었다.[7]

3. 인플레이션 수준별 고정계수 VAR 모형의 충격반응함수 추정 결과

위 절에서는 시변계수 VAR 모형에 기반하여 노동시장 상황 변화가 인플레이션에 미치는 영향의 시간변화 패턴을 분석하였다. 그러나 위에서 언급한 것처럼 IMF(2013)은 실업률 갭의 증대가 인플레이션에 미치는 효과가 인플레이션의 수준별로 달라질 수 있는 가능성을 제시한 바 있다. 이러한 가설을 검증하기 위해 본 장에서는 통상적인 고정계수 모형을 YoY 인플레이션 수준별로 샘플을 나누어 추정하는 방식을 사용한다. 이와 같은 이유로 다음과 같은 고정계수 VAR 모형을 설정한다.

$$z_t = c + B_1 z_{t-1} + \ldots + B_k z_{t-k} + u_t, \quad E(u_t u_t{}') = \Sigma_u \tag{8}$$

위 식에서 z_t는 위 절의 4변수 모형과 같은 $z_t = [v_t, \pi_t^m, \pi_t, \pi_t^e]'$, 즉, 빈일자리율과 연율화된 전월 대비 인플레이션율, 수입물가 인플레이션율, 소비자동향조사 중 향후 1년간 기대인플레이션율 순서로 구성된 내생변수 벡터를 의미한다. 시변계수 모형과의 일관성을 위해 모형 추정시 Uhlig(2005)과 Mountford and Uhlig(2009) 등 선행연구를 참조하여 식 (8)에 주어진 축약형 VAR의 계수행렬과 분산－공분산 행렬의 사전분포는 무한(infinite) 분산을 가지는 노말－위샤트(Normal-Wishart) 분포를 따른다고 가정하고 베이지안 방식으로 추정하였다. 추정된 축약형 모형의 계수행렬과 분산－공분산 행렬의 사후분포에서 5천개의 표본을 추출한 후, 각 표본에 대해서 위의 축차적 충격 식별 방법을 적용하여 최종적으로 5천개의 충격을 도출하여 충격반응함수를 시산하였다.

Figure 9는 YoY 인플레이션 수준으로 나눈 두 국면별 빈일자리율 충격에 대한 인플레이션의 충격반응함수를 보고하고 있다. 먼저 인플레이션이 높은(낮은) 국면은 해당 시점의 인플레이션이 한국은행의 인플레이션 목표보다 높은(낮은) 국면으로 정의하였다. Figure 9의 첫 번째 패널에 나와 있듯이 한국은행의 인플레이션 목표는 2009~16년에 대해서는 3%였으며 이후 기간에는 2%로 하향 조정되었다. 이러한 기준으로 보았을 때 인플레이션이 높았던 국면으로는 2010년대 초반과 2017년 대부분의 기간, 그리고 최근의 2021년 중반 이후가 식별되었다.

[7] 한편 해당 결과가 본고의 내생변수 외생성 순서 가정에 따라 달라질 수 있는지에 대한 검증 또한 필요하다. 특히 기대인플레이션의 경우 본고의 벤치마크 모형에서는 가장 덜 외생적이라고 가정하고 있으나, 기존 문헌에서 이와 같은 외생성 가정에 대한 일관된 합의가 없는 것이 사실이다. 따라서 기대인플레이션이 가장 외생적이라고 가정하여 TVC-VAR 모형의 내생변수를 $z_t = [\pi_t^e, v_t, \pi_t^m, \pi_t]'$ 의 순서로 설정하고 모형을 재추정하였다. 해당 결과는 부록에 제시되어 있는데 Figure 8에 제시된 결과는 이와 같은 기대인플레이션의 외생성 순서 가정에 민감하지 않고 강건하게 유지되는 것으로 나타났다.

(Unit: %)

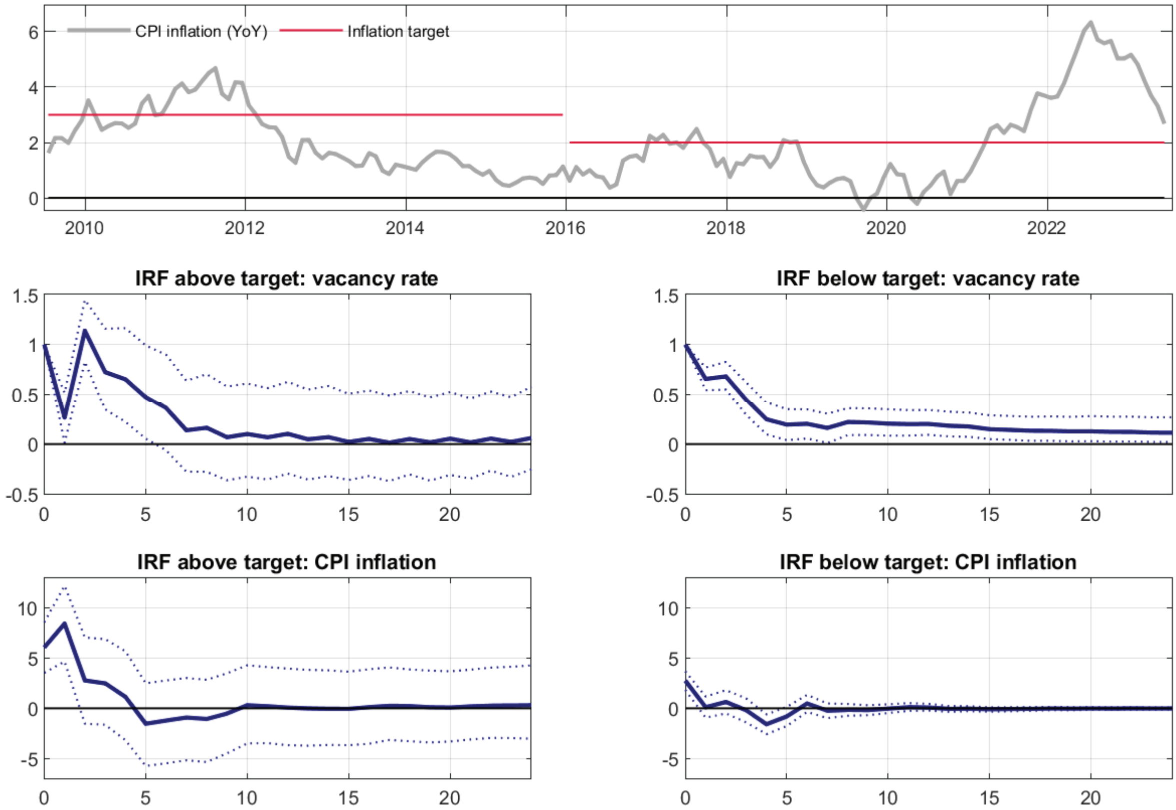

Figure 9. The Impulse Response Function of Inflation in Response to a Shock in the Job Vacancy Rate, Analyzed Across Different Inflation Regime Phases, Using a Four-Variable Fixed-Coefficient VAR Model for Korea

Note: In each figure, the solid line and dashed line represent the median of the posterior distribution and the [16%, 84%] error band estimates.

해당 그림의 맨 아래 두 패널에 나와 있는 국면별 1% 빈일자리율 충격에 대한 인플레이션의 충격반응함수를 보면 반응 패턴이 인플레이션 수준 국면별로 큰 차이를 보이는 것을 알 수 있다. 인플레이션이 높을 때에는 당기 충격반응함수가 중간값 기준 5%를 상회하는데 반해 인플레이션이 낮은 국면에서는 그 절반 이하인 2.5% 정도의 값을 가진다. 충격기 이후의 반응 또한 인플레이션이 높은 국면에서 더 크고 오래 지속되는 것을 알 수 있으며, 이는 빈일자율의 상승이 인플레이션에 미치는 상방 압력이 인플레이션이 높은 국면에서 체계적으로 더 큰 것을 의미한다. 이와 같은 결과는 Figure 8에 나타나 있는 필립스 곡선 기울기 증가가 전반적인 인플레이션 수준의 상승과 밀접한 관련을 맺고 있을 가능성을 시사한다.

Ⅳ. 통화정책 충격이 노동시장에 미치는 효과: 국소투영법 모형 및 추정 결과

실증분석의 마지막으로 본 장에서는 외생적 통화정책 충격이 빈일자리율과 실질임금 등

노동시장 변수들에 미치는 영향과 해당 영향이 특정 거시경제 국면별로 어떻게 달라지는지를 살펴본다. 이러한 분석은 두 단계로 이루어진다. 첫째로 고정계수 VAR 모형을 기반하여 외생적 통화정책 충격 시퀀스(monetary policy shock sequence)를 식별한다. 두 번째 단계에서는 이러한 외생적 통화정책 충격 시퀀스를 사용한 국소투영법을 바탕으로 해당 충격이 위의 두 노동시장 변수에 미치는 효과를 시산한다.

1. 통화정책 충격 식별을 위한 고정계수 VAR 모형

본 절에서 실증분석의 주목적은 금리인상 충격 발생 시 빈일자리율 및 실질임금이 해당 충격에 대해 어떻게 반응하는지를 시산하는 것이다. 이를 위해 가장 우선되어야 할 작업은 외생적 통화정책 충격의 식별이다. 이를 위해 다음의 식 (9)와 같은 고정계수 VAR 모형을 설정하고 해당 축약형 VAR의 계수행렬과 분산-공분산 행렬의 사전분포는 무한 분산을 가지는 노말－위샤트 분포를 따른다고 가정하고 베이지안 방식으로 추정한다. 무한 분산을 가지는 노말－위샤트 분포 가정은 계수행렬과 분산－공분산 행렬의 추정치가 통상적인 OLS 추정치와 가장 비슷하게 함으로써, 기존의 연구와 추정방법의 차이에서 오는 결과의 상이성을 최소화하기 위한 것이다.

$$z_t = c + Dx_t + B_1 z_{t-1} + \ldots + B_k z_{t-k} + u_t, \quad E(u_t u_t{}') = \Sigma_u \tag{9}$$

위 식에서 x_t는 외생변수 벡터를 의미한다. Calza *et al.*(2013)이나 Han and Hur (2020)에 제시되어 있듯이 우리나라와 같은 소규모 개방경제(Small Open Economy)의 통화정책 분석 시 해외부문의 변수들을 통제해 주는 것이 중요하다. 모형의 외생변수 벡터는 이와 같은 특성을 반영하기 위해 포함되었다. 구체적으로 Han and Hur(2020)에서와 같이 미국 산출, 미국 연방기금금리, 원유가격 및 우리나라의 실질실효환율을 외생변수로 고려하였다.[8] 미국 산출과 연방기금금리는 각각 글로벌 경기 및 글로벌 금융시장에 영향을 미치는 미국의 통화정책을 반영하는 변수로 포함되었다. 한편 원유가격 및 실질실효환율은 수입물가와 순수출 등에 영향을 미침으로써 소규모 개방경제인 우리나라 통화정책 결정에 판단 자료가 될 가능성을 상정하여 외생변수로 추가하였다.

식 (9)와 같은 축약형 VAR 모형을 바탕으로 통화정책 충격 식별을 위해 두 가지 충격 식별 방식을 사용한다. 먼저 내생변수 z_t가 산출, 소비자물가지수(CPI) 및 기준금리 3변수로 구성된 모형을 설정하고 위 절에서와 같은 축차적 구조를 이용하여 통화정책 충격을 식별한다. 동 모형에서의 축차적 구조는 기준금리가 산출 및 CPI보다 덜 외생적이라는 가정이다. 이러한 3변수 모형과 함께 내생변수가 산출, CPI, 기준금리 및 본원통화(monetary base) 4변수로 구성된 모형을 상정하고 Uhlig(2005)에서와 같이 충격반응함수에 부호제약(sign restriction)

[8]구체적으로 미국 연방기금금리는 분석기간 동안의 제로금리하한(zero lower bound)을 반영하기 위해 Wu-Xia의 그림자 금리(shadow rate)를 사용하였다. 한편 원유가격은 두바이(Dubai)유 가격을 사용하였다.

(Unit: %)

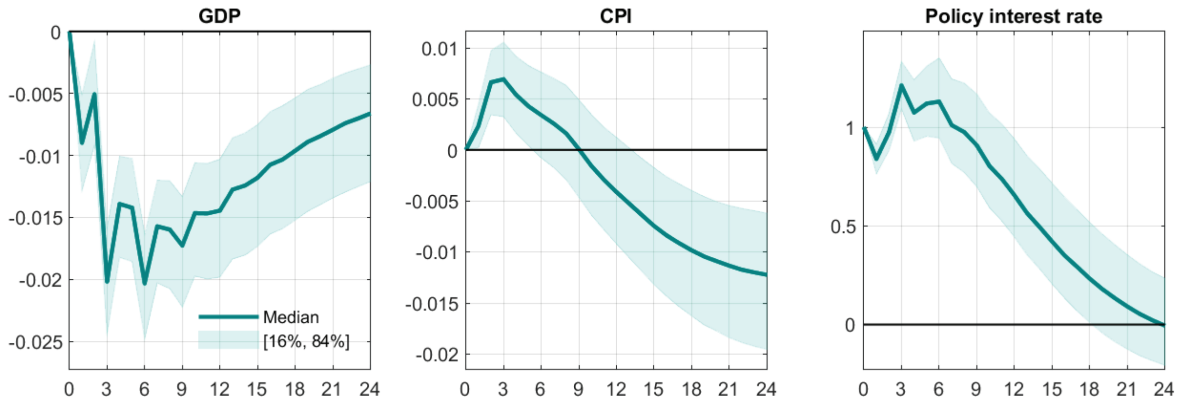

Figure 10. The Impulse Response Function of a Three-Variable Recursive VAR Model for Identifying Monetary Policy Shocks in Korea

Note: In each figure, the solid line and shading represent the median of the posterior distribution and the [16%, 84%] error band estimates.

(Unit: %)

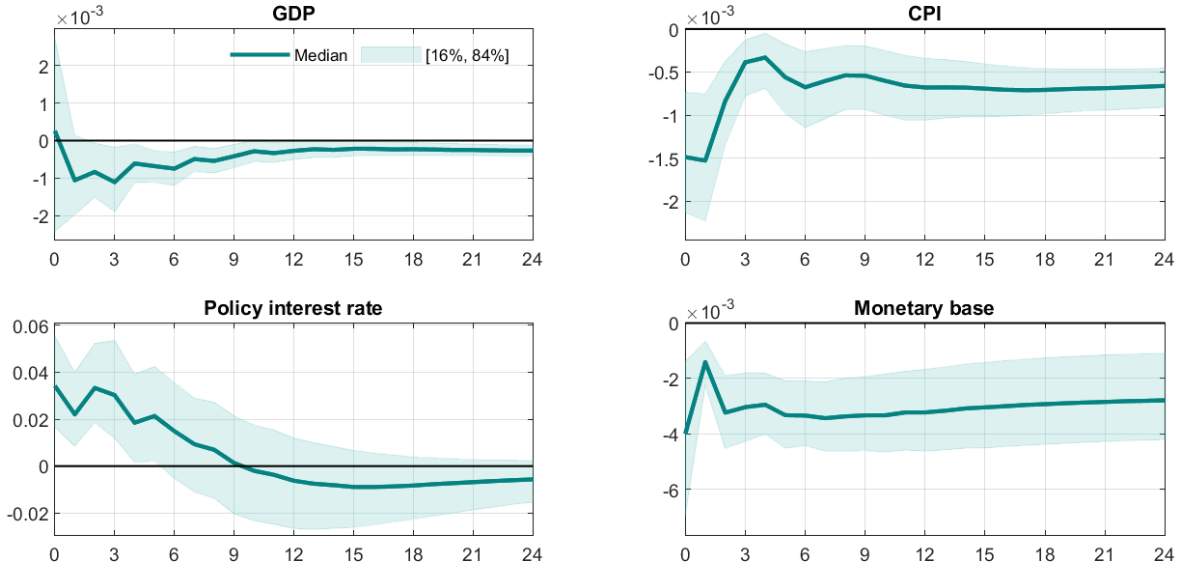

Figure 11. The Impulse Response Function of a Four-Variable Sign-Restricted VAR Model for Identifying Monetary Policy Shocks in Korea

Note: In each figure, the solid line and shading represent the median of the posterior distribution and the [16%, 84%] error band estimates.

을 부여하여 통화정책 충격을 식별한다. 구체적으로 긴축적 통화정책 충격은 충격 이후 3개월 동안 기준금리를 상승시키는 동시에 CPI와 본원통화를 감소시키는 충격으로 정의한다. 이러한 충격식별 제약은 김소영・김지혜(2021)에서 원용된 바 있다. 이와 같은 방식으로 모형 모수 추정치의 사후분포로부터 5천개의 샘플을 도출하여 충격반응함수를 시산한다.

축차적 가정을 통해 도출한 외생적 통화정책 충격에 대한 충격반응함수는 Figure 10에 제시되었다. 금리인상 충격에 대해 산출은 감소하고 CPI는 단기적으로 증가하였다가 충격 1년여 이후부터 하락하는 모습을 보인다. 충격 이후 단기적 CPI의 상승을 제외하면 이와 같은 반응 패턴은 전반적으로 음(-)의 수요충격으로서의 긴축적 통화정책 충격의 효과와 부합한다.

한편 Figure 11은 충격반응함수에 부호제약을 부여하여 식별한 통화정책 충격에 대한 충격반응함수를 보고하고 있다. 금리인상 충격에 대해 산출은 충격 2개월여 이후부터 유의하게 감소하는 것으로 나타났으며, CPI 및 본원통화는 충격 직후부터 지속적으로 감소하는 것으로 분석되었다. 위의 축차적 제약 방식의 결과와 마찬가지로 이와 같은 부호제약 VAR 결과는 통화정책 충격 효과에 대한 경제학 이론의 예측과 일치한다.

식 (9)에 주어진 VAR 모형의 잔차항 u_t를 선형변환(linear transformation)하면 이와 같은 외생적 통화정책 충격의 시계열을 얻을 수 있다. 이러한 통화정책 충격 시퀀스를 우리나라 기준금리와 함께 나타내면 Figure 12와 같다. 해당 시퀀스는 특정 시점에 어떠한 외생적 통화정책 충격(긴축적/완화적)이 어느 정도의 강도로 있었는지를 나타내는데, 축차적 제약 및 부호제약 모형 모두 충격 시퀀스의 증감이 전반적으로 기준금리 변동의 방향과 부합하는 모습을 나타낸다. 예를 들어 2010년 중반 이후의 금리상승기 및 2020년 전후의 금리인하기에 식별된 통화정책 충격 시퀀스가 주로 각각 양(+)과 음(-)의 값을 가지는 것을 알 수 있다. 또한 인플레이션 상승으로 인한 2022년 이후의 급격한 금리인상기에는 두 방법론으로 식별한 충격 시퀀스 모두 대부분 양(+)의 값을 나타낸다. 다만 중간값 기준 두 충격 시퀀스 간의 상관계수는 0.48로 분석되어 충격 식별 방식에 따라 식별된 통화정책 충격 시퀀스가 약간 달라질 수 있는 것으로 보인다.

(Unit: %)

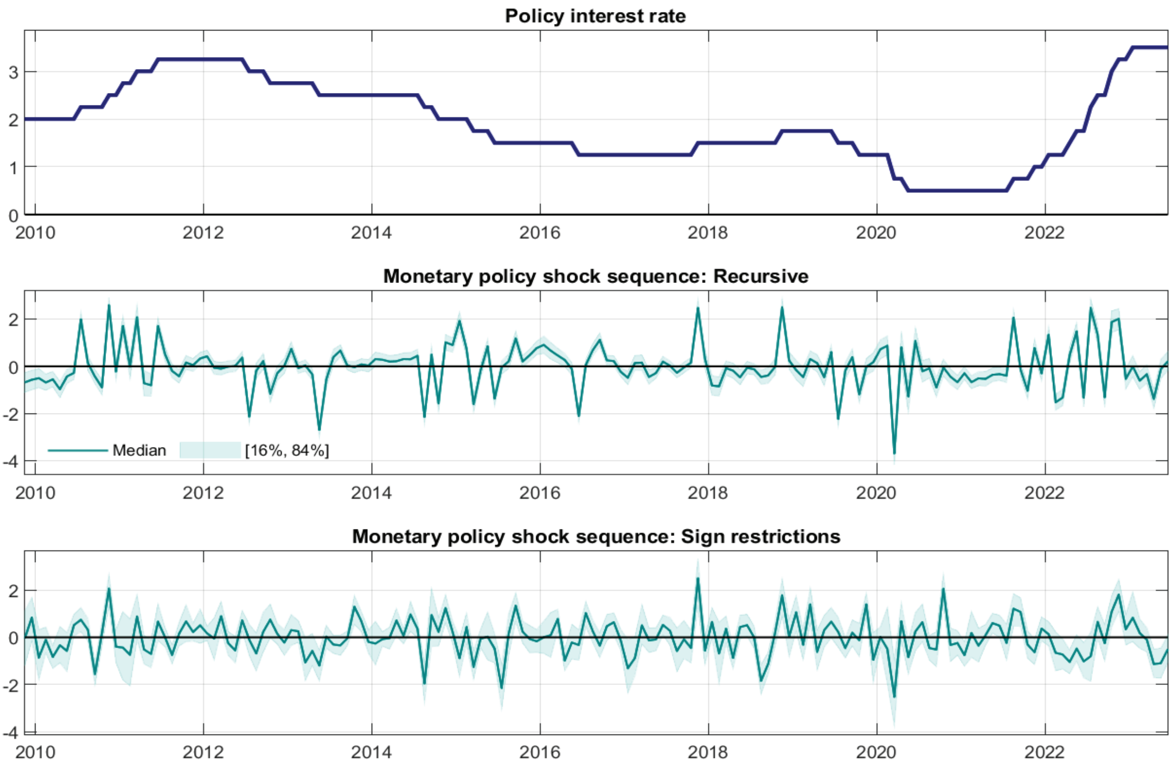

Figure 12. The Policy Interest Rate and Identified Monetary Policy Shocks in Korea

Note: In the two figures below, the solid line and shading represent the median of the posterior distribution and the [16%, 84%] error band estimates.

2. 국소투영법을 이용한 통화정책 충격의 노동시장에의 효과

위와 같이 식별된 통화정책 충격을 이용하여 통화정책 변화가 노동시장의 수량 변수인 빈일자리율과 가격변수인 실질임금에 어떠한 영향을 미치는지를 분석한다. 특히 해당 충격의 효과가 서로 다른 거시경제 국면별로 어떻게 달라지는지 분석하기 위해 국소투영법(Jordà, 2005)을 사용한다. 동 방법론은 Auerbach and Gorodnichenko(2012)나 Owyang *et al.* (2013) 등에서 미국을 대상으로 한 재정정책 변화의 경기 국면별 비선형적 효과 분석에 사용된 바 있다.

먼저 다음과 같이 주어진 선형(linear) 국소투영법 모형을 고려하자.

$$Z_{t+h} = \alpha_h + \beta_h S_t + \phi(L) X_{t-1} + X_t^{exo} + v_{t+h} \tag{10}$$

위 식에서 Z_{t+h}는 반응변수(빈일자리율 및 실질임금)를 나타내며 $h = 0, 1, 2, \ldots, H$ 이다. 한편 S_t는 위 절에서 식별된 외생적 통화정책 충격 시퀀스를 의미하는데, 구체적으로는 식별된 충격 시퀀스의 중간값 추정치를 사용한다. X_{t-1} 및 X_t^{exo}는 각각 통화정책 충격 식별 시 VAR 모형에 내생변수로 포함되었던 산출, CPI 및 기준금리와 반응변수 Z_t의 시차(lagged) 변수와 VAR 모형의 외생변수를 나타낸다. 마지막으로 v_{t+h}는 t기부터 $t+h$기까지 예측오차의 이동평균(moving average)이다.

이러한 모형에서 β_h는 충격 h기 이후의 충격반응함수를 나타낸다. 국소투영법 방법론의 가장 중요한 가정은 v_{t+h}가 모형에 포함된 독립변수(regressor)들과 상관관계를 가지지 않는다는 것이며, 이 경우 OLS를 통하여 β_h를 추정할 수 있게 된다. 다만 시계열분석의 특성상 v_{t+h}는 계열상관(serial correlation)을 가지고 있을 가능성이 높으며 이러한 이유로 Newey－West의 방식을 이용하여 해당 추정치의 표준오차를 구한다.

이와 같은 모형에 축차적 VAR 모형으로부터 도출한 통화정책 충격 시퀀스를 포함하여 시산한 충격반응함수가 Figure 13에 보고되어 있다. 금리인상 충격 발생에 대해 빈일자리율의 반응은 전반적으로 통계적으로 유의하지 않은 것으로 나타났으며, 실질임금의 경우 충격 발생 5~8개월 후에 대해서만 유의하게 감소하는 것으로 분석되었다.

Figure 14에 제시된 부호제약 VAR 모형 충격 사용 시 결과 또한 위의 그림과 유사하다. 빈일자리율의 반응은 모든 시계에 걸쳐 통계적으로 유의하지 않으며 실질임금도 충격 6개월 이후 감소와 15개월 이후 증가를 제외하고는 전반적으로 유의성이 떨어진다.

그러나 통화정책이 거시경제에 미치는 효과는 경기 국면별 또는 경제 상황별로 달라질 가능성이 존재한다. 예를 들어 Alpanda *et al.*(2021)은 OECD 18개국 데이터를 이용하여 통화정책 변화의 효과가 호황과 불황 시에 달라짐을 보였다. 본 연구에서도 이와 같은 가능성을 점검하기 위해 위의 선형 국소투영법 모형과 함께 다음과 같은 상태의존적 국소투영법 모형을 고려한다.

(Unit: %)

Figure 13. The Impulse Response Function of a Linear Model Using the Local Projection Method in Response to Monetary Policy Shocks, Analyzed with a Recursive VAR Model for Korea

Note: In each figure, the solid line and shading represent point estimates and the 95% confidence intervals.

(Unit: %)

Figure 14. The Impulse Response Function of a Linear Model Using the Local Projection Method in Response to Monetary Policy Shocks, Analyzed with a Sign-Restricted VAR Model for Korea

Note: In each figure, the solid line and shading represent point estimates and the 95% confidence intervals.

(Unit: %)

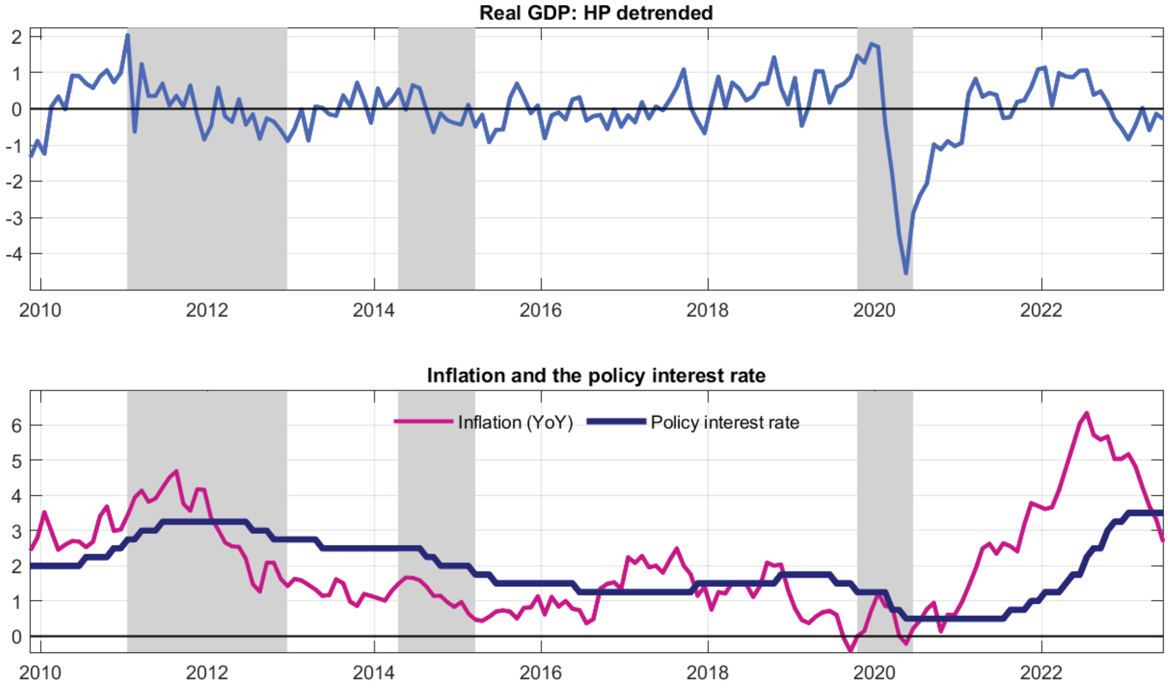

Figure 15. The Identified Recession Periods in Korea Based on OECD Data

Note: In each figure, the shaded areas indicate recession periods as defined by the OECD.

(11) $$Z_{t+h} = I_t\left[\alpha_{A,h} + \beta_{A,h} S_t + \phi_{A,h}(L) X_{t-1}\right] + (1 - I_t)\left[\alpha_{B,h} + \beta_{B,h} S_t + \phi_{B,h}(L) X_{t-1}\right] + X_t^{exo} + v_{t+h}$$

위 식에서 I_t는 특정 거시경제 상황을 나타내는 더미(dummy)변수이며 $I_t = 1$일 때 상태 A를 나타내고 $I_t = 0$일 때 상태 B를 나타낸다. 선형모형에서와 마찬가지로 $\beta_{A,h}$ 및 $\beta_{B,h}$는 각각 충격 h기 이후 상태 A와 B에서 Z_t의 충격반응함수를 의미하게 된다. 동 모형의 상태변수로 본 고에서는 다음의 두 가지를 고려한다. 첫 번째 상태변수로는 호황과 불황기를 나누어 분석한다. 이를 위해 Figure 15에 음영으로 표시된 바와 같이 OECD에서 제공하는 불황 지수(recession indicator)를 사용한다. 해당 자료상 2009년 이후 우리나라의 불황기는 2014년 전후, 2015년, 그리고 2020년 코로나19 팬데믹 발생 직후로 식별된다.

두 번째 상태변수로는 코로나19 팬데믹 발생 전과 후를 다룬다. 이를 위해 샘플을 2020년 이전인 2019년 12월까지와 이후 기간으로 나누어 국소투영법 분석을 시행한다.

먼저 Figure 16에는 축차적 VAR 모형으로부터 식별된 통화정책을 사용하여 호황·불황별 비선형성을 고려한 국소투영법 모형을 추정하여 얻은 충격반응함수를 나타낸다. 위의 선형모형 결과와는 다르게 호황・불황 간 충격반응함수의 상이성을 허용한 모형 결과는 경기국면별로 강한 비선형성을 나타낸다. 호황의 경우 외생적 통화정책 충격에 대해 빈일자리율과 실질임금 반응 모두 대체적으로 유의하지 않다. 그러나 불황기에는 긴축적 통화정책으로 인해 빈일자리율이 충격 3~7개월 이후 동안에 대해 유의하게 감소하는 패턴을 나타낸다. 한편 불황 시의 실질임금의 반응은 대부분의 시계에 대해 유의하지 않은 것으로 도출된다.

(Unit: %)

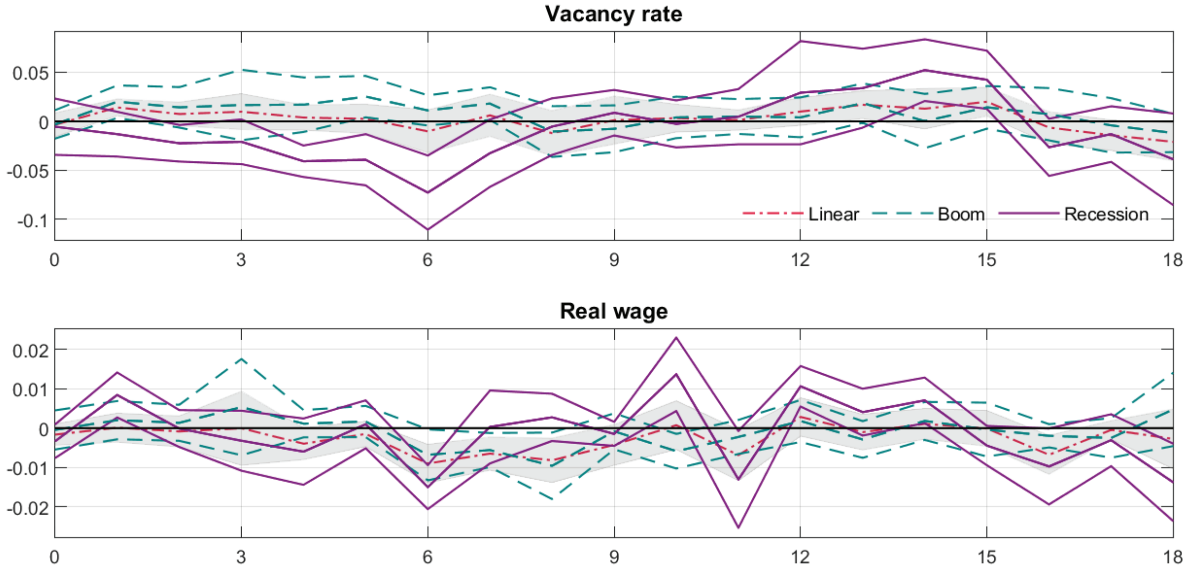

Figure 16. The Impulse Response Function of a Nonlinear Model Using the Local Projection Method in Response to Monetary Policy Shocks Identified by a Recursive Ordering, Analyzed Separately for Expansionary and Recessionary Periods in Korea

Note: 1) In each figure, the dotted line and shading represent point estimates and 95% confidence intervals for the linear model; 2) In each figure, the dashed line and solid line represent point estimates and 95% confidence intervals for expansionary and recessionary periods, respectively.

(Unit: %)

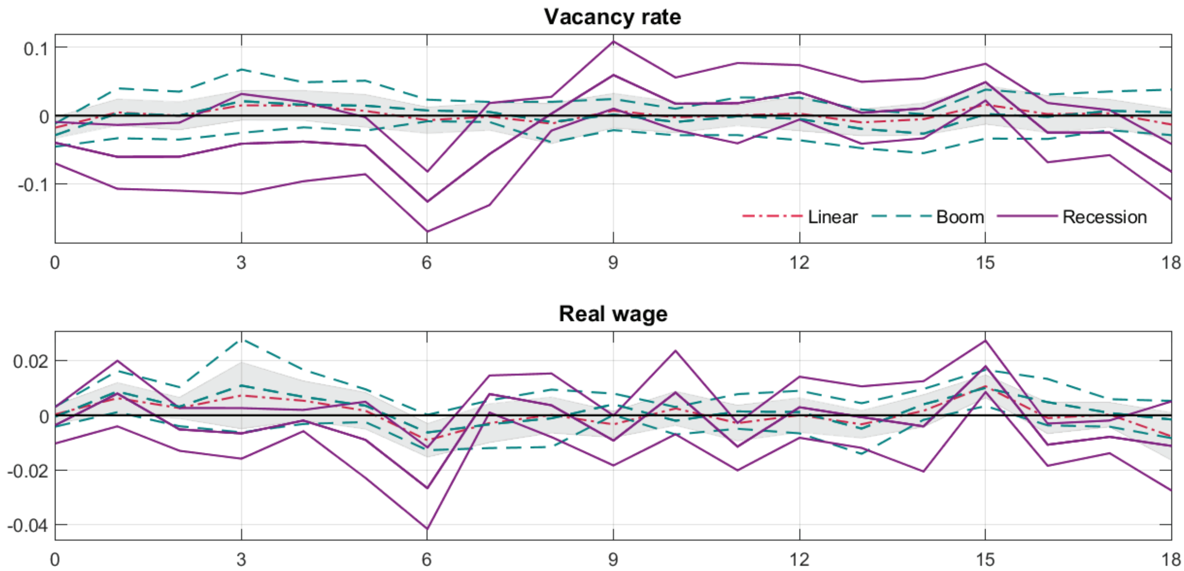

Figure 17. The Impulse Response Function of a Nonlinear Model Using the Local Projection Method in Response to Monetary Policy Shocks Identified by Sign Restrictions, Analyzed Separately for Expansionary and Recessionary Periods in Korea

Note: 1) In each figure, the dotted line and shading represent point estimates and 95% confidence intervals for the linear model; 2) In each figure, the dashed line and solid line represent point estimates and 95% confidence intervals for expansionary and recessionary periods, respectively.

(Unit: %)

Figure 18. The Impulse Response Function of a Nonlinear Model Using the Local Projection Method in Response to Monetary Policy Shocks Identified by a Recursive Ordering, Analyzed Separately for Periods Before and After the COVID-19 Pandemic in Korea.

Note: 1) In each figure, the dotted line and shading represent point estimates and 95% confidence intervals for the linear model; 2) In each figure, the dashed line and solid line represent point estimates and 95% confidence intervals for periods before and after COVID-19, respectively.

(Unit: %)

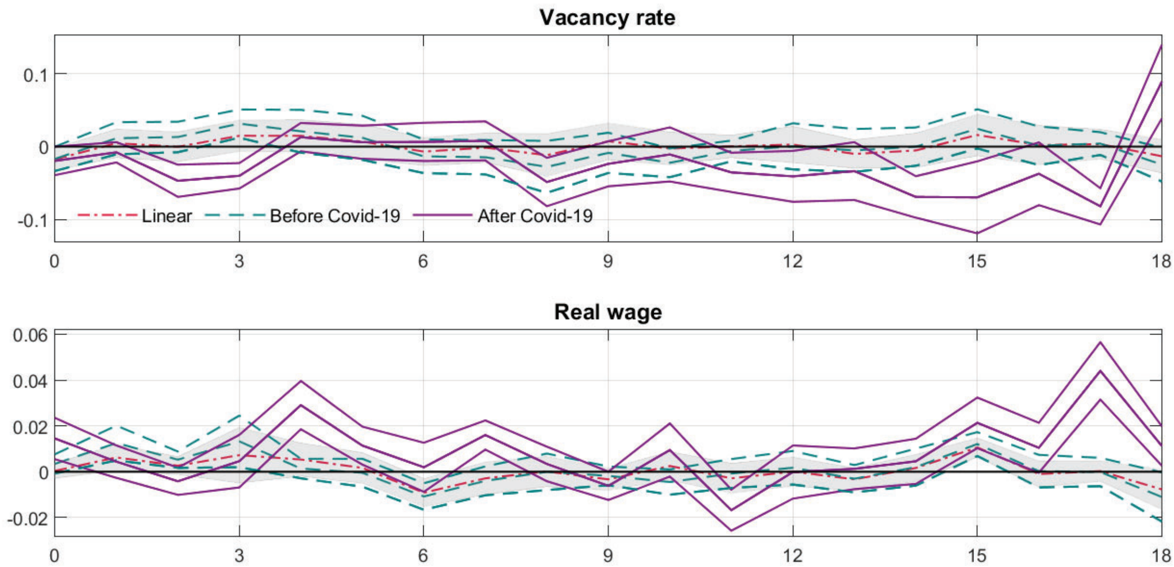

Figure 19. The Impulse Response Function of a Nonlinear Model Using the Local Projection method in Response to Monetary Policy Shocks Identified by Sign Restrictions, Analyzed Separately for Periods Before and After the COVID-19 Pandemic in Korea.

Note: 1) In each figure, the dotted line and shading represent point estimates and 95% confidence intervals for the linear model; 2) In each figure, the dashed line and solid line represent point estimates and 95% confidence intervals for periods before and after COVID-19, respectively.

불황기에는 일반적으로 통화정책이 완화적으로 운용되므로, 이러한 결과는 불황기 금리인하가 있을 시 빈일자리율은 단기적으로 유의하게 상승시킬 가능성을 시사한다.

이와 같은 결과는 부호제약 VAR로부터 식별된 통화정책을 사용하였을 때 다소 더 약하게 관측된다. 그럼에도 불구하고 Figure 17에 나타난 것처럼 긴축적 통화정책 충격이 충격 후 2개월 이내와 5~7개월 사이에서 빈일자리율을 유의하게 하락시키는 것을 확인할 수 있다. 따라서 통화 긴축이 빈일자리율의 유의한 감소를 일으킨다는 위의 결과는 충격 식별방식과 관계없이 유지된다고 볼 수 있다.

한편 코로나19 팬데믹 이전과 이후의 비선형성을 고려한 모형 결과는 Figure 18에 나와 있다. 먼저 축차적 VAR 충격을 사용했을 경우 긴축적 통화정책 시행 시 코로나19 이전 기간에 대해서는 빈일자리율의 반응이 1년 이내에는 전반적으로 유의하지 않은데 반해, 이후 시기에 대해서는 빈일자리율이 유의하게 감소하는 것을 확인할 수 있다. 실질임금의 반응은 두 시기 모두에 대해 충격 6~7개월 이후 기간에 대해 감소하는 것으로 나타나 시기별 차이가 크지 않은 것으로 보인다.

마지막으로 부호제약을 부여한 VAR 충격 결과는 Figure 19에 제시되어 있는데, 전반적으로 빈일자리율 반응도 패턴이 축차적 결과와 유사하다. 긴축적 통화정책 충격은 코로나19 이전 시기에 대해서는 빈일자리율을 유의하게 변화시키지 않으나 이후 기간에는 해당 변수를 단기적으로 유의하게 감소시킨다. 그러나 동 충격에 대한 실질임금의 반응은 두 국면 모두에서 단기적으로 증가하는 것으로 분석되어 축차적 VAR 결과와는 상이하다. 다만 코로나19 이전과 이후 시기에 대해 반응패턴이 유사하다는 공통점도 가진다.

V. 결론

본 연구는 우리나라에서 노동시장이 물가상승률에 미치는 영향이 시기에 따라 어떻게 변해왔는지와 통화정책 변화가 노동시장에 미치는 영향이 거시경제 국면별로 어떻게 달라졌는지를 분석하였다. 이를 위해 TVC－VAR을 포함한 VAR 모형 및 국소투영법을 사용하였다. 분석 결과 노동시장 상황이 인플레이션에 미치는 상방 압력은 최근 기간에 대해 증대되어 왔으며, 또한 이러한 상방 압력은 인플레이션 수준이 낮을 때 보다는 높을 때 더욱 큰 것으로 도출되었다. 통화정책이 노동시장에 미치는 효과 또한 경제 국면별로 다르게 나타났는데 불황기나 코로나19 팬데믹 이후 시기에 대해서는 외생적 금리인상이 빈일자리율을 단기적으로 유의하게 감소시키나, 호황기나 팬데믹 이전 시기에 대해서는 동 반응이 유의하지 않은 것으로 나타났다. 한편 통화정책 충격이 실질임금에 미치는 영향은 전반적으로 유의하지 않았다.

이와 같은 본 고의 결과는 우리나라에서 노동시장과 인플레이션 간의 관계가 볼록성(convexity)을 가질 가능성을 시사한다. 물가안정목표제 하에서의 통화정책이 일반적으로 인플레이션이 낮을 때에는 금리인하를, 높을 때에는 금리인상을 시행한다는 점에서 보면 이

러한 볼록성은 통화정책 운용에 있어 유리한 상황을 제공한다. 인플레이션이 낮을 때 금리를 인하하면 인플레이션의 상승보다 빈일자리율 증가의 효과가 상대적으로 클 것이고, 인플레이션이 높은 시기에 금리를 인상하면 빈일자리율의 감소보다 인플레이션의 하락 효과가 상대적으로 클 것이기 때문이다. 물론 본 고의 이러한 결과는 앞으로 더욱 엄밀한 분석을 통해 검증되어야 할 것이다. 이러한 관점에서 본 연구 이후 노동시장, 인플레이션 및 통화정책 간 비선형적 관계에 대한 풍부한 논의를 기대한다.

부 록

1. 깁스 샘플링을 이용한 TVC-VAR 모형의 추정

부록의 본 장에서는 본 고의 분석대상 모형인 TVC-VAR 모형의 추정에 대한 자세한 설명을 제시하도록 한다.

(1단계: 사전분포 설정) 비관측인자 B^T, A^T, Ω^T와 공분산계수 행렬 V의 초모수(hyperparameter)[1] Q, W, S에 대한 사전분포(prior distribution)를 설정. Primiceri(2005) 등 선행연구를 참조하여 초모수 Q, W, S의 사전분포는 독립 역－위샤트(inverse-Wishart) 분포를 따르며, 나머지 모수들의 초기값 B_0, α_0, $\log\ \sigma_0$은 정규분포를 따른다고 가정. 그 결과 B, α, $\log\ \sigma$의 전체 시퀀스들은 (Q, W, S값을 조건부로) 정규분포를 사전분포로 가지게 됨.

(2단계: 깁스 샘플링을 이용한 사후분포 추출) 추정모수의 조건부 결합확률분포를 조건부 확률분포들간의 곱으로 요인분해한 뒤 칼만 필터(Kalman filter) 및 평탄화(smoothing)를 이용하여 각각의 조건부 분포로부터 표본을 추출. 각 모수의 조건부 사후확률분포(conditional posterior distribution)는 모수별 사전분포에 데이터 Z와 기타 모수값을 조건부로 반영하여 정규분포 또는 역－위샤트 분포로 도출 가능하게 된다. 이후 다음과 같은 과정을 거쳐 사후분포로부터 표본추출.

1 행렬 A^T, Ω^T, V의 초기값을 설정한 뒤, 카터－콘(Carter-Kohn) 알고리즘을 이용하여 상태변수 행렬 B^T의 조건부 사후분포를 Ⓐ, Ⓑ로 요인 분해한 뒤 칼만 필터를 적용.

$$p(B^T | Y^T, A^T, \Omega^T, V) = \underbrace{p(B_T | Y^T, A^T, \Omega^T, V)}_{Ⓐ\ :\ Kalman\, filter} \underbrace{\prod_{t=1}^{T-1} p(B_t | B_{t+1}, Y^t, A^T, \Omega^T, V)}_{Ⓑ\ :\ backward\, recursion}$$

Ⓐ: 상태－공간모형에 칼만 필터를 순차적으로 적용해서 조건부 사후분포 $B_T | Y^T, A^T, \Omega^T, V \sim N(B_{T|T}, P_{T|T})$의 평균 $B_{T|T}$ 및 분산 $P_{T|T}$을 구한 뒤 동 분포로부터 표본 B_T를 추출.

Ⓑ: Ⓐ에서 얻은 B_T을 토대로 칼만 평탄화(Kalman smoothing)를 $t = T-1, T-2, \cdots, 1$에 대해 순차 적용하여 조건부 사후분포 $B_t | B_{t+1}, Y^t, A^T, \Omega^T, V \sim N(B_{t|t+1}, P_{t|t+1})$의 평균 $B_{t|t+1}$ 및 분산 $P_{t|t+1}$을 구한 뒤 동 분포로부터 표본 $B_{t|t+1}$을 추출.

[1] 사전분포 내 모수를 지칭하며 ‘모수의 모수(parameter of parameter)’라는 의미를 가짐.

② 주어진 B^T, Ω^T, V값 하에서 ①을 적용하여 정규분포로부터 A^T를 추출.

③ 변동성 모수행렬 Ω^T의 조건부 사후분포를 선형 정규분포로 근사한 뒤 주어진 A^T, B^T, V 하에서 ①을 적용하여 정규분포로부터 Ω^T를 추출.

④ 주어진 B^T, A^T, Ω^T값 하에서 ①을 적용하여 역－위샤트 분포로부터 V를 추출.

⑤ 동 체인이 수렴할 때까지 ①~④를 반복(N회를 반복한 뒤 최초 N_0회 추출 결과를 버리고 나머지 표본만을 사용).

2. 추가 결과

본 장에서는 본문에 포함되지 않은 추가 결과들을 제시한다. 먼저 Figure A1에는 우리나라 데이터를 이용한 4변수 TVC－VAR 모형에서 빈일자리율 대신 실업률을 노동시장 상황 변수로 사용했을 때의 충격반응함수를 나타내고 있다. 빈일자리율을 고려한 경우보다 전반적으로 반응의 유의성은 떨어지고 시변 반응패턴 또한 다르다. 그러나 충격 1개월 이후 반응의 경우 2010년대 들어 반응도가 증가하는 모습을 보이며 또한 2010년대 중반 이후부터는 반응이 통계적으로 0과 다른 것으로 도출되었다.

한편 본 고에서는 빈일자리율로 포착되는 노동시장 상황 변화에 대한 인플레이션의 반응을 고려했는데, 반대로 인플레이션의 변화에 대한 빈일자리율의 반응 또한 모형으로부터 시산할 수 있다. Figure A2는 본문의 TVC－VAR 모형에서 외생적 양(+)의 인플레이션에 충격에 대한 빈일자리율의 반응을 나타낸다. 분석 결과 인플레이션 상승에 대한 빈일자리율의 반응도는 2010년대 중반부터 코로나19 팬데믹 직후인 2020년대 초반까지 감소하는 것으로 나타났다. 특히 충격 3개월 이후 반응을 보면 이 기간 동안 유의하게 빈일자리율이 감소하며, 이는 해당 시점에서의 인플레이션 상승이 주로 수요 측면보다는 공급 측면에서의 충격에 기인한다는 점을 시사한다.

Figure A3에는 우리나라를 대상으로 한 본문의 벤치마크 4변수 TVC－VAR 모형에서 외생적 양(+)의 빈일자리율 충격에 대한 인플레이션의 반응을 기대인플레이션을 가장 외생적으로 가정한 대안적 모형의 반응과 비교한다. 추정 결과 충격기 및 충격 1~3분기 이후 반응의 시변패턴 및 반응도가 두 모형 간 거의 차이가 없는 것으로 나타났다. 이와 같은 결과는 우리나라 데이터를 추정한 본 고 4변수 TVC－VAR 모형 결과가 기대인플레이션에 대한 외생성 순서 가정에 대해 강건하게 성립함을 보여준다.

(Unit: %)

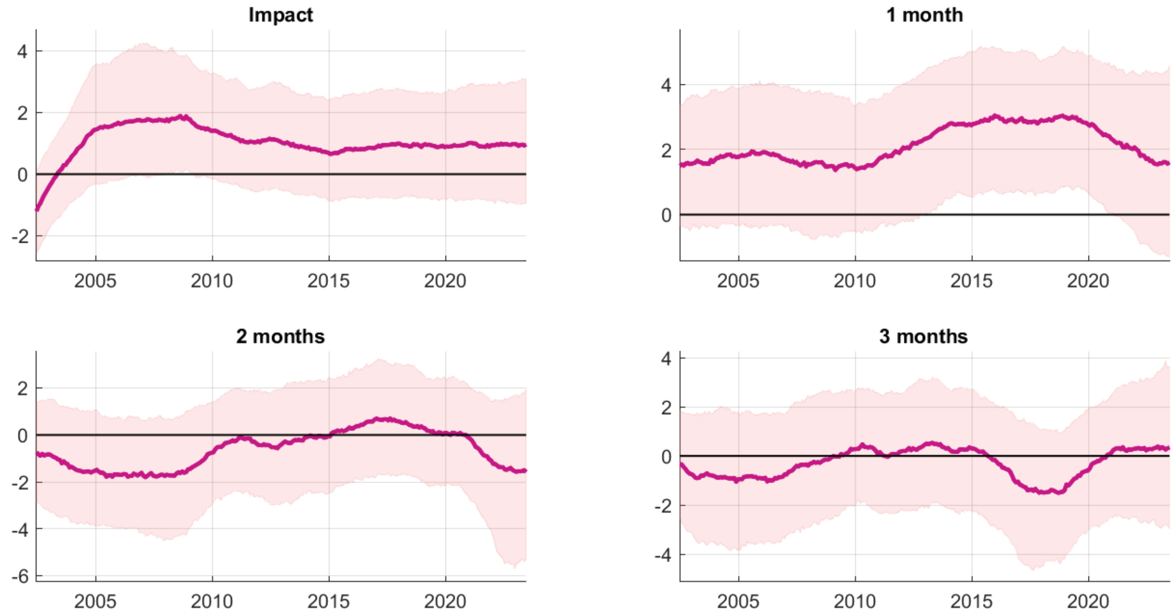

Figure A1. The Impulse Response Function of a Four-Variable Time-Varying Coefficient VAR Model for Korea, Using the Unemployment Rate as a Labor Market Condition Variable

Note: In each figure, the solid line and shading represent the median of the posterior distribution and the [16%, 84%] error band estimates.

(Unit: %)

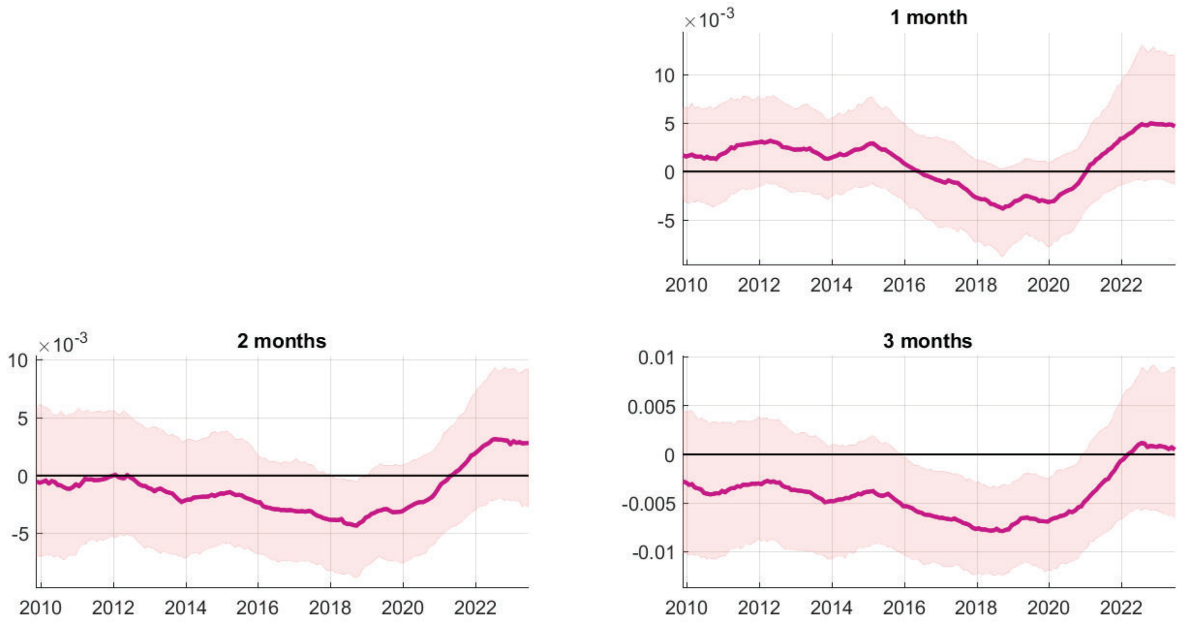

Figure A2. The Impulse Response Function of a Four-Variable Time-Varying Coefficient VAR Model for Korea, Analyzing the Response of the Job Vacancy Rate to a Shock in Inflation

Note: In each figure, the solid line and shading represent the median of the posterior distribution and the [16%, 84%] error band estimates.

(Unit: %)

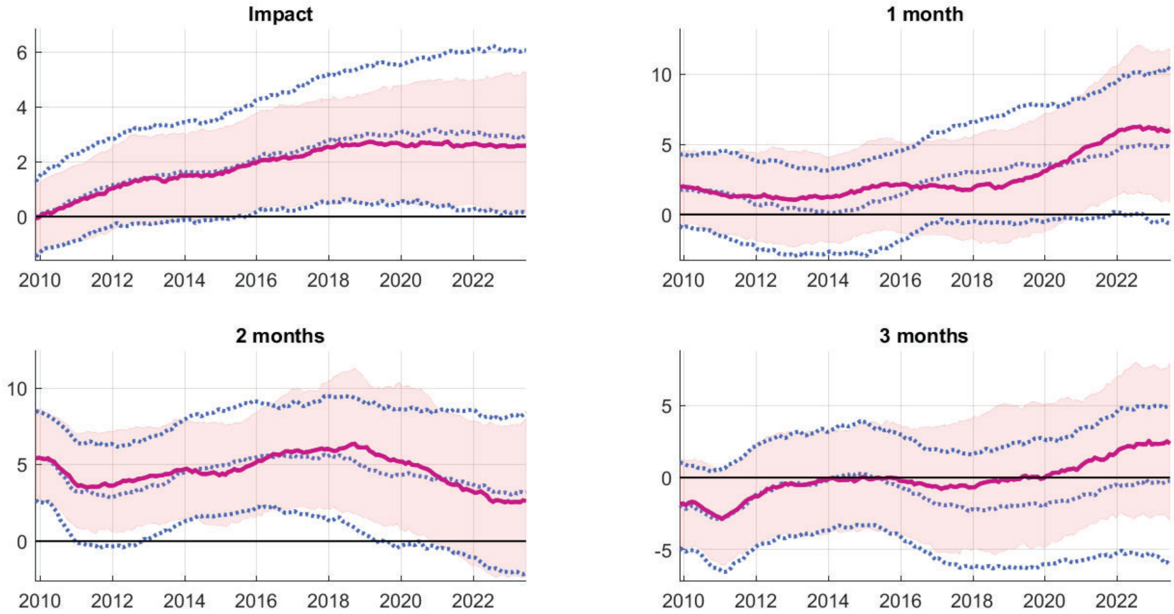

Figure A3. The Impulse Response Function of a Four-Variable Time-Varying Coefficient VAR Model for Korea, Comparing the Benchmark Model with a Model That Swaps the Order of Expected Inflation

Note: 1) In each figure, the solid line and shading represent the median of the posterior distribution and the [16%, 84%] error band estimates for the benchmark four-variable model; 2) In each figure, the dotted line represents the median of the posterior distribution and the [16%, 84%] error band estimates for the four-variable model that assumes the endogenous ordering of the variables as $z_t = [\pi_t^e, v_t, \pi_t^m, \pi_t]'$, with expected inflation treated as exogenous.

마지막으로 본문에서는 시변계수 VAR 모형에 기반하여 노동시장 상황 변화가 인플레이션에 미치는 영향의 시간변화 패턴을 분석하였다. 그러나 이와 같은 시변패턴 분석을 위해서 시변계수 모형 이외에도 통상적인 고정계수 모형을 샘플을 나누어 추정하는 방식 또한 기존 문헌에서 빈번히 사용되고 있다. 먼저 위 절의 시변계수 VAR 모형 결과의 강건성 검증을 위해 다음과 같은 고정계수 VAR 모형을 설정하고 구간이동방식(rolling window)으로 추정을 한다.

(A1) $$z_t = c + B_1 z_{t-1} + \ldots + B_k z_{t-k} + u_t, \quad E(u_t u_t') = \Sigma_u$$

위 식에서 z_t는 위 절의 4변수 모형과 같은 $z_t = [v_t, \pi_t^m, \pi_t, \pi_t^e]'$, 즉, 빈일자리율과 연율화된 전월 대비 인플레이션율, 수입물가 인플레이션율, 소비자동향조사 중 향후 1년간 기대인플레이션율 순서로 구성된 내생변수 벡터를 의미한다. 시변계수 모형과의 일관성을 위해 모형 추정시 Uhlig(2005)과 Mountford and Uhlig(2009) 등 선행연구를 참조하여 위 식 (A1)에 주어진 축약형 VAR의 계수행렬과 분산-공분산 행렬의 사전분포는 무한(infinite)산을 가지는 노말-위샤트(Normal-Wishart) 분포를 따른다고 가정하고 베이지안 방식

(Unit: %)

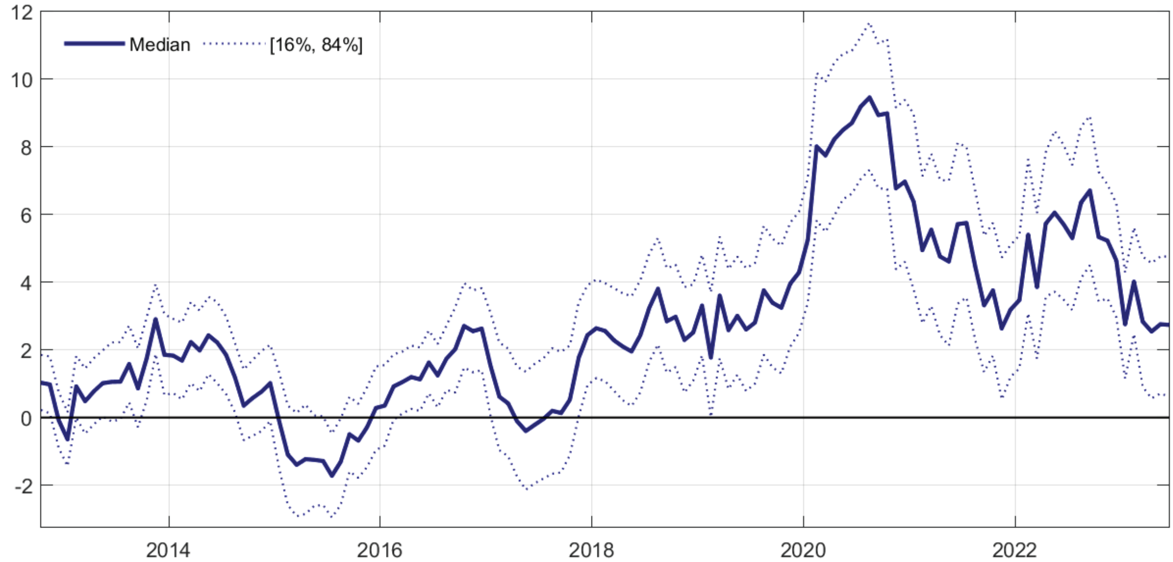

Figure A4. The Rolling Window Impulse Response Function of Current Inflation in Response to a Shock in the Job Vacancy Rate, Analyzed Using a Four-Variable Fixed-Coefficient VAR Model for Korea

Note: In the figure, the solid line and dotted line represent the median of the posterior distribution and the [16%, 84%] error band estimates.

으로 추정하였다. 추정된 축약형 모형의 계수행렬과 분산－공분산 행렬의 사후분포에서 5천개의 표본을 추출한 후, 각 표본에 대해서 위의 축차적 충격 식별 방법을 적용하여 최종적으로 5천개의 충격을 도출하여 충격반응함수를 시산하였다.

이러한 모형의 관측 구간(window) 크기를 40으로 설정하고 우리나라 데이터를 사용하여 추정 후 1% v_t 충격에 대한 당기 π_t의 충격반응함수를 구하면 Figure A4와 같다. 해당 그림에 제시된 rolling window 충격반응함수의 시변패턴은 위의 시변계수 VAR 모형 결과의 그것과 전반적으로 일치한다. 빈일자리율 충격에 대한 인플레이션의 반응도는 2018년경부터 이후 코로나19 발생 직후인 2020년 중반까지 지속적으로 증가해 왔으며 이후 기간에 대해 감소하였다가 2022년 중반 반등하는 추세를 나타냈다. 68% 밴드 기준 동 기간 동안의 충격반응함수는 통계적으로 0을 포함하지 않아 전반적으로 유의한 것으로 분석되었다. 이와 같은 결과는 시변계수 VAR 모형과 같이 코로나19 팬데믹 발생 이후 최근 기간에 대해 우리나라에서 빈일자리율 상승이 인플레이션에 미치는 상방 압력이 증대되었을 가능성을 시사한다.

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The changing relationship between labor market conditions and inflation in Korea†

By Joonyoung Hur・Minsok Chae*

This paper examines the time-varying relationship between the labor market, inflation, and monetary policy, particularly in light of recent high inflation and a tight labor market, with a focus on data from Korea. Analyzing data from July 2009 to June 2023, we find that the impact of the job vacancy rate—an indicator of labor market conditions—on inflation has gradually increased over time. Furthermore, the responsiveness of inflation to changes in labor market conditions is found to be greater during periods of high inflation compared to low inflation. Lastly, the influence of monetary policy changes on the job vacancy rate is particularly pronounced during recessionary periods and after the COVID-19 pandemic. These findings suggest the possibility of convexity in the relationship between the labor market and inflation in Korea. In such a scenario, raising interest rates during high inflation could lead to a relatively larger decrease in inflation than in job vacancies, which could create a favorable situation for monetary policy management.

Key Word: Labor Market, Job Vacancy Rate, Inflation, Monetary Policy
JEL Code: E31, E52, C32

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