

# **KDI** *Journal of Economic Policy*

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Exchange Rate Predictability in Korea  
.....Sookyung Park and Cheolbeom Park

Analysis of the Structural Changes in Household Debt Distributions by  
Householder Age in Korea and in the US  
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# KDI Journal of Economic Policy

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The KDI Journal of Economic Policy (KDI JEP) is a professional journal published on a quarterly basis. The Journal publishes papers on the academic and policy issues related to the development of Korea's economy. The KDI Journal of Economic Policy welcomes innovative and insightful academic papers on all areas of economics with an emphasis on empirical analysis that contain solid policy implications. KDI JEP is published in English starting in 2015, volume 37 number 1.

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# Time-varying Cointegration Models and Exchange Rate Predictability in Korea

By SOOKYUNG PARK AND CHEOLBEOM PARK\*

*We examine the validity of popular exchange rate models such as the purchasing power parity (PPP) hypothesis and the monetary model for Korean won/US dollar exchange rate. Various specification tests demonstrate that Korean data are more favorable for both models based on time-varying cointegration coefficients as compared to those based on constant cointegration coefficients. When the abilities to predict future exchange rates between those models based on time-varying cointegration coefficients are compared, an in-sample analysis shows that the time-varying PPP (monetary model) has better predictive power over horizons shorter (longer) than one year. Results from an out-of-sample analysis indicate that the time-varying PPP outperforms models based on constant cointegration coefficients when predicting future exchange rate changes in the long run.*

Key Word: Exchange rate, Monetary model, Predictability,  
Purchasing power parity, Time-varying cointegration

JEL Code: F37, F41

## I. Introduction

Understanding the movements of exchange rates is important, especially in Korea, where exports play an influential role in her growth. In spite of the importance of exchange rates, however, understanding the movements of exchange rates based on macroeconomic models has been a challenge to economists. Hence, the goal of this paper is to examine whether popular macroeconomic models such as the Purchasing Power Parity hypothesis (henceforth PPP) and/or the monetary model can explain fluctuations in the Korean won/US dollar exchange rate. More specifically, we investigate which model between the PPP hypothesis and the

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monetary model provides a better tool for understanding exchange rate fluctuations in Korea. In order to achieve this goal, we relate the exchange rate to macroeconomic variables based on the concept of cointegration. The cointegration approach has been widely applied in the literature on exchange rates since its introduction by Engle and Granger (1987). However, the cointegration relationships presented in this study include the constant cointegration relationship, which has been examined in many studies, as well as the type of cointegration relationship which allows cointegration coefficients to vary gradually over time.

There are reasons why we analyze the time-varying cointegration relationship between the exchange rate and macroeconomic variables in addition to the constant cointegration relationship between those variables. Many empirical studies have reported that the structure of the money market has changed over time.<sup>1</sup> Cheung and Chinn (2001) also show that the macroeconomic variables and economic models utilized by foreign exchange traders to understand exchange rate movements shift over time. Bacchetta and van Wincoop (2013) demonstrate that the relationship between the exchange rate and macroeconomic variables varies over time when the pertinent structural parameters are unknown. Finally, Bierens and Martins (2010) and Park and Park (2013) provide evidence of time-varying cointegration relationships among variables under the PPP hypothesis and among variables under the monetary model, respectively.

Most of the above-mentioned studies, however, focus on the US or other advanced economies.<sup>2</sup> In addition to the reasons discussed above, considering the time-varying cointegration relationship is particularly relevant in Korea because her economic structure has changed over time. These structural changes include financial and economic reforms suggested by International Monetary Fund (IMF) during the Asian Financial Crisis of 1997 as well as various currency swap agreements during the Global Financial Crisis. Given that these reforms and agreements must result in gradual changes in the economic environment in which the exchange rate and other macroeconomic variables are determined, it is a meaningful exercise to extend the time-varying cointegration approach to the won-dollar exchange rate in Korea under both the PPP hypothesis and the monetary model.

The paper is organized as follows. Section II briefly presents both the PPP hypothesis and the monetary model. Section III provides a discussion of the data and the econometric methodology of the time-varying cointegration approach. Section IV reports that the PPP hypothesis and the monetary model based on the constant cointegration approach are limited in terms of being able to explain the movements of the exchange rate in Korea. Section V shows that Korean data are more favorable when used with the PPP and the monetary model based on the time-varying cointegration approach through various model specification tests. Section VI compares the capability to predict future exchange rate changes among the time-varying PPP, the time-varying monetary model, and a combination of the

<sup>1</sup>Studies such as Stock and Watson (1993) and Mulligan and Sala-i-Martin (2000) show that the money demand function has unstable coefficients. Clarida *et al.* (2000) and Kim and Nelson (2006) demonstrate that monetary policy rules have also shifted over time.

<sup>2</sup>As an exception, Kim and Jei (2013) and Kim *et al.* (2009) examine time-varying cointegration relationships among variables under the PPP hypothesis for Asian countries.

two via in-sample and out-of-sample analyses. The in-sample analysis shows that the time-varying PPP shows better predictive power over horizons shorter than one year, whereas the time-varying monetary model outperforms when the horizons are longer than one year. The time-varying PPP shows better performance according to the results of the out-of-sample analysis. Concluding remarks are offered in Section VII.

## II. Theoretical Discussion: PPP and Monetary Model

In this section, we present a brief discussion of the PPP hypothesis and the monetary model, and derive the time-varying cointegration version of these models.

### A. Purchasing Power Parity (PPP)

The PPP hypothesis states that when goods are traded freely, the nominal exchange rate adjusts so that the goods must sell for the same price in both countries. This idea can be expressed by the following equation,

$$(1) \quad S_t = A \frac{P_t}{P_t^*},$$

where  $S_t$  is the nominal exchange rate,  $P_t$  is the domestic price level (i.e., in Korea), and  $P_t^*$  is the foreign price level (i.e., in the US).  $A$  is a constant which captures trade barriers and difference in preferences between the two countries. When temporary deviations from the PPP relationship is allowed, Equation (1) can be re-expressed after taking logarithms, as follows:

$$(2) \quad s_t = a + p_t - p_t^* + \varepsilon_t$$

where lower letters denote the logarithms of the corresponding capital letters, and  $\varepsilon_t$  represents temporary deviations from the PPP. Although  $s_t$  and  $p_t - p_t^*$  are known to be I(1) variables,  $s_t - (p_t - p_t^*)$  must be stationary under the PPP, which implies a [1, -1] cointegration vector for the exchange rate and relative price. Many empirical studies have examined the validity of the PPP under constant cointegration coefficients, providing evidence that the PPP does not hold in most cases. However, this failure of the PPP may be due to the fact that the constant cointegration coefficient cannot reflect gradual changes in economies as opposed to a failure of the PPP in general. Hence, we also consider the following PPP relationship based on the time-varying cointegration coefficient,

$$(3) \quad s_t = a + \beta_t(p_t - p_t^*) + \varepsilon_t,$$

where  $\beta_t$  is the cointegration coefficient which varies smoothly over time,

capturing the effect of gradual changes in the economic environment on the PPP relationship.

### B. Monetary Model

The monetary model has been examined in many studies, and there has been some debate regarding whether it accurately explains fluctuations in exchange rates. For example, Mark (1995) and Chinn and Meese (1995) show that the monetary model has significant predictive power for exchange rate movements, whereas Kilian (1999) and Berkowitz and Giorgianni (2001) provide evidence against exchange rate predictability based on the monetary model. The traditional monetary model examined in these studies can be summarized by the following four equations:

$$(4) \quad E_t(s_{t+1}) - s_t = \delta(i_t - i_t^*) + \pi_t$$

$$(5) \quad s_t = \beta(p_t - p_t^*)$$

$$(6) \quad m_t = p_t - \phi i_t + \gamma y_t + v_t$$

$$(7) \quad m_t^* = p_t^* - \phi i_t^* + \gamma y_t^* + v_t^*$$

where  $m_t$  and  $y_t$  are the logarithms of the money supply and real income level, respectively.  $i_t$  is the level of the nominal interest rate.  $\pi_t$  is the deviation from uncovered interest parity (UIP) or the unobserved risk premium, while  $v_t$  and  $v_t^*$  denote unobserved velocity shocks. We assume that  $\pi_t$ ,  $v_t$  and  $v_t^*$  follow stationary processes.<sup>3</sup>  $\gamma$  and  $\phi$  correspondingly represent the elasticity of the money-demand income and the semi-elasticity of the money-demand interest rate. Under the assumption of  $\Delta(m_t - m_t^*) \sim i.i.d.(0, \sigma_m^2)$  and  $\Delta(y_t - y_t^*) \sim i.i.d.(0, \sigma_y^2)$ , these four equations can be combined to express the following cointegration relationship between  $s_t$ ,  $(m_t - m_t^*)$  and  $(y_t - y_t^*)$ :

$$(8) \quad s_t = \frac{\lambda_1}{1 - \lambda_2} (m_t - m_t^*) - \frac{\lambda_1 \gamma}{1 - \lambda_2} (y_t - y_t^*) + \tilde{u}_t$$

Where  $\lambda_1 = \frac{\beta \delta}{\delta + \phi \beta}$ ,  $\lambda_2 = \frac{\phi \beta}{\delta + \phi \beta}$ ,  $\tilde{u}_t = \lambda_2 \left[ u_t + E_t \left[ \sum_{i=1}^{\infty} \lambda_2^i u_{t+i} \right] \right]$ , and

<sup>3</sup>These unobserved processes are assumed to follow nonstationary processes in Engel and West (2005), as they were not able to find evidence of cointegration between the exchange rate and observable fundamentals. Using the time-varying cointegration approach, however, we find cointegration evidence of these variables, as shown in the next section. As a result, we assume stationarity with regard to these unobserved components.



$u_t = (-\frac{\phi\pi_t}{\delta} + v_t^* - v_t)$ . Equation (8) implies the  $\left[1, \frac{-\lambda_1}{1-\lambda_2}, \frac{\lambda_1\gamma}{1-\lambda_2}\right]$  cointegration vector for  $s_t$ ,  $(m_t - m_t^*)$ , and  $(y_t - y_t^*)$ , and this constant cointegration vector becomes  $[1, -1, 1]$  under the assumption of  $\beta = \delta = \gamma = 1$ .

As shown in Park and Park (2013), however, data in advanced economies are not favorable when used with the monetary model based on constant cointegration coefficients. Hence, when the underlying parameters ( $\delta$ ,  $\beta$ ,  $\phi$ , and  $\gamma$ ) are allowed to vary over time, we can derive the following time-varying cointegration relationship:

$$(9) \quad s_t = \alpha_{1t}(m_t - m_t^*) + \alpha_{2t}(y_t - y_t^*) + \tilde{u}_t$$

$$\text{where } \lambda_{1t} = \frac{\beta_t \delta_t}{\delta_t + \phi_t \beta_t}, \quad \lambda_{2t} = \frac{\phi_t \beta_t}{\delta_t + \phi_t \beta_t}, \quad \alpha_{1t} = \lambda_{1t} + \sum_{i=1}^{\infty} E_t \left[ \left( \prod_{j=0}^{i-1} \lambda_{2t+j} \right) \lambda_{1t+i} \right]$$

$$\text{and } \alpha_{2t} = -\gamma_t \lambda_{1t} - \sum_{i=1}^{\infty} E_t \left[ \left( \prod_{j=0}^{i-1} \lambda_{2t+j} \right) \gamma_{t+i} \lambda_{1t+i} \right].$$

### III. Data and Econometric Methodology

#### A. Data

This study ascertains the validity of the PPP and monetary model in Korea. As a result, empirical analyses require data for the exchange rate (Korean won per US dollar) and data for macroeconomic variables such as the price index, money supply and real income levels for Korea and the US. Because the frequency of the data utilized in the analyses is monthly, industrial production is used for real income in both countries.<sup>4</sup> The M1 money stock and the Consumer Price Index (CPI) are used for the money supply and price-level variables.<sup>5</sup> Data for Korea and the US are obtained from the websites of the Bank of Korea and the Federal Reserve Bank of St. Louis, respectively.<sup>6</sup> The data of the money supply and real income levels are seasonally adjusted, and the sample period covers the period between January of 1980 and April of 2015.

<sup>4</sup>Due to data availability, the index for mining and manufacturing industrial products is used for the Korean real income data.

<sup>5</sup>Although some studies advocate the use of the Producer Price Index (PPI) to examine the PPP hypothesis, our results are not sensitive regarding whether CPI or PPI data are used in the analyses. Results based on the PPI are available upon request.

<sup>6</sup>The web address for the Bank of Korea is <http://ecos.bok.or.kr/>. The web address for the Federal Reserve Bank of St. Louis is <https://www.stlouisfed.org/>.

## B. Econometric Methodology

Considering that the cointegration approach under constant cointegration is widely applied in empirical studies, we introduce briefly the time-varying cointegration approach as proposed by Park and Hahn (1999) in this subsection. Suppose that the following time-varying cointegration relationship holds between  $s_t$ ,  $x_{1t}$ , and  $x_{2t}$ ,

$$(10) \quad s_t = \rho_0 + \rho_{1t}x_{1t} + \rho_{2t}x_{2t} + u_t$$

where  $u_t$  denotes the cointegration residuals and  $\rho_{1t}$  and  $\rho_{2t}$  are the time-varying cointegration coefficients.

Define smooth functions  $\rho_1$  and  $\rho_2$  on  $[0, 1]$  such that  $\rho_{1t} = \rho_1\left(\frac{t}{T}\right)$  and  $\rho_{2t} = \rho_2\left(\frac{t}{T}\right)$ , where  $T$  is the sample size. Under the assumption that  $\rho_1$  and  $\rho_2$  are smooth enough so that they can be approximated by a series of polynomials and/or trigonometric functions, Equation (10) can be written as follows:

$$(11) \quad \begin{aligned} s_t &= \rho_0 + \rho_{1t}x_{1t} + \rho_{2t}x_{2t} + u_t = \rho_0 + \rho_1\left(\frac{t}{T}\right)x_{1t} + \rho_2\left(\frac{t}{T}\right)x_{2t} + u_t \\ &= \rho_0 + \left[ \sum_{i=1}^{\kappa_1} \theta_i^1 \varphi_i^1\left(\frac{t}{T}\right) \right] x_{1t} + \left[ \sum_{i=1}^{\kappa_2} \theta_i^2 \varphi_i^2\left(\frac{t}{T}\right) \right] x_{2t} + u_{\kappa t} \\ &= \rho_0 + \chi_{\kappa_1 t}^{1'} a_{\kappa_1}^1 + \chi_{\kappa_2 t}^{2'} a_{\kappa_2}^2 + u_{\kappa t} \end{aligned}$$

Where  $\varphi_i^1$  and  $\varphi_i^2$  are the corresponding series functions used to approximate  $\rho_1$  and  $\rho_2$ ,  $\chi_{\kappa_1 t}^1 = \left[ \varphi_1^1\left(\frac{t}{T}\right), \dots, \varphi_{\kappa_1}^1\left(\frac{t}{T}\right) \right]'$ ,  $\chi_{\kappa_2 t}^2 = \left[ \varphi_1^2\left(\frac{t}{T}\right), \dots, \varphi_{\kappa_2}^2\left(\frac{t}{T}\right) \right]'$ ,  $a_{\kappa_1}^1 = [\theta_1^1, \dots, \theta_{\kappa_1}^1]'$ ,  $a_{\kappa_2}^2 = [\theta_1^2, \dots, \theta_{\kappa_2}^2]'$ , and  $u_{\kappa t} = u_t + \left[ \rho_1\left(\frac{t}{T}\right) - \sum_{i=1}^{\kappa_1} \theta_i^1 \varphi_i^1\left(\frac{t}{T}\right) \right] x_{1t} + \left[ \rho_2\left(\frac{t}{T}\right) - \sum_{i=1}^{\kappa_2} \theta_i^2 \varphi_i^2\left(\frac{t}{T}\right) \right] x_{2t}$ .

When  $s_t$ ,  $x_{1t}$ , and  $x_{2t}$  are nonstationary, canonical cointegration regression (CCR) offers better asymptotic results. Hence, Equation (11) under the CCR transformation becomes

$$(12) \quad s_t^{\dagger} = \alpha_0 + \chi_{k_1 t}^{l\dagger'} a_{k_1}^l + \chi_{k_2 t}^{2\dagger'} a_{k_2}^2 + u_{kt}^{\dagger}$$

Where  $\chi_{k_1 t}^{l\dagger'} = \left[ \phi_1^l \left( \frac{t}{T} \right), \dots, \phi_{k_1}^l \left( \frac{t}{T} \right) \right]' x_{1t}^{\dagger}$ ,  $\chi_{k_2 t}^{2\dagger'} = \left[ \phi_1^2 \left( \frac{t}{T} \right), \dots, \phi_{k_2}^2 \left( \frac{t}{T} \right) \right]' x_{2t}^{\dagger}$ , and the superscript  $\dagger$  denotes CCR transformed variables. Once the LS estimators for  $a_{k_1}^l$  and  $a_{k_2}^2$  in Equation (12) are obtained,  $\rho_1$  and  $\rho_2$  can then be approximated by  $\sum_{i=1}^{k_1} \hat{\theta}_i^l \phi_i^l$  and  $\sum_{i=1}^{k_2} \hat{\theta}_i^2 \phi_i^2$ , respectively. Fourier Flexible Form (FFF) series functions, which include polynomials and trigonometric functions, are utilized to approximate  $\rho_1$  and  $\rho_2$ .

#### IV. Assessment of Macroeconomic Models with Constant Cointegration Coefficients

Before beginning any analysis to examine a cointegration relationship, we check whether variables under the PPP or monetary model are indeed nonstationary in Korea, as they are in other countries. For this purpose, we use the Augmented Dickey-Fuller (ADF) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test for both the level and the first difference of the exchange rate, relative money, relative income and relative price. As shown in Table 1, the unit root null hypothesis of the ADF test cannot be rejected for those variables in levels, while the unit root null hypothesis is rejected in the first difference of the variables.

TABLE 1—UNIT ROOT TESTS FOR VARIABLES IN THE MONETARY MODEL AND PPP

Variables		ADF test	KPSS test
$s_t$	Level	-2.780 (0.206)	0.177
	First difference	-6.090 (0.000)	0.043
$(m_t - m_t^*)$	Level	-0.439 (0.986)	0.553
	First difference	-5.602 (0.000)	0.089
$(y_t - y_t^*)$	Level	-1.924 (0.640)	0.281
	First difference	-22.650 (0.000)	0.057
$(p_t - p_t^*)$	Level	-1.717 (0.742)	0.410
	First difference	-4.720 (0.001)	0.086

Note: Numbers in parentheses are the MacKinnon (1996) one-sided p-values for the ADF test statistics. Each lag length is determined by the Akaike information criterion (AIC). The null hypothesis of the Kwiatkowski-Phillips-Schmidt-Shin test is of stationarity and the alternative is the presence of a unit root. The asymptotic critical value for the test statistics is from Kwiatkowski-Phillips-Schmidt-Shin (2002), and it is 0.146 at the 5% level.

Furthermore, the stationarity null hypothesis of the KPSS test can be rejected for all of these variables in levels, whereas the stationarity null hypothesis is not rejected for any of the variables in the first difference. These results, shown in Table 1, strongly suggest that all of the variables under the PPP or the monetary model can be considered to be integrated of order one individually.

#### A. The PPP hypothesis with constant cointegration coefficients

In order to assess the capability of the PPP hypothesis to explain movements of the exchange rate in Korea, we initially examine whether  $z_t^{PPP} = s_t - (p_t - p_t^*)$  is stationary. That is, we investigate the validity of the [1, -1] cointegration vector between  $s_t$  and  $(p_t - p_t^*)$ . Hence, the ADF test is conducted for  $z_t^{PPP}$ . As shown in Table 2, the unit root null hypothesis can be rejected marginally for  $z_t^{PPP}$ . This implies that there exists a long-run relationship between  $s_t$  and  $(p_t - p_t^*)$  based on the [1, -1] cointegration vector.

When we remove the restriction on the cointegration vector, however, the plausibility of the PPP hypothesis is altered. That is, we subsequently address whether there exists any other constant cointegration vector between  $s_t$  and  $(p_t - p_t^*)$  rather than [1, -1]. For this purpose, the Engle-Granger test is conducted. The estimated cointegration coefficients between  $s_t$  and  $(p_t - p_t^*)$  in the first step of the Engle-Granger test are as follows:

$$s_t = 7.99 + 1.19(p_t - p_t^*) + \hat{\varepsilon}_t$$

(0.14) (0.15)

where numbers in parentheses are standard errors.<sup>7</sup>

TABLE 2—ASSESSMENT OF THE PPP WITH CONSTANT COINTEGRATION COEFFICIENTS

			Test Statistic	5% Critical Value
ADF test for $s_t - (p_t - p_t^*)$			-2.9231	-2.8683
The Engle-Granger Test			-3.1870	-3.3654
The Johansen Cointegration Test	With Trend	Trace Statistic	16.3009	25.8721
		Max Eigenvalue Statistic	11.8701	19.3870
	Without Trend	Trace Statistic	14.4693	15.4947
		Max Eigenvalue Statistic	11.8701	14.2646

Note: For the Engle-Granger test,  $s_t = \beta_0 + \beta_1(p_t - p_t^*) + \varepsilon_t$  is run in the first step, after which the ADF test is conducted for the residuals in the first step. The critical value for the ADF statistic is from Phillips and Ouliaris (1990). For the Johansen test, when the 'no cointegration' null is tested, a linear deterministic trend in the data is allowed and the computation of the critical values is based on MacKinnon-Haug-Michelis (1999) p-values. Lag intervals are selected by the AIC.

<sup>7</sup>Following Stock and Watson (1993), we employ dynamic least squares to have optimal estimates of cointegration parameters. The estimated results for first-difference terms are not reported to conserve space, but are available upon request.

The estimated cointegration vector is  $[1, -1.19]$ . Although the estimated coefficient is highly significant, the ADF test for the residuals from the first step of the Engle-Granger test states that the unit root null hypothesis cannot be rejected at the 5% level, as shown in Table 2. In addition to the Engle-Granger test, the cointegration test proposed by Johansen (1988) and Johansen and Juselius (1990) is considered in the last four rows of Table 2. Regardless of whether the trace statistic or the maximum eigenvalue statistic is used, the null of no cointegration cannot be rejected. Moreover, the results do not depend on whether the trend is added in the test or not.

The results in Table 2 are somewhat odd due to the following reason. The PPP with the restriction on the cointegration vector  $([1, -1])$  has some support from the data, but the constant cointegration PPP without the restriction does not. These somewhat odd results in Table 2 suggest that the PPP hypothesis based on the constant cointegration relationship has limited ability to explain the exchange rate in Korea.

#### B. The monetary model with constant cointegration coefficients

Similarly to the examination of the PPP hypothesis in the previous subsection, we first check whether  $z_t^M = s_t - (m_t - m_t^*) + (y_t - y_t^*)$  is stationary under the assumption of  $\beta = \delta = \gamma = 1$ . Hence, the ADF test is conducted for  $z_t^M$ . As shown in Table 3, the unit root null hypothesis cannot be rejected for  $z_t^M$ . This implies that we cannot find a long-run relationship between  $s_t$ ,  $(m_t - m_t^*)$  and  $(y_t - y_t^*)$  based on the  $[1, -1, 1]$  cointegration vector.

After removing the restriction on the cointegration vector, we also investigate whether there exists any other constant cointegration vector between  $s_t$ ,  $(m_t - m_t^*)$  and  $(y_t - y_t^*)$  rather than the  $[1, -1, 1]$  vector. For this purpose, the Engle-Granger test is utilized again. The estimated cointegration coefficients between  $s_t$ ,  $(m_t - m_t^*)$  and  $(y_t - y_t^*)$  in the first step of the Engle-Granger test are as follows:

$$s_t = 5.53 + 0.27(m_t - m_t^*) - 0.17(y_t - y_t^*) + \hat{u}_t$$

(0.45) (0.08)                      (0.15)

where numbers in parentheses are standard errors.

Although the estimated coefficients are highly significant and have correct signs, the estimated cointegration vector is significantly different from  $[1, -1, 1]$ . This implies that the assumption of  $\beta = \delta = \gamma = 1$  is unrealistic. In the second step, hence, the ADF test is utilized for the residuals from the first step of the Engle-Granger test to determine whether there exist other constant cointegration coefficients between  $s_t$ ,  $(m_t - m_t^*)$  and  $(y_t - y_t^*)$ . The unit root null hypothesis cannot be rejected at the 5% level, as shown in Table 3. Similarly to the examination of the PPP, the cointegration test proposed by Johansen (1988) and

TABLE 3—ASSESSMENT OF THE MONETARY MODEL WITH CONSTANT COINTEGRATION COEFFICIENTS

			Test Statistic	5% Critical Value
ADF test for $s_t - (m_t - m_t^*) + (y_t - y_t^*)$			-1.7385	-2.8683
The Engle-Granger Test			-2.6599	-3.7675
The Johansen Cointegration Test	With Trend	Trace Statistic	35.7324	42.9153
		Max Eigenvalue Statistic	21.9325	25.8232
	Without Trend	Trace Statistic	30.9787	29.7971
		Max Eigenvalue Statistic	19.4428	21.1316

Note: For the Engle-Granger test,  $s_t = \alpha_0 + \alpha_1(m_t - m_t^*) + \alpha_2(y_t - y_t^*) + \tilde{u}_t$  is run in the first step and the ADF test is then conducted for the residuals in the first step. The critical value for the ADF statistic is from Phillips and Ouliaris (1990). For the Johansen test, when the ‘no cointegration’ null is tested, a linear deterministic trend in the data is allowed and the computation of the critical values is based on MacKinnon-Haug-Michelis (1999) p-values. Lag intervals are selected by the AIC.

Johansen and Juselius (1990) is considered in the last four rows of Table 3. The null of no cointegration cannot be rejected in most cases. The only exception is the case when the trace statistic is used under no trend. Even if we can find one exceptional case, the results in Table 3 suggest that the monetary model with constant coefficients is also limited in its capability to explain the exchange rate in Korea.

## V. Assessment of Macroeconomic Models with Time-varying Cointegration Coefficients

The contradictory results for the PPP and the limited ability of the monetary model in the previous section suggest that the cointegration approach based on constant cointegration coefficients may be a reason for the failure of macroeconomic models to explain the exchange rate in Korea. Many theoretical and empirical reasons indicate that the relationship between the exchange rate and macroeconomic variables is not constant but varies over time. The results in studies such as Stock and Watson (1993), Mulligan and Sala-i-Martin (2000), Clarida *et al.* (2000), and Kim and Nelson (2006) suggest that the structure of the money market is constantly changing due to changes in both the demand and supply sides. Cheung and Chinn (2001) also find that the importance of economic variables in currency traders’ minds shifts over time. Even if the structural parameters are constant, Bacchetta and van Wincoop (2013) theoretically demonstrate that the cointegration coefficients can vary over time when those structural parameters are unknown and investors cannot distinguish macro fundamentals from unobservable shocks. Bierens and Martins (2010) and Park and Park (2013) provide evidence of time-varying cointegration relationships from advanced countries under the PPP hypothesis and under the monetary model, respectively.

Considering these reasons and the evidence presented, we pursue the time-varying cointegration approach for both the PPP and the monetary model. Hence, we conduct model specification tests proposed by Park and Hahn (1999) and Bierens and Martins (2010) to determine whether Korean data can be used with the

time-varying cointegration approach rather than the constant cointegration approach. First, the following two test statistics proposed by Park and Hahn (1999) are considered,

$$\tau_1^* = \frac{RSS_{FC} - RSS_{FC}^s}{\hat{\omega}_{Tk}^{2*}} \quad \text{and} \quad \tau_2^* = \frac{\sum_{t=1}^T \left( \sum_{i=1}^t \hat{u}_i^* \right)^2}{T^2 \hat{\omega}_{Tk}^{2*}},$$

where  $RSS_{FC}$  is the sum of the squared residuals from the restricted cointegration vector of either  $[1, -1]'$  or  $[1, -1, 1]'$ , or from the CCR transformed regression with constant coefficients.  $RSS_{FC}^s$  is the sum of the squared residuals from the CCR transformed regression augmented with superfluous regressors. We include time polynomials  $t$ ,  $t^2$ ,  $t^3$ ,  $t^4$ ,  $t^5$  and  $t^6$  as superfluous regressors.  $\hat{\omega}_{Tk}^{2*}$  is the long-run variance estimate of the transformed errors  $\hat{u}_{kt}^*$  in Equation (12), and  $\hat{u}_i^*$  denotes the fitted residuals of the transformed regression with constant coefficients. In order to estimate  $\hat{\omega}_{Tk}^{2*}$ , the Bartlett kernel is used with the lag truncation value selected by the method in Andrews (1991). The null hypothesis of those test statistics is that there exists a constant cointegration relationship between those variables, while the alternative hypothesis is a time-varying cointegration relationship. As presented in the first three rows of Table 4, the null hypothesis for  $\tau_1^*$  and  $\tau_2^*$  is strongly rejected in all cases unanimously.

The fourth row of Table 4 shows the result when the Lagrange ratio test proposed by Bierens and Martins (2010) is employed. The null and alternative hypotheses are also a constant cointegration relationship and a time-varying cointegration relationship, respectively. Regarding the test of the PPP hypothesis, the null hypothesis is rejected at the 5% level regardless of the lag order or the number of Chebyshev polynomials in the Bierens and Martins test. Similarly, the null hypothesis of constant cointegration for the monetary model is rejected at the

TABLE 4—MODEL SPECIFICATION TESTS FOR THE MODEL WITH TIME-VARYING COINTEGRATION

	PPP	Monetary Model
$\tau_1^*$ from the regression with the cointegrating vector $[1, -1]'$ for the PPP or $[1, -1, 1]'$ for the monetary model	19,095,000	257,640
$\tau_1^*$ from CCR transformed regression with the constant coefficient	1971.4	659.4631
$\tau_2^*$ from CCR transformed regression with the constant coefficient	20.3028	7.4922
Bierens and Martins test	34.3683 (0.0000)	19.5789 (0.0033)
$\tau^*$	6.5271	11.3577

Note: Regarding  $\tau_1^*$ ,  $\tau_2^*$  and the Bierens and Martins test, the null hypothesis is cointegration with constant coefficients, while the alternative hypothesis is time-varying cointegration. Numbers in parentheses are p-values of the Bierens and Martins test statistics. Regarding  $\tau^*$ , the null hypothesis is time-varying cointegration, while the alternative hypothesis is no cointegration. The 5% critical value for  $\tau_1^*$  or  $\tau^*$  is 12.59, as reported in Park and Hahn (1999). In addition, the 5% critical value for  $\tau_2^*$ , reported in Shin (1994), is 0.314 for the PPP hypothesis and 0.221 for the monetary model.

5% level for a lag order larger than three, regardless of the number of Chebyshev polynomials.<sup>8</sup>

Further, we investigate whether the rejection of the constant cointegration relationship is due to the absence of a cointegration relationship between these variables or due to a time-varying cointegration relationship between these variables. For this purpose, we employ  $\tau^* = \frac{RSS_{TVC} - RSS_{TVC}^s}{\hat{\omega}_{T_k}^{2*}}$ , where  $RSS_{TVC}$  is the sum of the squared residuals from the CCR transformed regression with time-varying coefficients and  $RSS_{TVC}^s$  is the sum of the squared residuals from the time-varying-coefficient CCR transformed regression augmented with superfluous regressors. The null hypothesis is that there exists a time-varying cointegration relationship, while the alternative hypothesis is that there is no cointegration at all. Hence,  $\tau^*$  diverges under no time-varying cointegrating relationship. As shown in the last row of Table 4,  $\tau^*$  is lower than the 5% critical value (12.59) for both the PPP and the monetary model. Therefore, we conclude that Korean data are favorable for use with the PPP with time-varying cointegration coefficients and the monetary model with time-varying cointegration coefficients.

Given that the time-varying approach is supported by Korean data, we estimate the time-varying cointegration parameters with the method of Park and Hahn (1999). Figure 1 shows the estimated  $\beta_t$  values (the time-varying coefficient for  $(p_t - p_t^*)$ ) along with the 95% confidence bands under the PPP.<sup>9</sup> The estimated cointegration parameters are far from constant and are always above one. Figures 2 and 3 present the estimated  $\alpha_{it}$  (the time-varying coefficient for  $(m_t - m_t^*)$ ) and

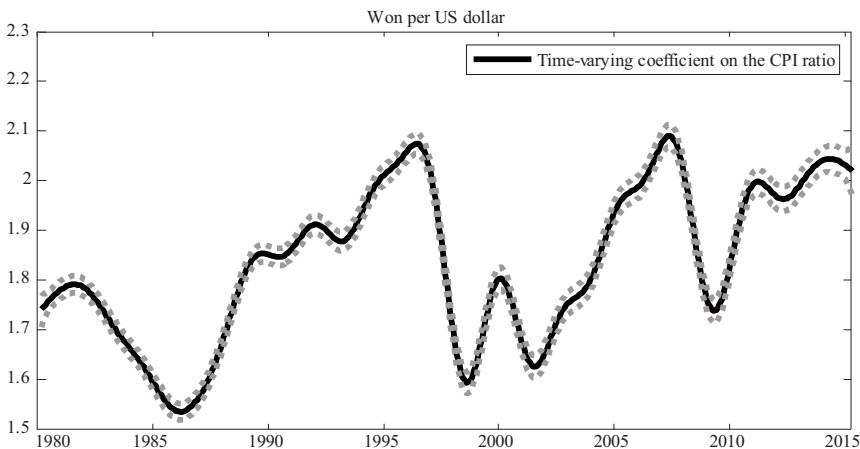


FIGURE 1. TIME-VARYING COINTEGRATION COEFFICIENT FOR  $(p_t - p_t^*)$  UNDER THE PPP

<sup>8</sup>The Bierens and Martins test statistics and p-values in parentheses shown in Table 4 are those with three lag orders and two Chebyshev polynomials.

<sup>9</sup>The time-varying coefficients using CPI indices could be estimated as being larger than those using the PPI indices because CPIs include a large number of non-traded goods and services. A plot of the estimated time-varying coefficients with the use of the PPI indices is available upon request.



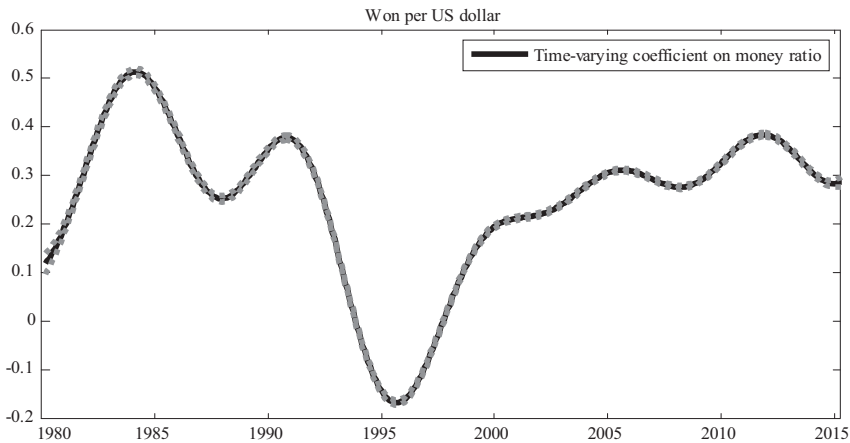


FIGURE 2. TIME-VARYING COINTEGRATION COEFFICIENT FOR  $(m_t - m_t^*)$  UNDER THE MONETARY MODEL

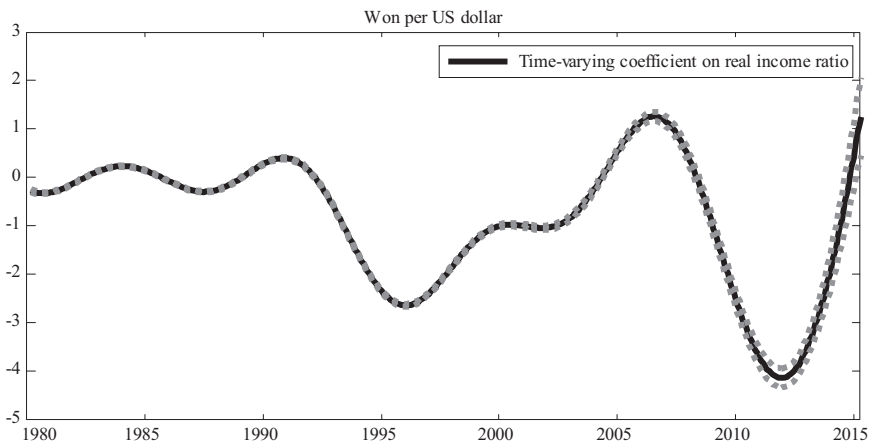


FIGURE 3. TIME-VARYING COINTEGRATION COEFFICIENT FOR  $(y_t - y_t^*)$  UNDER THE MONETARY MODEL

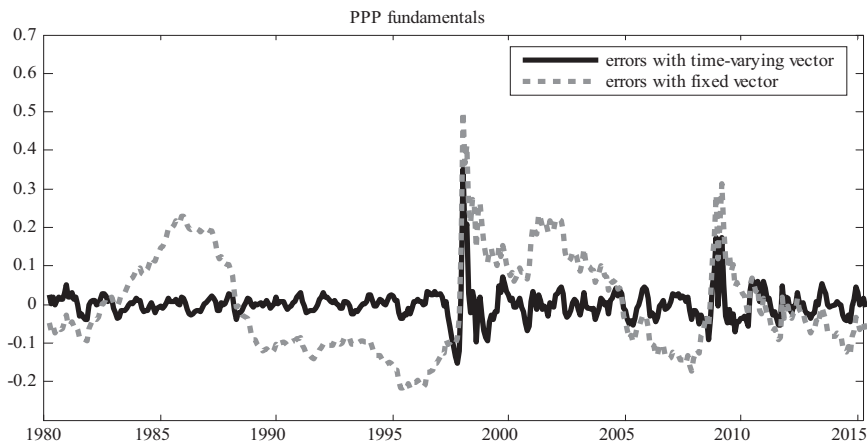


FIGURE 4. COINTEGRATING ERRORS FROM THE PPP MODEL WITH TIME-VARYING AND FIXED COEFFICIENTS

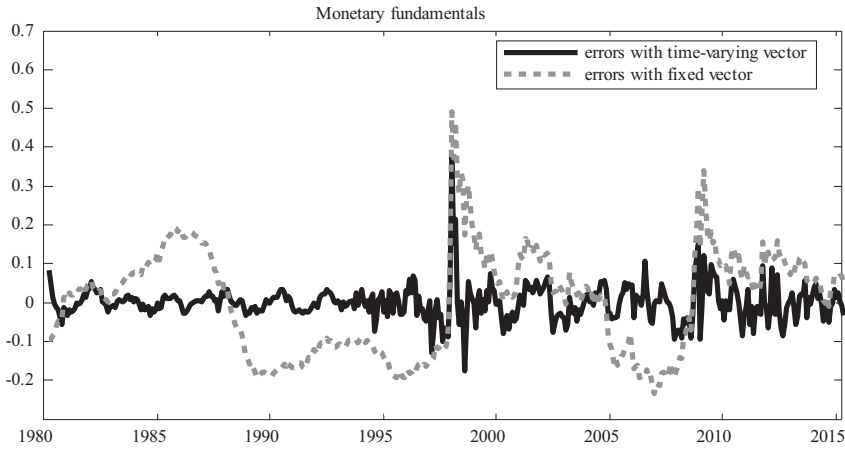


FIGURE 5. COINTEGRATING ERRORS FROM THE MONETARY MODEL WITH TIME-VARYING AND FIXED COEFFICIENTS

$\alpha_{2t}$  (the time-varying coefficient for  $(y_t - y_t^*)$ ) under the monetary model. Again, the estimated cointegration coefficients are not constant at all, but they have signs consistent with the standard monetary model in most cases.

Figure 4 compares the cointegration errors under the PPP with the  $[1, -1]$  cointegration vector and errors under the PPP with time-varying cointegration coefficients. Similarly, Figure 5 compares the cointegration errors under the monetary model between the  $[1, -1, 1]$  cointegration vector and time-varying cointegration coefficients. Both figures show that the residuals from the time-varying cointegration regressions appear to be much more stable and stationary than those from the restricted cointegration vectors. This finding is consistent with the results in Table 4.

## VI. The Predictability of the Exchange Rate and the Time-varying Cointegration Approach

The results of various specification tests indicate that data in Korea are favorable to time-varying cointegration approach. Because the time-varying cointegration approach enables both the PPP and the monetary model to pass those specification tests, we compare the predictive abilities of these models to forecast the exchange rate in this section. That is, we check whether deviations from the time-varying long-run equilibrium value of the exchange rate under the PPP or the monetary model are useful in predicting future changes of the exchange rate.

### A. In-sample Analysis

In order to determine the predictive abilities of the models, we consider the following univariate predictive regression:

$$(13) \quad s_{t+k} - s_t = \gamma_{0,k} + \gamma_k z_t^{TVC} + w_{t+k,t}$$

where  $z_t^{TVC} = s_t - \beta_t(p_t - p_t^*)$  under the PPP, and  $z_t^{TVC} = s_t - \alpha_{1t}(m_t - m_t^*) - \alpha_{2t}(y_t - y_t^*)$  under the monetary model. As the exchange rate moves toward long-run equilibrium over time,  $\gamma_k$  should be negative.

The results of the in-sample analysis are presented in Table 5.  $\gamma_k$  (the slope coefficient in the predictive regression) always has correct signs and is significant regardless of forecast horizons or regardless of the underlying model used. The PPP model has impressive predictive power for horizons shorter than one year. Specifically, the PPP model can explain 31% of the variation in the exchange rate at a six-month horizon. As horizons become longer, however, the monetary model shows better forecasting ability. We also run the following regression to determine whether the combination of the PPP and the monetary model improves the predictive power:

$$(14) \quad s_{t+k} - s_t = \gamma_{0,k} + \gamma_{1,k} z_t^{TVC,1} + \gamma_{2,k} z_t^{TVC,2} + w_{t+k,t}$$

where  $z_t^{TVC,1} = s_t - \beta_t(p_t - p_t^*)$  and  $z_t^{TVC,2} = s_t - \alpha_{1t}(m_t - m_t^*) - \alpha_{2t}(y_t - y_t^*)$ . As shown in the last three columns of Table 5,  $\gamma_{1,k}$  is significant over shorter horizons, while  $\gamma_{2,k}$  is significant over longer horizons. However, the combination of the two models does not improve the predictive ability much over the PPP for short horizons and/or over the monetary model for long horizons. This implies that the time-varying PPP relationship is the dominant reason for the time-varying monetary model among four structural equations (Equations (4) – (7)) under the monetary model.

TABLE 5—PREDICTIVE REGRESSIONS:  
IN-SAMPLE ANALYSIS

Forecasting Horizon ( $k$ )	Time-varying PPP		Time-varying Monetary Model		Time-varying PPP + Time-varying Monetary Model		
	$\gamma_k$ (T-statistics)	$\bar{R}^2$	$\gamma_k$ (T-statistics)	$\bar{R}^2$	$\gamma_{1,k}$ (T-statistics)	$\gamma_{2,k}$ (T-statistics)	$\bar{R}^2$
1	-0.2757 (-6.1937)	0.1006	-0.24 (-5.3517)	0.0988	-0.1712 (-3.4517)	-0.1444 (-2.9295)	0.1199
6	-1.2317 (-6.8911)	0.3113	-0.8523 (-5.5743)	0.1967	-1.0305 (-3.8621)	-0.2775 (-1.3152)	0.3215
12	-1.2195 (-7.6954)	0.1589	-1.2816 (-5.1457)	0.2226	-0.4897 (-2.2506)	-1.0099 (-3.4466)	0.2348
24	-0.9074 (-5.6222)	0.0692	-0.9462 (-4.4534)	0.0865	-0.373 (-1.5247)	-0.7385 (-2.6095)	0.0884
36	-0.8034 (-5.0077)	0.0704	-0.7703 (-5.4014)	0.0746	-0.4183 (-1.9073)	-0.5307 (-2.7486)	0.0762
48	-0.9496 (-4.3616)	0.0885	-0.9224 (-5.817)	0.0935	-0.4826 (-1.733)	-0.6403 (-3.0603)	0.0953

Note: Numbers in parentheses are t-statistics based on Newey-West standard errors.

### B. Out-of-sample Analysis

We also compare the out-of-sample performance of both models to that of the random walk without drift, which has been the benchmark for assessing the out-of-sample performance of exchange rate models in many studies since Meese and Rogoff (1983). In the out-of-sample analysis, time-varying cointegration errors are constructed using data up to January of 2005, and then the predictive regression in Equation (13) is run to estimate  $\gamma_{0,k}$  and  $\gamma_k$ . Using the estimated values of  $\gamma_{0,k}$  and  $\gamma_k$  and the last observation of cointegration errors, forecasts are made for future changes in the exchange rate. We repeat these steps while keeping the window size constant. When comparing the out-of-sample performance of the time-varying PPP or the time-varying monetary model to that of a random walk model, we employ the Clark and West (2007) test statistic. The null hypothesis is that two competing forecasting models have an equal mean-squared prediction error. We construct the Clark-West test statistic so that it has a significantly positive sign if the regression model with time-varying cointegration errors exhibits superior predictive power in relation to the random walk model.

Table 6 reports the test results. Unlike the impressive results in the in-sample analysis, the time-varying PPP and the time-varying monetary model outperform the random walk model at the 10% level only when the forecast horizon reaches 48 months. Even if the time-varying PPP and the time-varying monetary model are combined, the out-of-sample performance does not improve at all. This deterioration of the performance of both time-varying models in the out-of-sample analysis, however, may not result from the nature of those models. Instead, it may be related to the loss of power resulting from the smaller sample size for the estimation in the out-of-sample analysis, as emphasized by Inoue and Kilian (2004) and Bacchetta *et al.* (2010). This issue should be further investigated with more observations in the future.

We also compare the out-of-sample performances of time-varying models with those of the counterparts based on constant cointegration models. The results are reported in Table 7. Consistent with Table 6, the Clark-West test statistic is designed to have a significantly positive sign if the regression model with time-

TABLE 6—PREDICTIVE REGRESSIONS: OUT-OF-SAMPLE ANALYSIS:  
COMPARISON WITH RANDOM WALK

Forecasting Horizon ( $k$ )	Time-varying Monetary Model vs. Random Walk	Time-varying PPP vs. Random Walk	Time-varying Monetary Model + Time-varying PPP vs. Random Walk
1	-0.7897 (0.7852)	0.1875 (0.4256)	-0.6504 (0.7423)
6	-0.2459 (0.5971)	-2.7513 (0.997)	-2.0785 (0.9812)
12	-0.7704 (0.7795)	-0.9674 (0.8333)	-0.7397 (0.7703)
24	-2.5407 (0.9945)	-0.5072 (0.694)	-2.4493 (0.9928)
36	0.2753 (0.3915)	1.2295 (0.1094)	-0.2793 (0.61)
48	1.8133 (0.0349)	1.6084 (0.0539)	1.786 (0.0371)

Note: Numbers in parentheses are p-values.

TABLE 7—PREDICTIVE REGRESSIONS: OUT-OF-SAMPLE ANALYSIS:  
COMPARISON BETWEEN TIME-VARYING COINTEGRATION MODEL AND CONSTANT COINTEGRATION MODEL

Forecasting Horizon ( <i>k</i> )	Time-varying Monetary Model vs. Constant Coefficient Monetary Model	Time-varying PPP vs. Constant Coefficient PPP	Time-varying Monetary Model + Time-varying PPP vs. Constant Coefficient Monetary Model + Constant Coefficient PPP
1	-2.4145 (0.9921)	-2.7930 (0.9974)	-0.6604 (0.7455)
6	-2.132 (0.9835)	-2.7896 (0.9974)	-1.6917 (0.9546)
12	0.082 (0.4673)	-1.9335 (0.9734)	0.1603 (0.4363)
24	1.2522 (0.1053)	1.7249 (0.0423)	0.1027 (0.4591)
36	1.7973 (0.0361)	2.8229 (0.0024)	1.3525 (0.0881)
48	2.4844 (0.0065)	3.6397 (0.0001)	3.0417 (0.0012)

Note: Numbers in parentheses are p-values.

TABLE 8—PREDICTIVE REGRESSIONS: OUT-OF-SAMPLE ANALYSIS:  
COMPARISON BETWEEN TIME-VARYING MODELS

Forecasting Horizon ( <i>k</i> )	Time-varying PPP vs. Time-varying Monetary Model		Time-varying PPP vs. Time-varying Monetary Model + Time-varying PPP	
	$\frac{RMSE_{PPP}}{RMSE_M}$	Diebold-Mariano statistic	$\frac{RMSE_{PPP}}{RMSE_{M+PPP}}$	Diebold-Mariano Statistic
1	0.9478	1.2387 (0.1077)	0.9743	0.8406 (0.2003)
6	1.039	-0.7739 (0.7805)	1.0131	-0.9156 (0.8201)
12	0.9232	1.8169 (0.0346)	0.9181	2.8012 (0.0025)
24	0.9246	1.5419 (0.0615)	0.94	2.3414 (0.0096)
36	0.8960	1.9954 (0.023)	0.8681	2.3003 (0.0107)
48	0.9835	0.2582 (0.3981)	0.9781	0.6961 (0.2432)

Note: Numbers in parentheses are p-values.

varying cointegration errors exhibits superior predictive power to the corresponding constant cointegration model. The constant cointegration approach shows significantly better out-of-sample performances in short horizons than the time-varying cointegration approach, regardless of underlying macroeconomic models. As the forecast horizon increases, however, the time-varying models show better out-of-sample forecast ability regardless of underlying macroeconomic models. The superiority of the predictability from the time-varying model over the counterparts from the constant cointegration model becomes significant at horizons longer than one or two years.

Finally, we compare the out-of-sample performances among the time-varying PPP, the time-varying monetary model, and the combination of the two. The first two columns of Table 8 show horse race results between the time-varying PPP and

the time-varying monetary model. The time-varying PPP outperforms the time-varying monetary model at all horizons except for the six-month horizon, and the gap in the forecast performance is significant at 12–36 month horizons according to the Diebold-Mariano test. Similarly, the time-varying PPP always shows better out-of-sample performance against the combination of the two models except with a six-month horizon, as shown in the last two columns of Table 8. Again, the superior performance of the time-varying PPP relative to the combined model is significant at 12–36 month horizons according to the Diebold-Mariano test. Although the time-varying PPP shows the best out-of-sample performance, the results should be interpreted with caution, as argued by Inoue and Kilian (2004) and Bacchetta *et al.* (2010).

## VII. Discussion

This paper shows that when cointegration coefficients are allowed to vary over time, both the PPP and the monetary model can pass various specification tests, implying that macroeconomic variables based on those models are tightly linked with the exchange rate in Korea. When the abilities to predict future exchange rates between those models based on time-varying cointegration coefficients are compared, the in-sample analysis shows that the time-varying PPP (monetary model) shows better predictive power with horizons shorter (longer) than one year. The results of the out-of-sample analysis indicate that the time-varying PPP performs better when used to predict future changes in the exchange rate.

In addition to these findings, the movements of time-varying coefficients appear to have some signaling power for the Korean economy. The time-varying cointegration coefficient based on the PPP increased around the periods of the Asian currency crisis and the global financial crisis, which may reflect the drastic depreciation of the Korean currency around the time of those crises. The seemingly upward-sloping trend in the time-varying coefficients based on the PPP in Figure 1 suggests a depreciation of the real exchange rate resulting from the slowdown of the growth in the Korean economy.<sup>10</sup> The time-varying coefficients based on the monetary model in Figures 2 and 3 also behaved abnormally around these two crises. The coefficients of the relative money (for the relative income) are usually positive (negative) as the theoretical model predicts, but they became negative (positive) around the two crises, implying a drastic depreciation of the Korean currency as compared with fundamentals at those times.

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<sup>10</sup>According to the Balassa-Samuelson hypothesis, a country with an increase in productivity relative to other countries experiences a rise in its price level and real appreciation.

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# Analysis of the Structural Changes in Household Debt Distributions by Householder Age in Korea and in the US

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*This paper analyzes how and why household debt distribution by the householder age has changed over the past decade both in Korea and the US. Data shows that the proportion of household debt held by younger households has decreased, while that held by older households has increased. Empirical analysis shows that a change in the demographic distribution of householders is the main driving force that has shifted the household debt distribution. Given that demographic aging is an inevitable trend, the proportion of household debt held by older households is also expected to increase. Therefore, the Korean government must preemptively prepare for the household debt problem, especially for debt held by older households, by strengthening macro-prudential policies, preventing asset price deflation, restructuring household debt contract structures, and reforming labor market inflexibility.*

Key Word: Household debt distribution, Demographic distribution, Household income, Household asset

JEL Code: C14, D31, G28, J11

## I. Introduction

Household debt in Korea has steadily increased since the early 2000s, with the growth rate accelerating more rapidly since 2012. Accordingly, policymakers and researchers in Korea have been seriously concerned about the consistent increase in household debt. Those who claim that the current level of household debt is too high argue that large amounts of household debt can lead to a deterioration in economic growth (e.g., Cecchetti *et al.* 2011; IMF 2012; Bornhorst and Arranze (2013)). On the other hand, some argue that the general quality of household debt in Korea is moderate, as the majority of household debt is held by

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high-income and high-asset households (e.g., Hahm *et al.* 2010; Kim and Byun 2012; Kim and Yoo 2013).

In this paper, I analyze the household debt problem considering the aging population. More specifically, I examine how and why the household debt distribution by householder age group has changed over the past decade. It is well known that the elderly population has increased in Korea. Here, I analyze how the change in the demographic composition affects the household debt distribution by householder age. Moreover, I examine the effects of changes in household income and asset distribution on the change in the household debt distribution.

Initially, I compare Korea's household debt distribution by the householder's age to that of the US within and across time. The main motivation for comparing those two countries is that Korea's household debt-to-GDP ratio in 2013 is nearly identical to that of the US for 2003 and 2013 (see Figure 1). The US ratio increased to almost 95% and later deleveraged after the global financial crisis. Korea's household debt-to-GDP ratio, on the other hand, has not experienced any large adjustments, even after the global financial crisis. It is well known that US households took out much in loans, especially mortgages, before the financial crisis. Low-income and low-credit (or subprime-level) households could easily take out large amounts of loans before the economic crash (Mian and Sufi 2009; Keys *et al.* 2013; and others). By comparing the 2004 US household debt distribution, when loans were carelessly issued, to Korea's recent household debt distribution, I can examine the risk level of the current Korean household debt problem, especially by age group.<sup>1</sup> (Note that the aggregate levels of household debt-to-GDP ratios in both countries in these two years are nearly identical.) In addition, I examine household income, (net) assets, debt-to-income ratios, and debt-to-asset ratio distributions by householder's age. By comprehensively analyzing household's financial characteristics and comparing Korea to the US, I can evaluate the potential risks to Korean households.

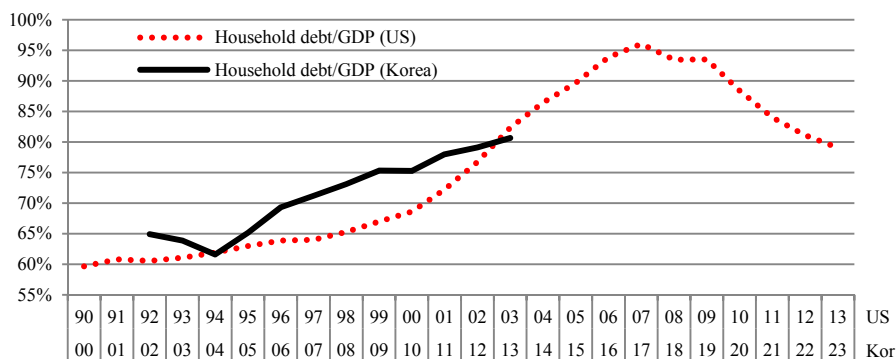


FIGURE 1. HOUSEHOLD DEBT-TO-GDP RATIOS FOR KOREA AND THE US

Note: Data are from the OECD and the Bank of Korea. Household debt data in the flow of funds table is used.

<sup>1</sup>Because the US data used in this paper is not surveyed annually, the data wave of 2004 is selected. Please see the next section for more details about data sources.

Next, I analyze how the household debt distribution by householder age group has changed over the last ten years (in the case of the US, I can examine changes over the last 20 years).<sup>2</sup> The data shows that the proportion of household debt held by (relatively) younger households has decreased, while that of older households has increased over the last ten years. Specifically, the household debt distribution by the householder age group has shifted to the right. Moreover, the income, asset, and demographic distribution of households by householder age have all simultaneously shifted to the right. The shift in the income distribution is mainly driven by the changes in demographic factors. That is, as the proportion of older households increases, the proportion of income held by older households also increases. However, this explanation does not apply to household debt or asset distributions. Even after controlling for demographic factor, the proportion of household debt and assets held by young households has decreased, while that held by older households has increased. We can also observe such patterns in the US.

This motivates me to examine which factors mainly drive the change in the household debt distribution. More specifically, I consider household debt distribution by householder age group in 2004 and 2012<sup>3</sup> and analyze which household-specific characteristics affect changes in these distributions. Applying DiNardo *et al.* (1996), I consider a counter-factual 2004 household debt distribution where only the householder age distribution follows the distribution of 2012, while other household-specific characteristics remain in line with the 2004 distribution. By analyzing the results of this exercise, I can examine the effects of changes in householder's demographic distribution over the last ten years on the household debt distribution. Similarly, I simulate a counter-factual scenario where only the household income (asset) distribution follows the distribution of 2012, with other household characteristics remaining in line with the 2004 distribution. Accordingly, the change in the householder demographic composition is the main driver behind the change in the household debt distribution by householder age. The demographic factor can explain the shift in the household debt distribution nearly by half. On the other hand, changes in either the income or asset distribution do not fully explain the change in the household debt distribution. I can also draw similar conclusions for the US, though the explanatory power of the change in the demographic composition is smaller than in Korea.

Given that demographic aging is an inevitable trend in Korea, as well as in the US, the proportion of household debt held by older households is also expected to increase. Hence, the Korean government must preemptively prepare for the household debt problem, especially for debt held by older households before the problem is exacerbated. Here, I propose policy directions which should be considered by the Korean government. First, the government should speed up the reforming of labor market inflexibility to prevent a sudden drop in household income when the householder reaches retirement age. Second, policymakers should monitor the possibility of asset price deflation more carefully. Third, household debt contracts in Korea should be restructured from the short-run bullet type to

<sup>2</sup>In the case of Korea, the sample period of available micro-data is insufficient. Please see section II for more details.

<sup>3</sup>I used the most recently released KLIPS data (2012) and the 2004 wave of the KLIPS. In the case of the US, I choose the survey years of 2004 and 2013. The data section offers additional details.

long-run amortization loans. Lastly, macro-prudential policies, such as debt-to-income (DTI) regulations, must be strengthened to spread the risk from unexpected adverse shocks.

There are many papers that analyze the potential risk of household debt in Korea. However, to the best of my knowledge, no studies have analyzed the structural risk of household debt which originates from an aging population. Kim and Byun (2012) analyzed individual-level debt distributions by income, credit score, occupation, financial intermediary type, age, and regional groups. Hahm *et al.* (2010) and Kim and Yoo (2013) also implemented a similar empirical exercise. Generally, these papers conclude that the current level of Korean household debt is not high enough to threaten the stability of financial system. However, certain types of households, such as low-income, non-banking debtors, are potentially vulnerable in negative stress scenarios. These papers commonly analyze household debt distributions by diverse debtor-specific characteristics at a certain time. Unlike those papers, I examine household debt distributions from a long-term perspective and analyze how and why the household debt distribution has changed structurally.

Other papers examine how household debt responds to unexpected exogenous shocks. Jeong and Kang (2013) analyzed household debt responses from unexpected changes in productivity (TFP), interest rates, or house prices. Justiniano *et al.* (2015) assert that the leverage and deleverage in US household debt is mainly driven by households' taste for housing services. These papers commonly used a DSGE-style model and introduced certain exogenous shocks. My analysis regarding changes in household debt is driven more by a structural factor: changes in the demographic composition. In addition, this paper, unlike other papers, analyzes the household debt distribution rather than aggregate amounts (or levels) of household debt.

The remainder of this paper is organized as follows. Section II introduces the micro-data used in this paper. Section III compares Korea and US household debt distributions in a certain survey year (through a static comparison or a cross-section analysis). Section IV examines how the household debt distribution both in Korea and the US has changed over the last decade (via a dynamic comparison or a time-series analysis). Section V analyzes which factor(s) has (have) mainly driven the change in the household debt distribution over the past ten years. Finally, section VI concludes with policy implications.

## II. Data Description

I used two household level micro-data to analyze the Korean household debt distribution: the Korean Labor and Income Panel Study (KLIPS) and the Survey of Household Finances and Living Conditions (SHFLC). KLIPS is a panel dataset which initiated in 1999. The most recently released survey was in 2012. SHFLC started in 2010, and the most recently updated survey was done in 2014. SHFLC is a panel structure between 2010 and 2011. Afterward, SHFLC re-sampled the interviewees in 2012, hence taking on a panel structure for the period of 2012 to 2014. SHFLC contains more finely categorized household asset and debt information than KLIPS. Unfortunately, because the initial survey year of SHFLC

is 2010, I used KLIPS and SHFLC simultaneously to analyze the structural changes in the household debt distribution over the decade.

For the US case, I used the Survey of Consumer Finances (SCF) released by the Federal Reserve Board. SCF is similar to SHFLC, though with many more questionnaires. SCF has been released every three years, starting in 1983, and is not a panel dataset. Given that this paper analyzes the cross-sectional distributions of household debt over different years, a panel structure is not in fact necessary.<sup>4</sup>

Each dataset contains different household debt and asset categories. Hence, we need to clarify how aggregate household-level debt and assets are calculated. For KLIPS, household debt is the sum of financial debt (including secured and unsecured debt), non-financial debt, personal debt, jeonse<sup>5</sup> deposits owed to renters, debt owed to mutual assistance society (or lodge money debt), and other loans. Similarly, aggregate household-level debt in SHFLC is defined by summing up the following components: financial debt, which includes both secured and unsecured debt; lodge money debt; debts related to credit cards; and jeonse deposits owed to renters. For SCF, total household debt is the sum of the following debt categories: mortgage/land contracts, debt related to investment real estate and vacation properties, business debt, vehicle loans, land contracts and notes (debt), credit card debt, home equity lines of credit, lines of credit not secured by residential property, education loans, other loans, loans for home improvement, other debt, margin loans, loans backed by insurance, and loans backed by pensions.

Similar to household debt, each dataset also defines household-level assets differently. For KLIPS, the sum of the housing value, jeonse deposits, and financial assets<sup>6</sup> is defined as the household total assets.<sup>7</sup> For SHFLC, household assets are calculated as the sum of financial assets, which includes all types of savings and financial investments, jeonse deposits, and real assets including real estate and non-real estate real assets. Household assets in SCF are defined by summing up the following components: the value of the primary residence, investment real estate and vacation properties; business equity; vehicles; financial assets;<sup>8</sup> other assets; and land contracts and notes.

Table 1 summarizes household debt, income, assets, and net assets both in Korea and the US. The fraction of households that hold any type of debt (real-estate-related debt) in Korea is 65% (30%), while it is 77% (49%) and 75% (45%) in 2004 and 2013, respectively, in the US. Because it is meaningless to compare the levels of household debt between two countries, I measure the household debt burden by calculating the debt-to-income and the debt-to-asset ratios in both countries. The household debt-to-income ratio in Korea is 1.28 in 2014, while the

<sup>4</sup>Since each survey asks the exact amount of remaining household debt, I can calculate and compare household debt-related moments by using these different data sources.

<sup>5</sup>Jeonse is one way of leasing a house in Korea. Instead of paying monthly rents, a renter makes a lump-sum deposit on a rental space, which is around 70% of the market value.

<sup>6</sup>Financial asset is the sum of the following components: saving, stock, bond, mutual fund, insurance, lodge money, uncollected loan.

<sup>7</sup>KLIPS also contains some non-real estate real asset categories, such as vehicle, jewelry, artwork, and golf/condominium memberships. However, these asset categories are only included in limited waves of the survey. To make a consistent asset measure within KLIPS, I excluded those categories.

<sup>8</sup>Financial asset is the sum of the following components: checking account, IRA/Keogh, certificate deposit, saving/MMF, mutual fund/hedge fund, saving bond, any other bonds, stocks, brokerage account, annuity/any trust/managed investment account, life insurance

TABLE 1—SUMMARY STATISTICS OF HOUSEHOLD DEBT, INCOME, AND ASSETS IN KOREA AND THE US

	Korea (2014)	US (2004) <sup>9</sup>	US (2013)
<b>Total household debt</b>			
% of households holding debt	65%	77%	75%
Average amount of total debt	₩59,941,762	\$108,959	\$101,449
Median amount of total debt	₩10,000,000	\$29,168	\$22,500
Average amount of total debt conditional on having debt	₩91,174,289	\$142,354	\$135,849
Median amount of total debt conditional on having debt	₩40,000,000	\$70,892	\$63,040
<b>Total real estate related debt</b>			
% of households holding real estate debt	30%	49%	45%
Average amount of real estate debt	₩29,349,407	\$93,363	\$85,594
Median amount of real estate debt	₩0	\$0	\$0
Average amount of real estate debt conditional on having real estate debt	₩98,711,051	\$188,645	\$189,388
Median amount of real estate debt conditional on having real estate debt	₩60,000,000	\$120,867	\$119,000
<b>Household income</b>			
Average income	₩46,760,775	\$84,052	\$84,024
Median income	₩38,000,000	\$51,800	\$45,000
Average income conditional on having debt	₩54,376,386	\$91,125	\$90,390
Median income conditional on having debt	₩45,000,000	\$59,200	\$54,000
Average income conditional on having real estate debt	₩60,973,678	\$113,234	\$118,268
Median income conditional on having real estate debt	₩51,000,000	\$75,234	\$74,000
<b>Household assets</b>			
Average assets	₩333,643,540	\$619,874	\$580,805
Median assets	₩193,600,000	\$196,964	\$154,450
Average assets conditional on having debt	₩403,953,840	\$615,746	\$560,155
Median assets conditional on having debt	₩249,000,000	\$216,451	\$175,851
Average assets conditional on having real estate debt	₩492,215,490	\$833,011	\$802,991
Median assets conditional on having real estate debt	₩326,700,000	\$328,315	\$283,900
<b>Household net asset<sup>10</sup></b>			
Average net assets	₩273,701,780	\$510,915	\$479,356
Median net assets	₩154,530,000	\$100,024	\$63,800
Average net assets conditional on having debt	₩312,779,550	\$473,392	\$424,305
Median net assets conditional on having debt	₩185,570,000	\$104,020	\$64,400
Average net assets conditional on having real estate debt	₩347,733,360	\$623,259	\$592,272
Median net assets conditional on having real estate debt	₩223,310,000	\$173,901	\$126,600

ratio is 1.30 and 1.21 in 2004 and 2013, respectively, in the US.<sup>11</sup> The household debt-to-income ratio conditional on having household debt is 1.68 in Korea, while it is 1.56 and 1.50 in 2004 and 2013, respectively, in the US. Hence, Korean households have slightly larger amounts of household debt in terms of their income than the US households. We can also observe even through the micro-level data that households in the US deleveraged their debts after the global financial crisis (in terms of their income).

The household debt-to-asset ratio in Korea is 0.18, while the ratio in the US is 0.18 and 0.17 in 2004 and 2013, respectively. The household debt-to-asset ratio conditional on holding debt in Korea is 0.23, while it is 0.23 and 0.24 in 2004 and 2013, respectively, in the US. Household debt held by Korean households in terms of their assets is quite similar to that held by US households. Given that the average

<sup>9</sup>Unit: 2013 USD

<sup>10</sup>Net assets = Total household assets - Total household debt

<sup>11</sup>The ratio of household debt to income in Korea is calculated by ₩59,941,762/₩46,760,775

housing price in the US decreased significantly in the aftermath of the global financial crisis, the average household assets in the micro-level data also decreased by 6.3%. At the same time, US households also deleveraged their debt after the financial crisis, leading to identical US household debt-to-asset ratios in 2004 and 2013.

Using aggregate household debt statistics masks several important features and the potential vulnerability related to household debt in Korea. Hence, I examine the Korean household debt distribution and compare it to the distribution in the US. More specifically, I mainly focus on household debt distributions by householder age. It is well known that Korean society is aging, and the speed of this trend is more rapid than in any other OECD member country. The general trend is the same in the US, though the speed of population aging is slower. I sampled households in which the householder's age is between 20 and 79, which covers nearly every household that carries on economic activities. It is known that the SCF data surveys very wealthy households. Hence, I dropped extremely rich or highly indebted US households when calculating statistical moments.<sup>12</sup> (Specific explanations are in the footnotes of each figure and table in the next section.)

### III. Static Analysis of Household Debt Distribution

In this section, I compare the 2014 Korean household debt distribution by householder age to the 2004 US household debt distribution. As shown in Figure 1, the recent household debt-to-GDP ratio in Korea is similar to the 2003 and 2013 ratios in the US. Before the global financial crisis, the US household debt increased monotonically. Next, US households deleveraged their debt through government-driven loan-modification programs, foreclosures, bankruptcies, and other measures (Gerardi and Li 2010 and Robinson 2009). Given that the 2014 Korea and 2004 US data are similar in terms of household debt-to-GDP ratio levels and their increasing trends, I initially choose those two years and compare the household debt distributions of two countries.

I define two measures which I mainly use in this paper to analyze household debt distributions by householder age. First, I calculate what portions of debt are held by a certain age group. Let  $m_i$  be the amount of debt held by household  $i$ , and  $w_i$  be the sample weight. Then, the proportion of debt held by a certain age group can be calculated as follows:

$$(1) \quad Q_{Age\ group} = \frac{\sum_{i \in Age\ group} w_i m_i}{\sum_{i \in All\ population} w_i m_i}$$

Under this measure, the debt-holding ratio by a certain age group may increase when the number of people in the age group is large enough. In order to control for an age-specific population effect, I define the second measure as shown below.

<sup>12</sup>Please see the following FRB report ([http://www.federalreserve.gov/econresdata/scf/files/index\\_kennickell.html](http://www.federalreserve.gov/econresdata/scf/files/index_kennickell.html)) I also calculated moments without excluding extremely rich or indebted households in the Appendix.

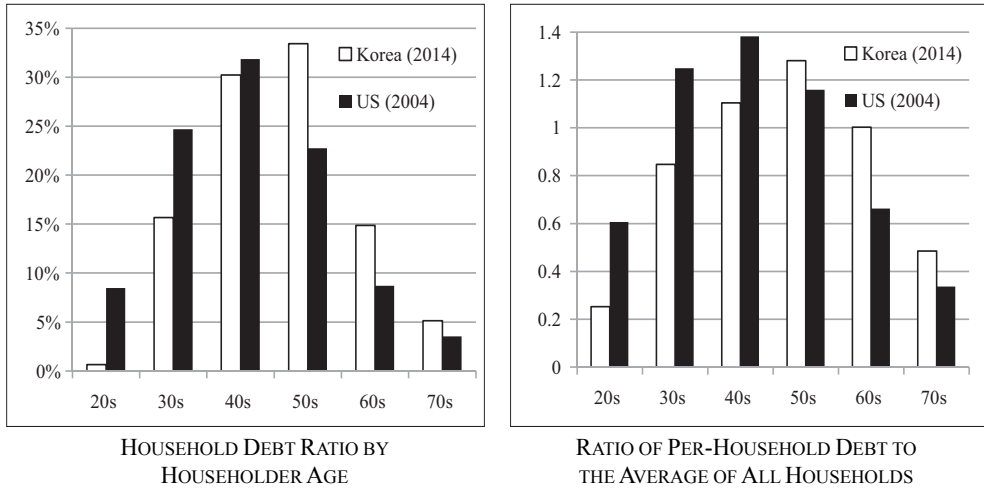


FIGURE 2

Note: US Households with debt in the top 1% are dropped.

Source: (Korea) 2014 SHFLC; (US) 2004 SCF

$$(2) \quad P_{Age\ group} = \frac{\sum_{i \in Age\ group} w_i m_i / \sum_{i \in Age\ group} w_i}{\sum_{i \in All\ population} w_i m_i / \sum_{i \in All\ population} w_i}$$

This is the ratio of the average debt held by a certain age group to the average debt held by the whole population. Hence, this ratio measures the relative amounts of debt held by a certain age group while controlling for demographic effects.

Figure 2 compares the 2014 Korea to the 2004 US household debt distributions by the householder age group. The left figure is the debt-holding ratio by householder's age ( $Q_{Age\ group}$ ), and the right figure is the ratio of the average amount of debt held by a certain age to the average of all households ( $P_{Age\ group}$ ).

The older population in Korea holds a greater portion of the debt compared to this segment in the US, particularly those in their 50s. The debt of Korean households with householders in their 50s accounts for approximately 33% of all household debt, while it is 23% in the US, even lower than the debt held by those in their 40s. When I control for the demographic differences between Korea and the US, Korean household debt is comparatively more concentrated in the older-aged groups, particularly those in their 50s. Korean households with householders in their 50s are carrying 28% more debt than that held by the average household of the entire economy, which is higher by about 16% in the US. Due to the high proportion of the population in their 50s, along with the large amount of average debt, in Korea, the absolute proportion of their debts is much higher than that in the US.

Having large amounts of household debt may not be a serious problem if households have high enough income or asset simultaneously. In Figure 3, I present the household income distribution by householder age group. I similarly consider two measures: the proportion of household income held by a certain age group, and



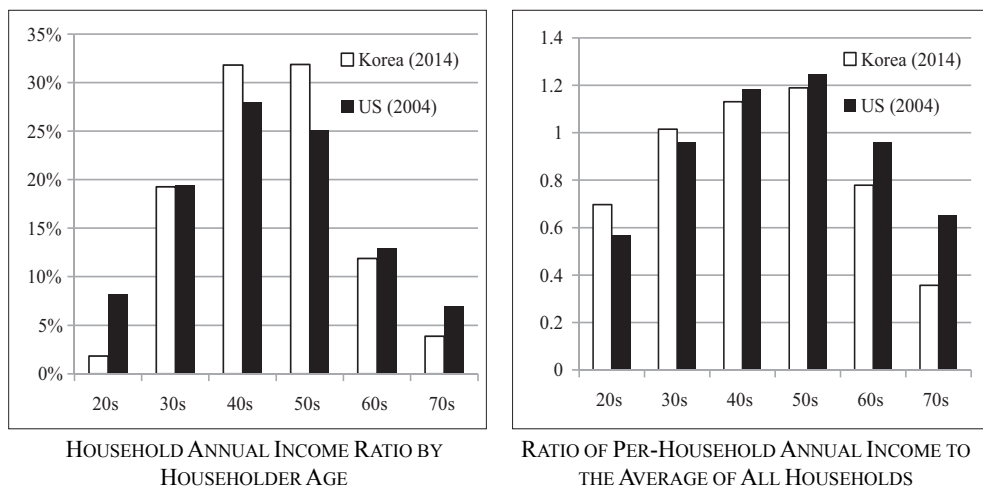


FIGURE 3

Note: US Households with incomes in the top 1% are dropped.

Source: (Korea) 2014 SHFLC; (US) 2004 SCF

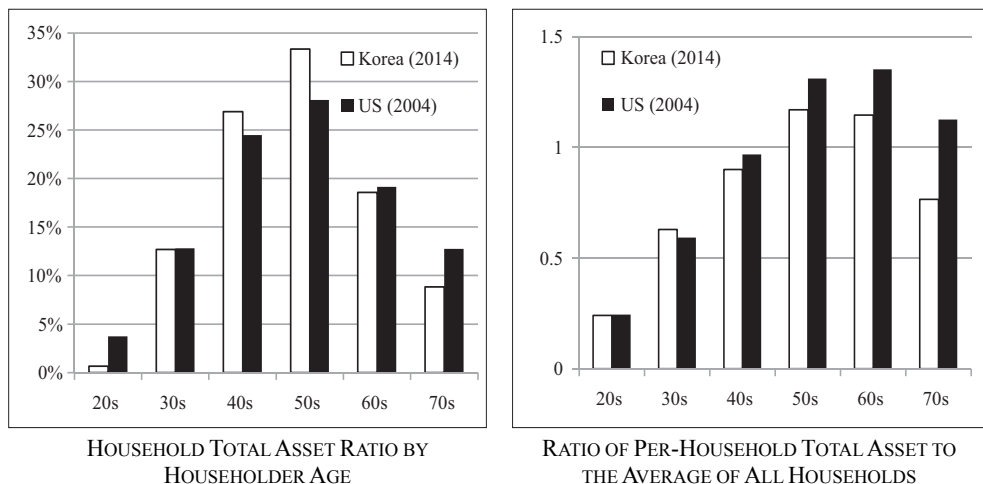


FIGURE 4

Note: US Households with assets in the top 1% are dropped.

Source: (Korea) 2014 SHFLC; (US) 2004 SCF

the ratio of the average income of a certain age group to the average of all households. The figure shows that Koreans experience a sharp decline in their incomes after their retirement age, implying that older people are more likely to face repayment and liquidity problems. The proportion of income earned by the population in their 50s in Korea is higher than that in the US, which is mainly attributed to population effects.

Figure 4 reports the asset distribution by householder age. Older people in Korea own comparatively fewer assets than the same age group in the US. The average

amounts of assets held by the older group, especially those in their 60s, are higher than those held by younger people both in Korea and the US. However, the average asset held by the older population in Korea is low relative to that in the US.

Similar to the asset distribution, older Koreans have lower amounts of net assets compared to the US households, as presented in Figure 5. Hence, these households in Korea, for whom income levels are also lower than those in the US, are more likely to be vulnerable to adverse asset price or liquidity shocks compared to their counterparts in the US.

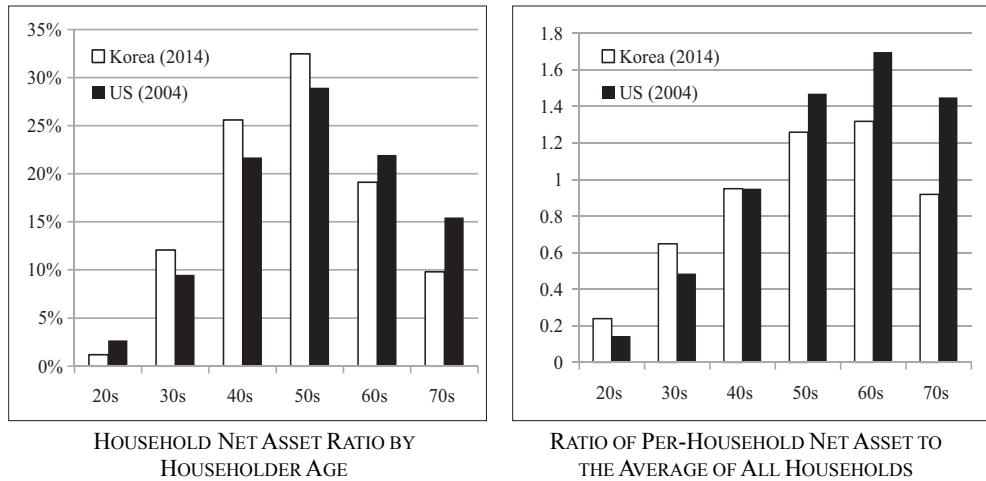


FIGURE 5

Note: US Households with assets in the top 1% are dropped.

Source: (Korea) 2014 SHFLC; (US) 2004 SCF

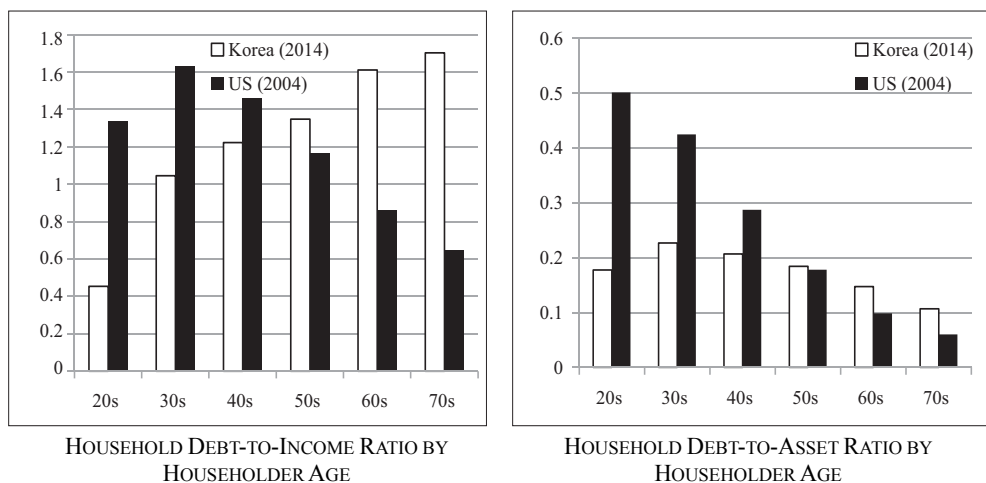


FIGURE 6

Note: US households with either income or asset levels in the top 1% are dropped.

Source: (Korea) 2014 SHFLC; (US) 2004 SCF

In sum, Korea's debt-to-income ratio increases as householders become older, unlike the US, and Korea's debt-to-asset ratio does not decrease as rapidly as that of the US. The US debt-to-income ratio decreases as householders become older, as US people tend to borrow early in their lives and repay the debt throughout their life, including mortgages and education loans. On the other hand, the ratio in Korea is much higher than that in the US especially when people reach retirement age. Unlike the US, Korean households tend to take out loans without repaying the principal over their life cycle. Instead, they simply refinance the loans every 2-5 years, rolling over the debt again until their retirement age. In addition, a sudden drop in income after retirement age may be another factor which increases the debt burden of the older population in Korea. A similar interpretation can be applied to the debt-to-asset ratio. Because older Koreans have large amounts of debt even after their retirement age, along with lower assets than their US counterparts, the debt burden of older people, as evaluated by their assets, is greater in Korea.

#### IV. Dynamic Analysis of Household Debt Distribution

In the previous section, I examined household debt distributions during a certain survey year. In this section, I compare how the household debt distribution has changed over the last ten years (20 years in the case of the US). Then, I can analyze whether the household debt problem is a static (or time-invariant) or dynamic problem. If it turns out that the household debt distribution changes over time, we can estimate the potential change in the household debt distribution in the future and preemptively prepare policy measures to resolve the problem.

Figure 7 presents the Korean household debt distributions by householder age in 2004 and 2014. The proportion of debts held by older households has gradually increased over the last ten years, while the debt held by households less than 40

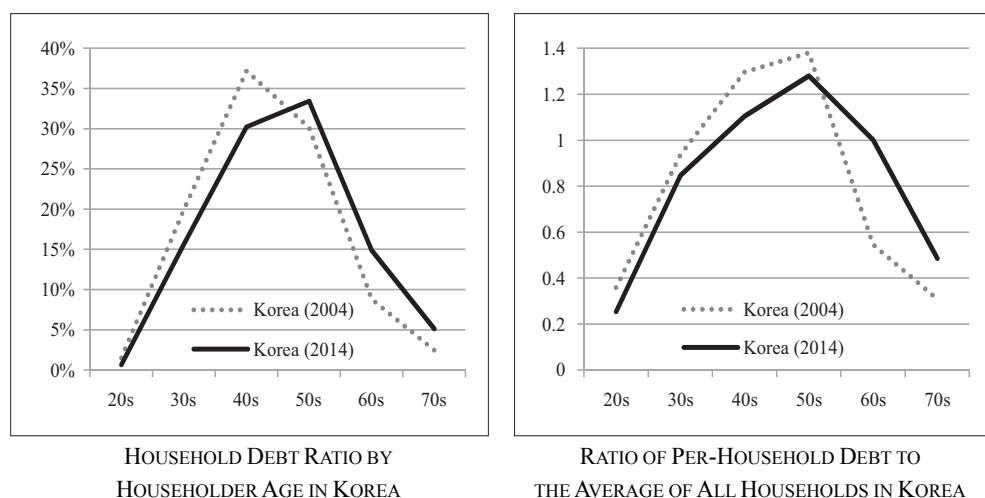


FIGURE 7

Source: 2004 KLIPS and 2014 SHFLC

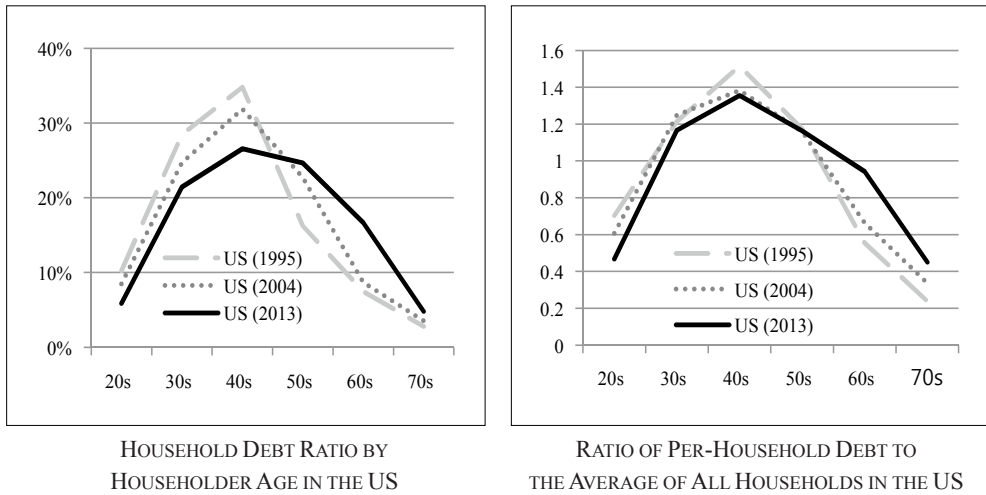


FIGURE 8

Note: US Households with debt in the top 1% are dropped.

Source: 1995, 2004, and 2013 SCF

years of age had decreased. When I control for the effect of demographic changes, the average debt held by those in their 60-70s shows an increase, whereas that of the other age group shows a decrease. Hence, the Korean household debt distribution by householder age has shifted to the right over the last ten years.

The household debt distribution in the US also has shifted to the right over the last 20 years. The proportion of debt held by young households has decreased, while that held by older households has increased. When I control for demographic changes, the average household debt held by those in their 60-70s has increased, especially after the recent financial crisis.

I also examine the changes in household income distributions by householder age, as in the household debt distribution. The Korean household income distribution has similarly shifted to the right over the past ten years. That is, the proportion of household income held by those in their 50s has increased, while that held by those in their 30-40s has decreased over the past ten years. The change in the household income distribution is mainly driven by changes in the demographic compositions. As the number of older households increases, the portion of the total income held by these households also increases.

We can also observe similar patterns of changes in the household income distribution in the US. The proportion of the total household income held by young households has decreased, while that held by older households has increased. When I control for the demographic effects, the average household income (normalized by the average of all households) is nearly identical, especially between 1995 and 2004.

The proportion of household income held by older Korean households is much lower than that held by their counterpart group in the US. In addition, the average amount of income for Korea's older households is much lower than that in the US. This pattern is also found nearly ten years ago. Hence, the fact that Korean

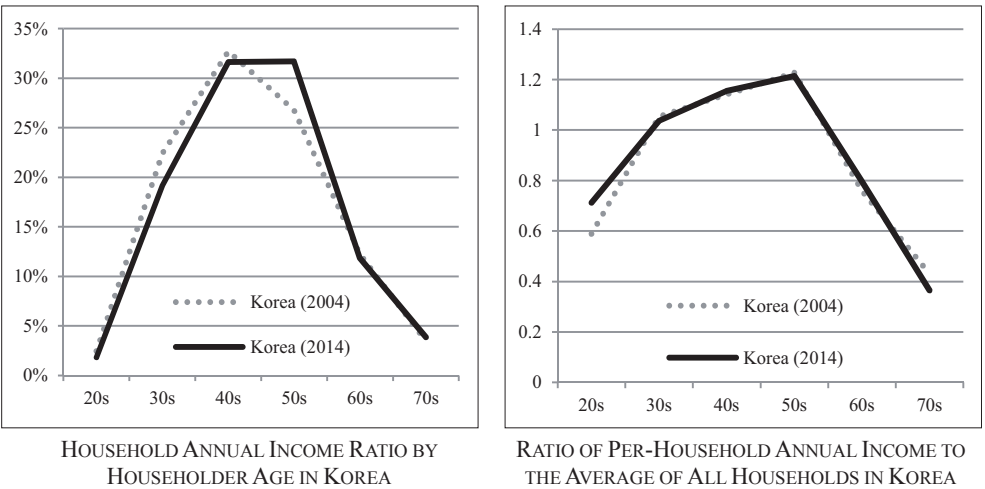


FIGURE 9

Source: 2004 KLIPS and 2014 SHFLC

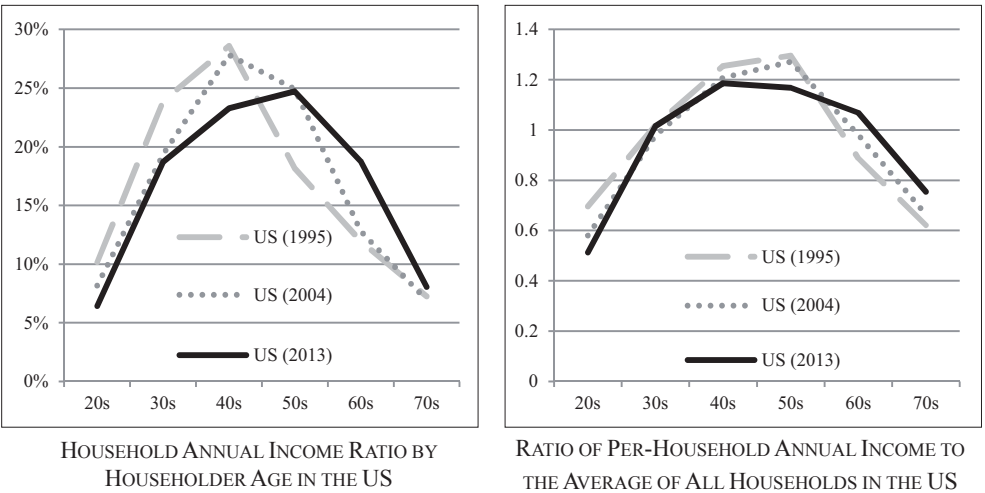


FIGURE 10

Note: US Households with incomes in the top 1% are dropped.

Source: 1995, 2004, and 2013 SCF

households, on average, tend to experience a steep decline in their income once they retire from their jobs is a persistent problem which has not recently been demonstrated.

Household assets held by older Korean households have increased slightly over time. However, the proportion of assets held by older Korean households is much lower than that in the US. At the same time, the average asset level is lower in Korea compared to the US.

In sum, the proportion of household debt held by each age group has shifted over

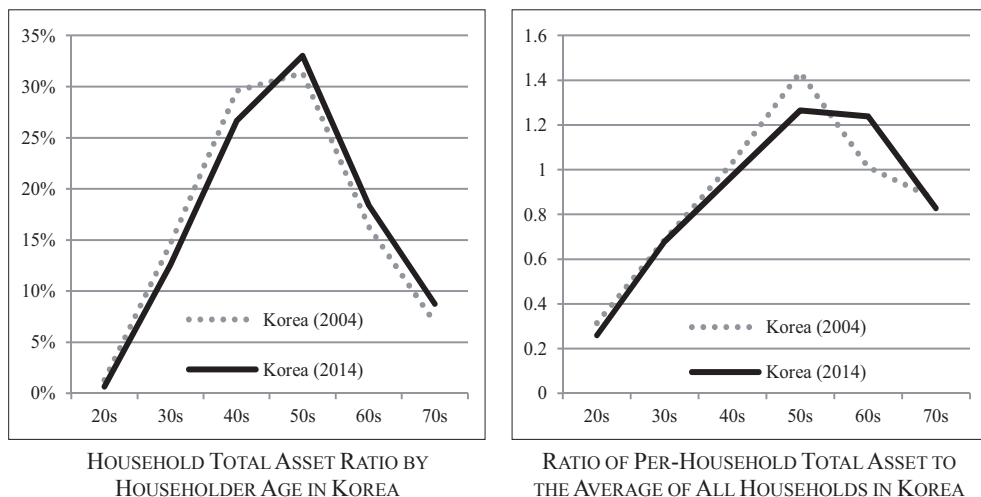


FIGURE 11

Source: 2004 KLIPS and 2014 SHFLC

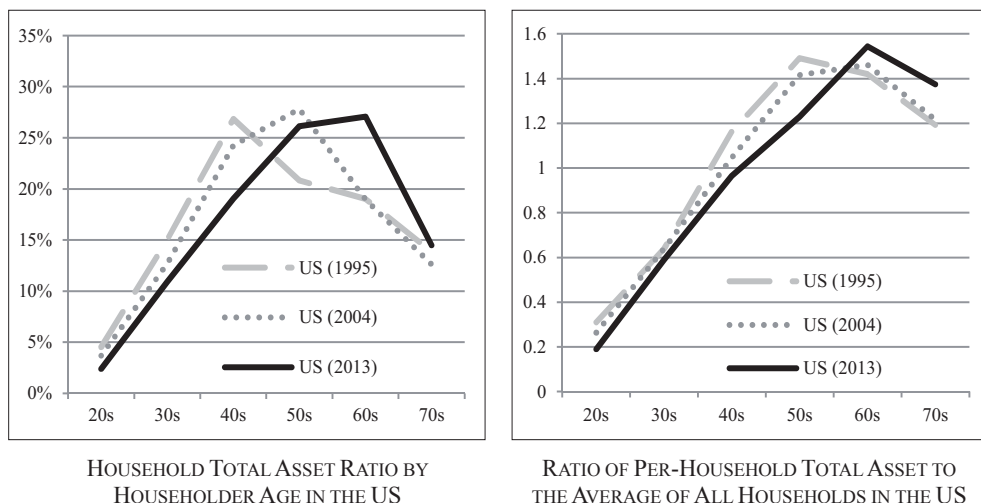


FIGURE 12

Note: US Households with assets in the top 1% are dropped.

Source: 1995, 2004, and 2013 SCF

the last ten years. At the same time, the distributions of household income and assets have also shifted to the right. Therefore, when we prepare policy measures to resolve the household debt problem, we must understand the nature of the household debt distribution, which is not time-invariant. In the following section, I analyze why the household debt distribution has shifted both in Korea and in the US. In turn, I examine estimated changes in the household debt distribution in the near future and draw policy implications.

## V. Analyzing the Driving Forces behind the Changes in the Household Debt Distribution

In the previous section, I found that household debt, income, and asset distributions by householder age group have shifted over the past ten years. In this section, I analyze the main driving force that has shifted the household debt distribution. More specifically, I analyze whether changes in demographic (or age), income, or asset distributions have shifted household debt distributions, as well as how much each component has contributed to the shift. This analysis is based on DiNardo, Fortin, and Lemieux (1996) and its application.

### A. Analysis Methodology

Let  $(m_i, z_i, t)$  be an observation specific to household  $i$ , where  $m$  is the amount of household debt,  $z$  denotes the household-specific characteristics, and  $t$  is a (survey) year which takes only two values to examine the change in the distribution from the initial to the terminal year of the analysis. Let  $f_t(m)$  be household debt density function (pdf) at time  $t$ . The unconditional household debt density function can then be rewritten as follows:

$$(3) \quad f_t(m) = \int f(m | z, t_m = t) dF(z | t_z = t) = f(m; t_m = t, t_z = t)$$

That is, the unconditional density,  $f_t(m)$ , is the integral of the conditional density of household debt at time  $t_m$  over the distribution of the household characteristics density function  $dF(z | t_z = t)$  at time  $t_z$ .

Suppose that the household characteristics  $z$  is composed of four components: the householder age ( $z_1$ ), income ( $z_2$ ), asset ( $z_3$ ), and other characteristics ( $z_4$ ). That is,  $z = (z_1, z_2, z_3, z_4)$ . Then, we can rewrite the above density function as follows:

$$(4) \quad \begin{aligned} & f(m; t_m = t, t_{z_1|z_2, z_3, z_4} = t, t_{z_2, z_3, z_4} = t) \\ &= \int f(m | z_1, z_2, z_3, z_4, t_m = t) dF(z_1 | z_2, z_3, z_4, t_{z_1|z_2, z_3, z_4} = t) \\ & \quad dF(z_2, z_3, z_4 | t_{z_2, z_3, z_4} = t) \end{aligned}$$

Following the notation of DiNardo *et al.* (1996), we consider a counter-factual time  $t$  household debt density for which the household characteristics except for  $z_1$  remain at their  $t$ -year and the  $z_1$  distribution is switched to their  $t'$ -year where  $t \neq t'$ . For example, we can imagine a hypothetical 2004 ( $t$ ) household debt

distribution in which only the householder's age distribution follows their 2012 ( $t'$ ) and all other household characteristics distributions remain at their 2004 ( $t$ ). Such a counter-factual density can be written as

$$\begin{aligned}
 (5) \quad & f(m; t_m = t, t_{z_1|z_2, z_3, z_4} = t', t_{z_2, z_3, z_4} = t) \\
 &= \int f(m | z_1, z_2, z_3, z_4, t_m = t) dF(z_1 | z_2, z_3, z_4, t_{z_1|z_2, z_3, z_4} = t') \\
 &\quad dF(z_2, z_3, z_4 | t_{z_2, z_3, z_4} = t) \\
 &= \int f(m | z_1, z_2, z_3, z_4, t_m = t) \Psi_{z_1|z_2, z_3, z_4}(z_1, z_2, z_3, z_4) \\
 &\quad dF(z_1 | z_2, z_3, z_4, t_{z_1|z_2, z_3, z_4} = t) dF(z_2, z_3, z_4 | t_{z_2, z_3, z_4} = t)
 \end{aligned}$$

where  $\Psi_{z_1|z_2, z_3, z_4}(z_1, z_2, z_3, z_4)$  is a weighting function defined by

$$(6) \quad \Psi_{z_1|z_2, z_3, z_4}(z_1, z_2, z_3, z_4) = \frac{dF(z_1 | z_2, z_3, z_4, t_{z_1|z_2, z_3, z_4} = t')}{dF(z_1 | z_2, z_3, z_4, t_{z_1|z_2, z_3, z_4} = t)}$$

The only difference between the original household debt density function and the counter-factual density function is the weight function,  $\Psi_{z_1|z_2, z_3, z_4}(z_1, z_2, z_3, z_4)$ . The weighting function can be reorganized using Bayes' rule, as follows:

$$(7) \quad \Psi_{z_1|z_2, z_3, z_4}(z_1, z_2, z_3, z_4) = \frac{dF(z_1 | z_2, z_3, z_4, t_{z_1|z_2, z_3, z_4} = t')}{dF(z_1 | z_2, z_3, z_4, t_{z_1|z_2, z_3, z_4} = t)} = \frac{\frac{Pr(t_{z_1|z_2, z_3, z_4} = t' | z_1, z_2, z_3, z_4)}{Pr(t_{z_2, z_3, z_4} = t' | z_2, z_3, z_4)}}{\frac{Pr(t_{z_1|z_2, z_3, z_4} = t | z_1, z_2, z_3, z_4)}{Pr(t_{z_2, z_3, z_4} = t | z_2, z_3, z_4)}}$$

In the actual computation, I used the probit model to solve the last term of the above equation. That is, dummy variables are generated, which are 1 if the data year is  $t'$  and 0 otherwise. Similarly, another dummy variable is generated, which is 1 if the data year is  $t$  and 0 otherwise. In such a case, for example, the weighting function can be calculated as follows:

$$(8) \quad Pr(t_{z_1|z_2, z_3, z_4} = t' | z_1, z_2, z_3, z_4) = \Phi(\beta z)$$

In the actual implementation, I used the age of the household head, the square of his/her age, log real assets, log real income, an education dummy (1 if less than a high school degree, 0 otherwise), homeownership status, and the number of



household members.

Because I mainly analyzed how the household debt distribution by householder age changes over time, it is necessary to manipulate the unconditional density function to obtain the household debt distribution by householder age group. The portion of household debt held by each age group can be rewritten as follows:

$$(9) \quad \frac{\sum_{i \in \text{Age group}} w_i m_i}{\sum_{i \in \text{All population}} w_i m_i} \approx \frac{\int_{\text{Age group}} mf(m; t_m = t, t_{z_1|z_2, z_3, z_4} = t, t_{z_2, z_3, z_4} = t) dm}{\int_{\text{All population}} mf(m; t_m = t, t_{z_1|z_2, z_3, z_4} = t, t_{z_2, z_3, z_4} = t) dm}$$

Similarly, we consider the counter-factual time- $t$  household debt distribution by householder age where only the  $z_1$  distribution changes of their time- $t'$  and other household characteristics remain at their time- $t$ .

$$(10) \quad \frac{\int_{\text{Age group}} mf(m; t_m = t, t_{z_1|z_2, z_3, z_4} = t', t_{z_2, z_3, z_4} = t) dm}{\int_{\text{All population}} mf(m; t_m = t, t_{z_1|z_2, z_3, z_4} = t', t_{z_2, z_3, z_4} = t) dm}$$

$$= \frac{\int_{\text{Age}} \int f(m|z_1, z_2, z_3, z_4, t_m = t) \Psi_{z_1|z_2, z_3, z_4}(z_1, z_2, z_3, z_4) dF(z_1|z_2, z_3, z_4, t_{z_1|z_2, z_3, z_4} = t) dF(z_2, z_3, z_4|t_{z_2, z_3, z_4} = t) dm}{\int_{\text{Pop}} \int f(m|z_1, z_2, z_3, z_4, t_m = t) \Psi_{z_1|z_2, z_3, z_4}(z_1, z_2, z_3, z_4) dF(z_1|z_2, z_3, z_4, t_{z_1|z_2, z_3, z_4} = t) dF(z_2, z_3, z_4|t_{z_2, z_3, z_4} = t) dm}$$

$$\approx \frac{\sum_{i \in \text{Age group}} m_i \sum_{\forall j|m_i} \Psi_{z_1|z_2, z_3, z_4}(z_1, z_2, z_3, z_4)_{ij} w_{ij}}{\sum_{i \in \text{All population}} m_i \sum_{\forall j|m_i} \Psi_{z_1|z_2, z_3, z_4}(z_1, z_2, z_3, z_4)_{ij} w_{ij}}$$

$$= \frac{\sum_{i \in \text{Age group}} m_i \Psi_{z_1|z_2, z_3, z_4}(z_1, z_2, z_3, z_4)_i w_i}{\sum_{i \in \text{All population}} m_i \Psi_{z_1|z_2, z_3, z_4}(z_1, z_2, z_3, z_4)_i w_i}$$

Therefore, the counter-factual household debt distribution by householder age can be calculated using the newly defined weighting function,  $\Psi_{z_1|z_2, z_3, z_4}(z_1, z_2, z_3, z_4) w$ .

Here, I only consider cases in which only the distribution of  $z_1$  changes to the year  $t'$ . We can also extend the household debt density function where the distribution of  $z_1$  and  $z_2$  both change to the year  $t'$ , while the other characteristics remain at time  $t$ . Then, the counter-factual unconditional density function can be written as follows,

$$\begin{aligned}
(11) \quad & f(m; t_m = t, t_{z_1|z_2, z_3, z_4} = t', t_{z_2|z_3, z_4} = t', t_{z_3, z_4} = t) \\
& = \int f(m | z_1, z_2, z_3, z_4, t_m = t) dF(z_1 | z_2, z_3, z_4, t_{z_1|z_2, z_3, z_4} = t') \\
& \quad dF(z_2 | z_3, z_4, t_{z_2|z_3, z_4} = t') dF(z_3, z_4 | t_{z_3, z_4} = t) \\
& = \int f(m | z_1, z_2, z_3, z_4, t_m = t) \Psi_{z_1|z_2, z_3, z_4}(z_1, z_2, z_3, z_4) dF(z_1 | z_2, z_3, z_4, t_{z_1|z_2, z_3, z_4} = t) \\
& \quad \Psi_{z_2|z_3, z_4}(z_2, z_3, z_4) dF(z_2 | z_3, z_4, t_{z_2|z_3, z_4} = t) dF(z_3, z_4 | t_{z_3, z_4} = t)
\end{aligned}$$

where the additional weighting function can be defined by

$$(12) \quad \Psi_{z_2|z_3, z_4}(z_2, z_3, z_4) = \frac{dF(z_2 | z_3, z_4, t_{z_2|z_3, z_4} = t')}{dF(z_2 | z_3, z_4, t_{z_2|z_3, z_4} = t)} .$$

The other procedures are identical to those used earlier. The only difference is that the new weighting function when calculating the household debt distribution by householder age is  $\Psi_{z_1|z_2, z_3, z_4}(z_1, z_2, z_3, z_4) \Psi_{z_2|z_3, z_4}(z_2, z_3, z_4) w$ , rather than  $\Psi_{z_1|z_2, z_3, z_4}(z_1, z_2, z_3, z_4) w$ .

Before presenting numerical results, several factors should be noted with regard to the methodology presented here.<sup>13</sup> The spirit of the methodology is similar to that of Oaxaca (1973). However, the Oaxaca decomposition mainly focuses on how the average of a variable (e.g., the average household debt) would change if the average of a certain explanatory variable (e.g., the average householder's age) changes, *ceteris paribus*. Unlike Oaxaca's methodology, DiNardo *et al.* (1996) focused on changes in the overall density if the distribution of explanatory variable(s) changes, *ceteris paribus*. As noted in DiNardo *et al.* (1996), this method cannot take into account the general equilibrium effect of a change in the explanatory variable(s). For example, when the household demographic distribution changes, the household asset or income distribution would change, in turn indirectly affecting the household debt distribution. This methodology cannot take into account such an indirect effect from changes in the density of explanatory variables.

## B. Results

In this subsection, I analyze how changes in the distribution of household-specific characteristics affect the household debt distribution by householder age group. As presented in the previous section, the household debt distribution has

<sup>13</sup>Also see DiNardo *et al.* (1996) for more details about the major features of the analysis methodology.

shifted to the right over the past ten years. At the same time, household demographics, income, and asset distributions have also changed. Among those changes, I examine which factors mainly affect changes in the household debt distribution, based on the methodology suggested in the previous subsection.

I choose two survey years, 2004 and 2012, using the KLIPS data.<sup>14</sup> First, I consider a counter-factual scenario in which only household demographic (or age) distributions change to those of 2012, while other household characteristics remain at 2004. By analyzing such a counter-factual scenario, I could analyze how changes in demographic distributions contribute to changes in household debt distributions. The top left figure in Figure 13 shows that changes in the demographic distribution from 2004 to 2012 contribute to the change in the household debt distribution by nearly half (see the dotted line). A change in the household income distribution also slightly affects the change in the household debt distribution (see the top right figure). However, the effect of the change in the income distribution is smaller than that caused by the change in the demographic distribution. A change in the asset distribution has almost no effect on the household debt distribution (see the bottom left figure). Simultaneous changes in household income and demographic distributions from 2004 to 2012 cause the 2004 household debt distribution nearly to converge to the 2012 distribution. Therefore, a change in the demographic distribution, partly in conjunction with a change in the income distribution, is the main driving force which has shifted the Korean household debt distribution over the last ten years.

To measure quantitatively how changes in each household characteristic explain

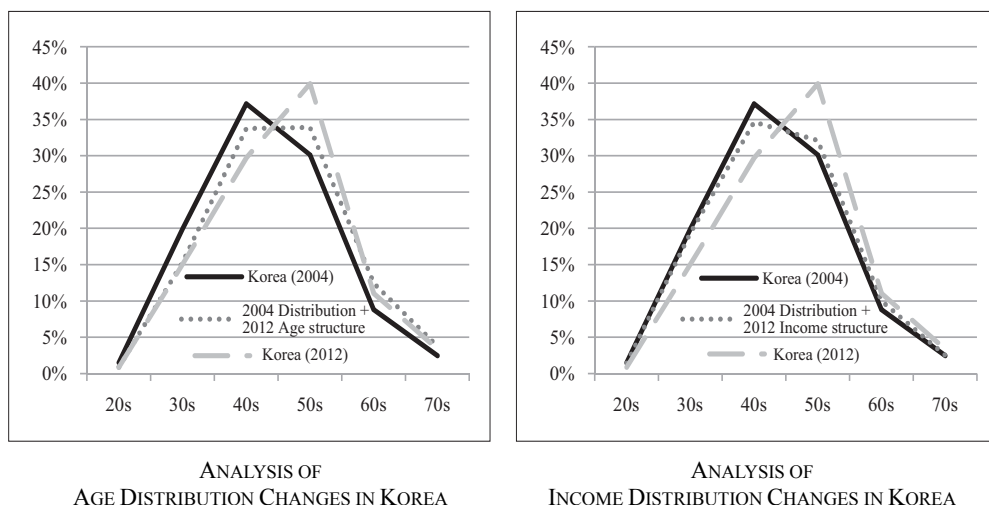


FIGURE 13. CHANGES IN THE HOUSEHOLD DEBT DISTRIBUTION BETWEEN 2004 AND 2012 DRIVEN BY EITHER AGE, INCOME, OR ASSET DISTRIBUTION CHANGES

<sup>14</sup>By choosing the 2004 and 2012 survey years from KLIPS, I could eliminate potential inconsistencies originating from different datasets. I also implemented a similar exercise using the 2004 KLIPS and the 2014 SHFLC data. The qualitative results were nearly identical. See the Appendix.

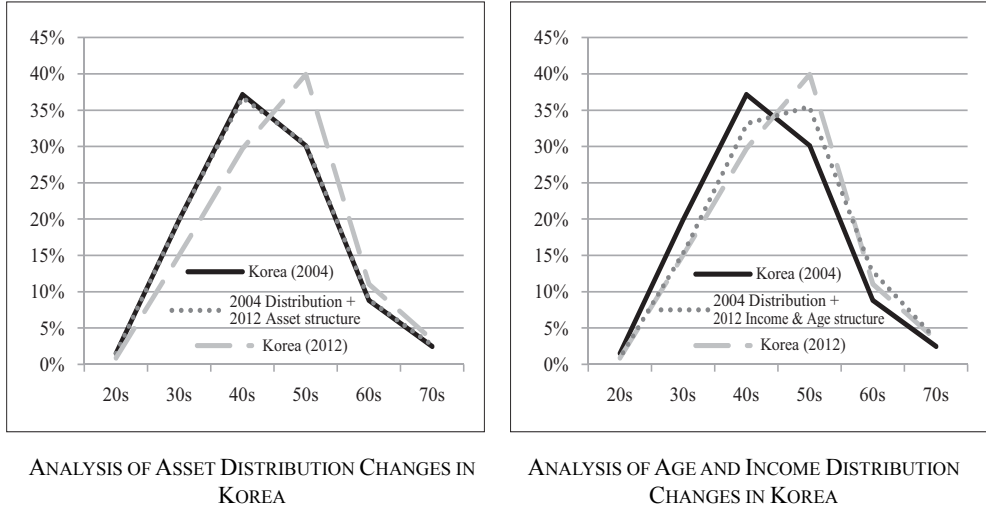


FIGURE 13. CHANGES IN THE HOUSEHOLD DEBT DISTRIBUTION BETWEEN 2004 AND 2012 DRIVEN BY EITHER AGE, INCOME, OR ASSET DISTRIBUTION CHANGES (*CONTINUED*)

Source: 2004 and 2012 KLIPS

changes in the household debt distribution, it is necessary to define the “distance” measure between two different densities. Let  $g$  be the (conditional) density function of household debt by householder age.<sup>15</sup> Let  $g_t$  be the household debt distribution at time  $t$ , and  $g_z$  be the counter-factual household debt distribution where only the household characteristic  $z$  follows the 2012 distribution while other household characteristics remain at their 2004. The Figure 13 shows a visual representation of the density functions of  $g_{04}(age)$ ,  $g_{12}(age)$ , and  $g_z(age)$ , where  $z \in \{age, income, asset, income and age\}$ . I define the measure of the distance between two densities as follows.<sup>16</sup>

$$(13) \quad D_{a,b} = \int |g_a(age) - g_b(age)| d(age)$$

The explanatory power of the change in the household debt distribution attributed to household characteristics  $z$  is then measured as follows:

$$(14) \quad \frac{D_{04,12} - D_{z,12}}{D_{04,12}}$$

<sup>15</sup>More specifically,  $g$  is defined as  $\frac{\sum_{i \in Age} \tilde{w}_i m_i}{\sum_{i \in All\ population} \tilde{w}_i m_i}$ , where  $\tilde{w}_i$  is either the sample or the manipulated weight. If I consider a counter-factual household debt distribution, the weight  $\tilde{w}_i$  is then defined as a multiplication of the sample weight  $w_i$  and the weighting function  $\Psi(\cdot)$ .

<sup>16</sup>It is also possible to define other types of distance measures, such as  $\int [g_a(age) - g_b(age)]^2 d(age)$ .

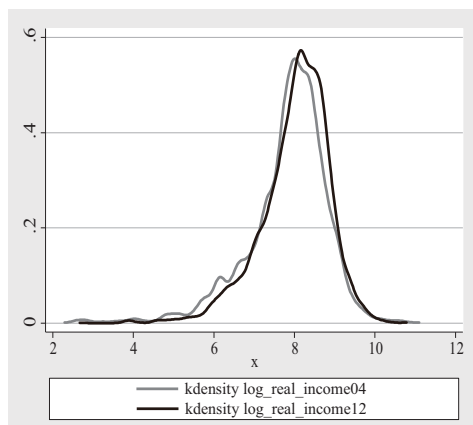
If the change in the household characteristic  $z$  fully shifts the 2004 household debt distribution to 2012, the measure  $D_{z,12}$  would be 0. Hence, the explanatory power of  $z$  is 100%. On the other hand, if the household characteristic  $z$  cannot explain any shift in the household debt distribution between 2004 and 2012, the measure  $D_{z,12}$  would be equal to  $D_{04,12}$ . Hence, the explanatory power of  $z$  is zero.

Table 2 reports how each combination of household characteristics can explain changes in the household debt distribution between 2004 and 2012. A change in the demographic distribution can explain a change in the household debt distribution by nearly half. A change in the income (asset) distribution can explain a change in the household debt distribution by 24.8% (3.5%). Simultaneous changes in the household age, income, and asset distributions can explain changes in the household debt distribution by 64%. However, there remains 36% of the change in the household debt distribution which is not explained by simultaneous changes in the household age, income, and asset distributions. I suspect that changes in the financial market environment or household-specific idiosyncratic shocks may account for this unexplained gap.

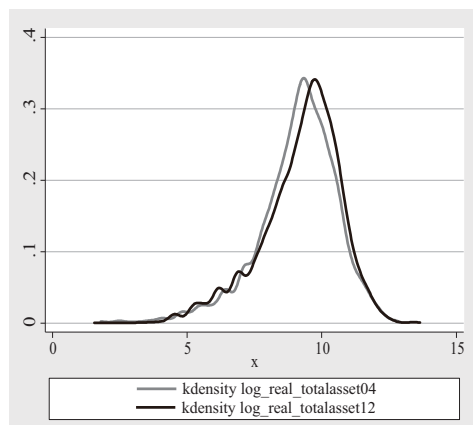
This leads to the question of how much household income, asset, and demographic distributions have changed over the last 10 years. Figure 14 presents

TABLE 2—DECOMPOSING CHANGES IN THE KOREAN HOUSEHOLD DEBT DISTRIBUTION BY HOUSEHOLD CHARACTERISTICS

		Explanatory Power
Effect of	Age	53.6%
	Income	24.8%
	Asset	3.5%
	Age + Income	62.1%
	Age + Asset	53.8%
	Income + Asset	27.7%
	Age + Income + Asset	64.0%

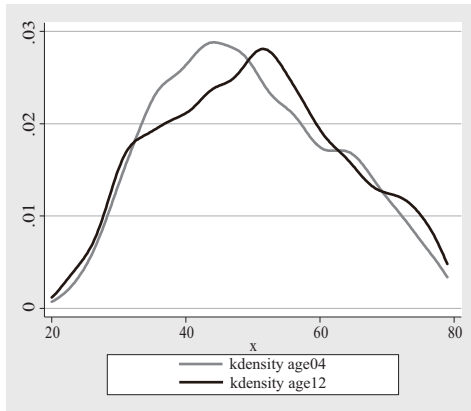


KERNEL DENSITY OF THE 2004 AND 2012 LOG REAL INCOME IN KOREA



KERNEL DENSITY OF THE 2004 AND 2012 LOG REAL ASSET IN KOREA

FIGURE 14



KERNEL DENSITY OF 2004 AND  
2012 HOUSEHOLDER AGE IN KOREA

FIGURE 14 (CONTINUED)

Note: A Gaussian kernel function is used.

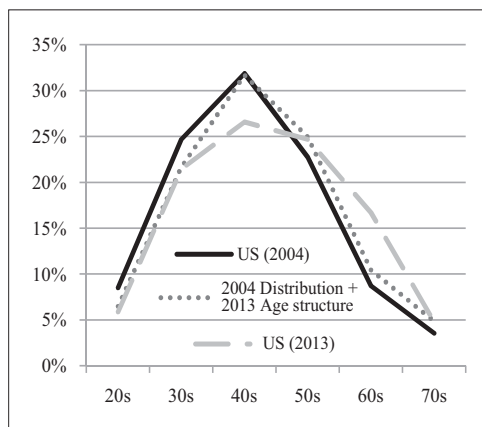
Source: 2004 and 2012 KLIPS

the kernel density of the log real household income, log real assets, and the age distribution. Household income and asset distributions have slightly shifted to the right, which partly reflect the (real) growth in the Korean economy. Not surprisingly, the householder age distribution has shifted to the right visibly. Though household asset, income, and age distributions have all shifted over the last ten years, the change in the household debt distribution is mainly explained by the change in the age distribution.

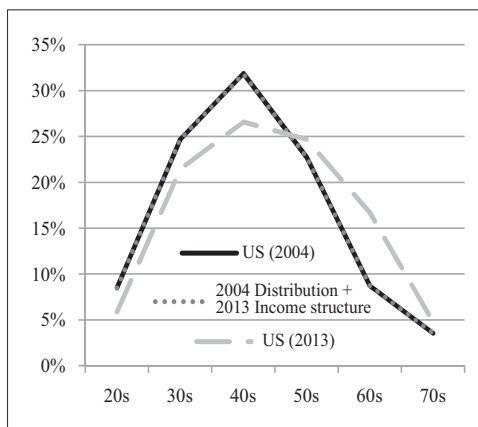
I can draw similar results for the US. As shown in Figure 15, the change in the demographic distribution partly affects the change in the household debt distribution by householder age. However, changes in the household income and asset distributions have nearly no effect on changes in the household debt distribution.

Table 3 reports that a change in the demographic distribution can explain a change in the household debt distribution by 44%. However, changes in either the income or asset distribution have negligible explanatory power. Hence, the change in the household debt distribution over the last decade in the US is mainly driven by the change in the demographic distribution, as it was in Korea.

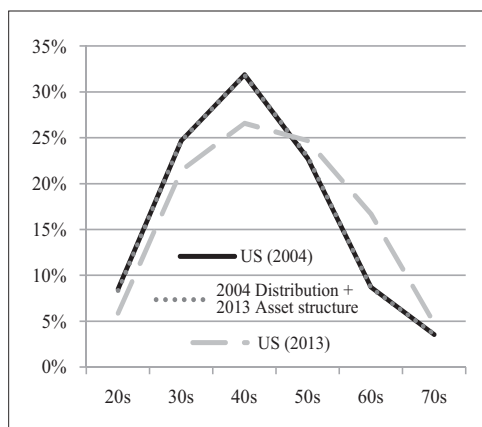
Between 2004 and 2013, the US economy experienced an unprecedented boom and bust, especially in the housing market. More specifically, US financial intermediaries lent money to households with (relatively) lax screening efforts, which contributed to the boost in the housing market (Keys *et al.* (2013)). As a result, many subprime loans were issued, which triggered and exacerbated the financial crisis starting in 2007. After the crisis, the US government implemented many government-driven mortgage modification programs, which partly reduced the household financial burden. Given that the US economy experienced numerous events over the last ten years, explaining the change in the household debt distribution simply with household-specific characteristics may not be successful.



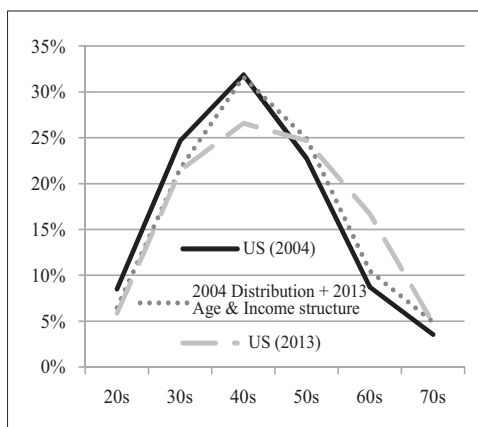
ANALYSIS OF  
AGE DISTRIBUTION CHANGES IN THE US



ANALYSIS OF  
INCOME DISTRIBUTION CHANGES IN THE US



ANALYSIS OF  
ASSET DISTRIBUTION CHANGES IN THE US



ANALYSIS OF  
AGE AND INCOME DISTRIBUTION CHANGES IN THE US

FIGURE 15. CHANGES IN THE HOUSEHOLD DEBT DISTRIBUTION BETWEEN 2004 AND 2013 DRIVEN BY EITHER AGE, INCOME, OR ASSET DISTRIBUTION CHANGES

Source: 2004 and 2013 SCF

TABLE 3—DECOMPOSING CHANGES IN THE US HOUSEHOLD DEBT DISTRIBUTION BY HOUSEHOLD CHARACTERISTICS

		Explanatory Power
Effect of	Age	44.0%
	Income	0.0%
	Asset	1.7%
	Age + Income	44.2%
	Age + Asset	41.5%
	Income + Asset	6.4%
	Age + Income + Asset	40.2%

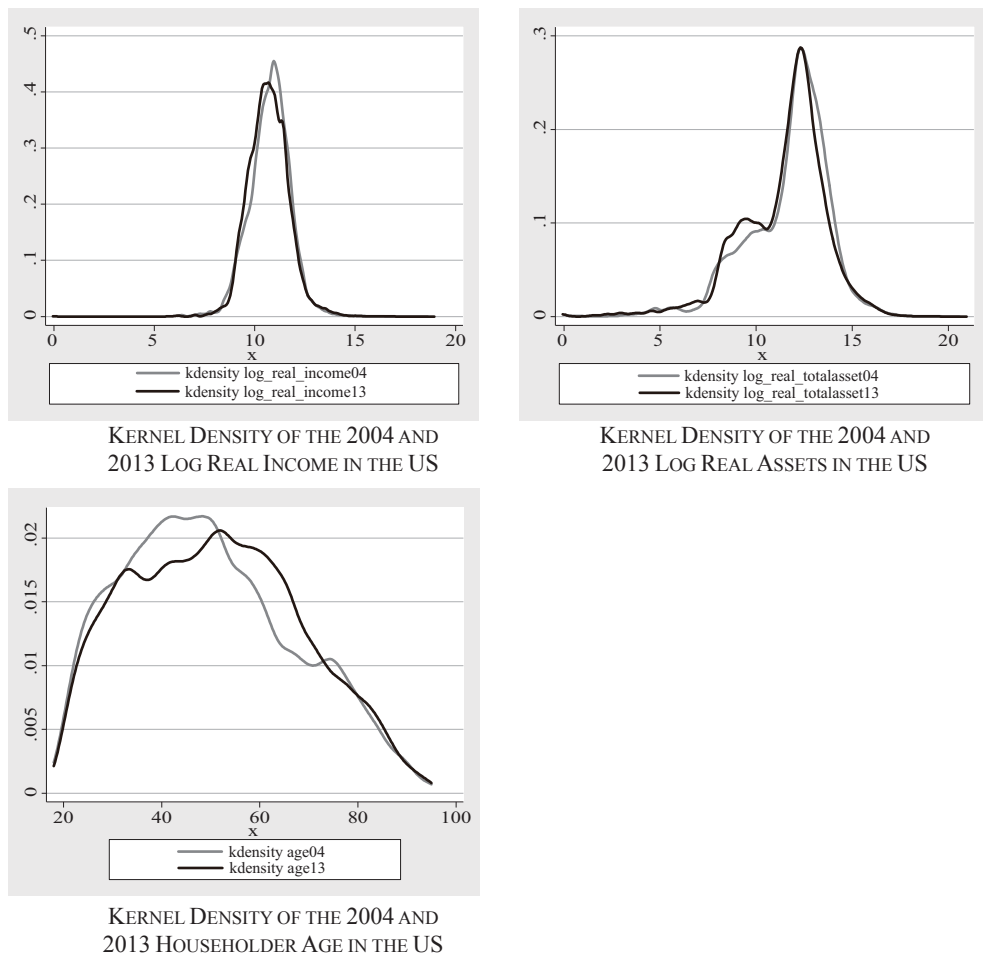


FIGURE 16

Note: A Gaussian kernel function is used.

Source: 2004 and 2013 SCF

Kernel densities of the log real income, real asset, and age distributions are presented in Figure 16. The income and asset distributions have not changed significantly over the last ten years. However, we can observe that the US population is also aging. Hence, the change in the household demographic distribution is also an important factor which explains the shift in the household debt distribution in the US, as it does in Korea.

## VI. Concluding Remarks

In this paper, I analyze how household debt distribution in Korea and the US has changed over the last ten years. Household debt distribution by householder's age in both countries has shifted to the right. My analysis shows that the shift in the



household debt distribution is mainly driven by a change in householder's demographic distribution, especially for Korea. Changes in either household income or asset distribution cannot successfully explain the shift in the household debt distribution. For the US, the change in demographic distribution can partly, though not enough, explain the change in the household debt distribution.

One possible reason why the demographic factor has a strong power in explaining the shift in the household debt distribution in Korea is the Korean-specific debt contract structure. Most mortgage and non-mortgage debt contracts in Korea are short-term and bullet-type loans. That is, households tend to take out loans with a 2-5 year contract period. And then, they repay nothing or pay only interests while in their contract duration. When it comes to the contract expiration date, households refinance loans again, with contract periods of 2-5 years. Hence, the loan principal does not decrease as time goes on and is rolled over repeatedly, with simply paying back the interest. This allows us to observe the cohort effect in debt distribution over the long-time.

On the contrary, the debt contract structure in the US is quite different. Households tend to take out loans, especially mortgages, with a long-term horizon. They then pay back both interest and principal over their life cycle. In turn, household net equity increases as householders become older. This explains why the demographic effect which explains the change in the household debt distribution is not as strong as in the Korean case. In addition, the US economy has experienced a housing/asset boom and bust over the last ten years. Hence, it is difficult to explain the full shift in the household debt distribution merely according to the change in the distribution of demographic or household-specific characteristics.<sup>17</sup>

We can draw the following policy implications for the Korean economy from this analysis. First, as Korean people become older, the proportion of household debt held by older households is expected to increase more in the near future.<sup>18</sup> If older households have large amounts of assets and incomes, the household debt problem will not be serious. However, as presented in the main text, householder income levels for those in their 60-70s suddenly decrease. In turn, it is highly probable that older householders may experience more severe liquidity problems as they become older, along with their debt principal burden. Furthermore, the large portion of the income earned by older Koreans comes from either wages or income from businesses, while these households in the US mostly earn their income from social security, pensions, and annuities (or public transfers).<sup>19</sup> That is, the incomes earned by Korean seniors are less secure and stable than those earned by their US

<sup>17</sup>Differences in debt contract structures may lead to different patterns of the changes in the household debt distribution. Examining the empirical relationship between debt contract structures and household debt distributions would be an important future research topic.

<sup>18</sup>One should be cautious in forecasting future household debt distributions based on my empirical analysis. The methodology used here assumes a "time-invariant" relationship between household debt distributions and household characteristic variables, except for the demographic distribution, between 2004 and 2012. It is possible that household asset or income distributions will change significantly in the near future, which may be the main effect of any change in the household debt distribution. If the macroeconomic environment changes abruptly, as experienced in the US over the last decade, the explanatory power of the change in the demographic distribution may diminish. In addition, it is possible that the general equilibrium effect of any change in the demographic distribution would amplify/deflate its effects on the household debt distribution.

<sup>19</sup>Please see the Appendix for more details about the income decomposition.

counterparts. Therefore, policymakers need to consider diverse measures to improve and stabilize old-aged income. One possible way may be a structural change in the labor market which extends the retirement age of workers through the implementation of a wage peak system. In a similar vein, due to the seniority-based wage system in the current Korean labor market, older employees are unable to avoid early retirement and become self-employed, which in general leads to a sudden decrease in their incomes.

Second, Korean policymakers need to monitor the possibility of asset price deflation more carefully. Many researchers have found that Korean household debt problems will not shift toward systematic risk because Korean households have enough assets, providing a safe buffer for the debt problem. If Korean asset prices are deflated for some exogenous reasons, financial intermediaries may force households to pay back their debt, as their collateral value also decreases. In such a case, it is possible that households will start selling their assets in the market to pay back their remaining debt burden, which in turn would lead to a decrease in asset prices again. The worst scenario may be a collapse in asset values along with a sudden increase in household defaults. In order to avoid such a sudden drop in asset values while preserving a certain level of income for senior citizens, policymakers can consider an extension of asset-backed security markets or reverse mortgage programs. These programs may reduce the likelihood of a sudden drop in asset prices while preventing an abrupt decrease in the incomes of older households.

Third, policy efforts should be strengthened to make a transition in the debt contract structure from short-term bullet-type to long-term amortized loans. As mentioned earlier, Korean households tend to roll over their debt without reducing their principal. This phenomenon is possible due to the prevalence of short-term bullet-type loans. Under an economy in which asset (or housing) values consistently increase, this type of loan contract structure is sustainable. That is, households have capital gain opportunities with a constant (nominal) value of debt. Hence, even when householders retire, experiencing a steep decrease in their incomes, they have already accumulated high enough levels of net assets while young. However, as the Korean economy has become more developed, the chances for capital gain have narrowed. Under this environment, households that take out loans without reducing their debt levels have little chance to realize capital gains (or increased net asset holdings) when they retire. Because retired households tend to experience a serious decrease in their incomes, these households may face both liquidity and net asset shocks. This motivates why Korean policymakers should seriously consider a change in the debt contract structure. By inducing Korean households to pay back their debts over their life cycle, as is done the US households, older Korean households can retire from their jobs without concern over their remaining debt, even when their incomes after retirement suddenly decrease.

In sum, the household debt problem in Korea is partly a structural problem originating from the change in the demographic composition. It is difficult to avoid or reverse the changes in demographic trends. However, the Korean government can avoid potential system risk by strengthening macro-prudential policies and through labor market restructuring, asset market monitoring, enacting changes in

debt contract structures, and other means. It is well known that Korea's speed of population aging is the fastest among OECD member countries. I recommend that the Korean government take action as soon as possible before the problem worsens.

## APPENDIX

### A. Robustness Check of Main Analysis

In this Appendix, I analyze which household-specific factors cause household debt distribution by householder age group to move using the 2004 KLIPS and 2014 SHFLC datasets. In the main text of this paper, I conducted the same exercise using 2004 and 2012 KLIPS data. Because different datasets may define and

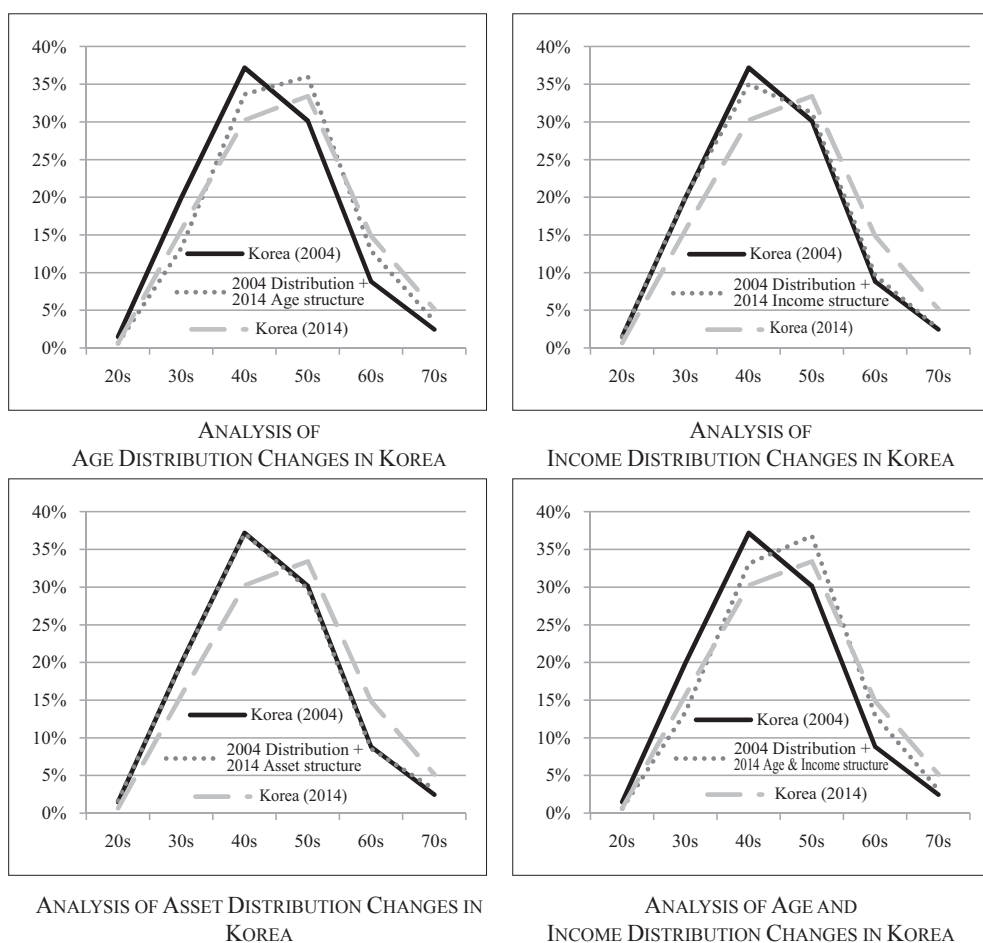
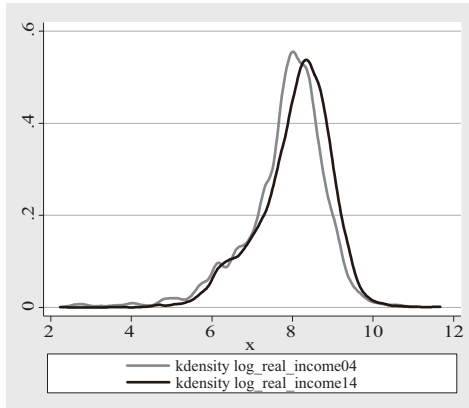


FIGURE A1. CHANGES IN THE HOUSEHOLD DEBT DISTRIBUTION BETWEEN 2004 AND 2014 DRIVEN BY EITHER AGE, INCOME, OR ASSET DISTRIBUTION CHANGES

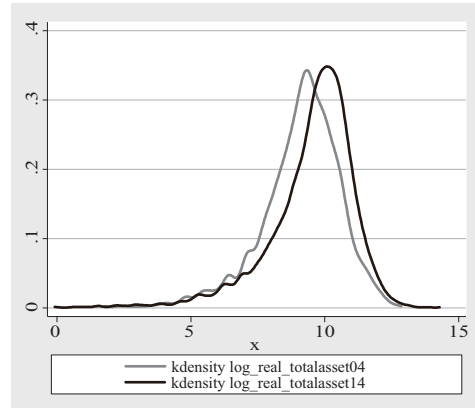
Source: 2004 KLIPS and 2014 SHFLC

TABLE A1—DECOMPOSING CHANGES IN KOREAN HOUSEHOLD DEBT DISTRIBUTION BY HOUSEHOLD CHARACTERISTICS

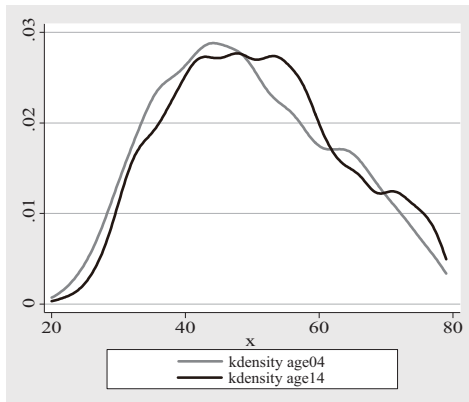
Effect of	Explanatory Power
Age	50.3%
Income	16.7%
Asset	0.9%
Age + Income	48.2%
Age + Asset	48.8%
Income + Asset	25.1%
Age + Income + Asset	40.8%



KERNEL DENSITY OF THE 2004 AND 2014 LOG REAL INCOMES IN KOREA



KERNEL DENSITY OF THE 2004 AND 2014 LOG REAL ASSETS IN KOREA



KERNEL DENSITY OF THE 2004 AND 2014 HOUSEHOLDER AGES IN KOREA

FIGURE A2

Note: A Gaussian kernel function is used.

Source: 2004 KLIPS and 2014 SHFLC

survey household-specific characteristics in different ways, I used a single data source (or KLIPS) in the main exercise. As a robustness check, I implement the same exercise using the most recently released data, 2014 SHFLC, along with the 2004 KLIPS.

The qualitative results are identical to those presented in the main text. The exercise shows that a change in the householder age distribution is the main driving force that shifts the household debt distribution between 2004 and 2014. The counter-factual distribution overestimates the debt-holding ratio for householders in their 40-50s. Changes in the household income distribution can partly explain the shift in the household debt distribution, which is consistent with results in the main text.

The change in the household debt distribution between 2004 and 2014 is explained by the change in the demographic distribution by nearly half. On the other hand, the changes in the income and asset distributions can explain the changes in the household debt distributions by 16.7% and 0.9%, respectively. Therefore, the result showing that a change in the household debt distribution is mainly driven by a change in householder age distribution is a robust result. However, the explanatory power of a change in either the income or asset distribution is under-estimated compared to the benchmark exercise.

In Figure A2, I present the kernel density of log real incomes, log real assets, and householder ages using the 2004 KLIPS and 2014 SHFLC data. Though the real asset and income distributions have shifted to the right over the last ten years, these movements have little explanatory power to explain the change in the household debt distribution. Not surprisingly, the density of the householder age also has shifted to the right over the last ten years.

### *B. Analysis of Extreme Samples in the SCF*

When I analyze the US household debt distribution, I dropped sample households that have extremely large amounts of debt. That is, households with total debt in the top 1% are dropped. Because the SCF over-samples wealthy households when selecting its interviewees to match the wealth distribution of the US, I dropped these extreme sample households. Contrary to the SCF, the SHFLC selects its sample based on geographic areas, house occupancy types, and education, not considering the right tail of household wealth. Hence, by dropping the extremely wealthy or indebted households in the SCF, I can make a reasonable comparison between the SCF and the SHFLC data.

In this appendix, I analyze how the inclusion of the top 1% indebted households changes the household debt statistics and distributions. In addition, I examine how the inclusion of the top 1% income- or asset-rich households changes the household income and asset distributions. As presented in Table A2, average household debt in 2013 in the US is around \$101K, while it decreases to \$83K if I drop the top 1% of indebted households. This indicates that highly indebted households distort the average statistics of household debt. A similar interpretation can also be made when I calculate the conditional average household debt and (conditional/unconditional) average real-estate-related household debt.

In Figure A3-A5, I calculate the household debt, income, and asset distributions by householder age with and without including extremely indebted or rich households. When I include highly indebted households, household debt levels of those in their 50s and 70s show a slight increase. However, household debt held by US

households in their 40-50s remains lower than that held by Korean households. The ratio of per-household debt to the average of all households increases, especially for those in their 50s and 70s, when I include highly indebted households.

TABLE A2—CHARACTERISTICS OF EXTREME HOUSEHOLD SAMPLES IN THE US

	2013 US	
	Not dropped	Dropping top 1% household samples
<b>Total household debt<sup>20</sup></b>		
% of households holding debt	75%	74%
Average amount of total debt	\$101,449	\$83,255
Median amount of total debt	\$22,500	\$21,400
Average amount of total debt conditional on having debt	\$135,849	\$111,858
Median amount of total debt conditional on having debt	\$63,040	\$60,540
<b>Total real estate related debt<sup>21</sup></b>		
% of households holding real estate debt	45%	45%
Average amount of real estate debt	\$85,594	\$68,392
Median amount of real estate debt	\$0	\$0
Average amount of real estate debt conditional on having real estate debt	\$189,388	\$153,201
Median amount of real estate debt conditional on having real estate debt	\$119,000	\$116,000

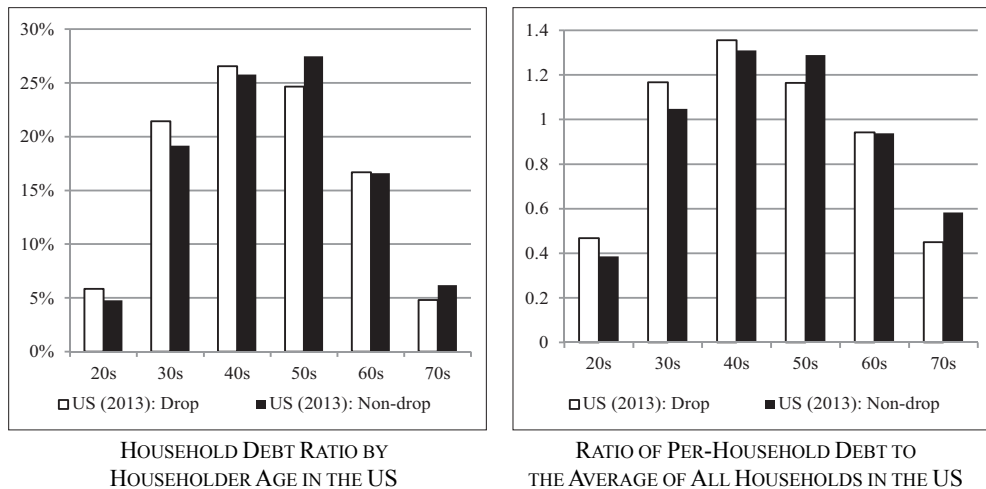


FIGURE A3

Note: Households with debts in the top 1% are dropped (white bar). All sample households are included in the black bar.

Source: 2013 SCF

<sup>20</sup>Households with total debt in the top 1% are dropped.

<sup>21</sup>Households with real estate debt in the top 1% are dropped.

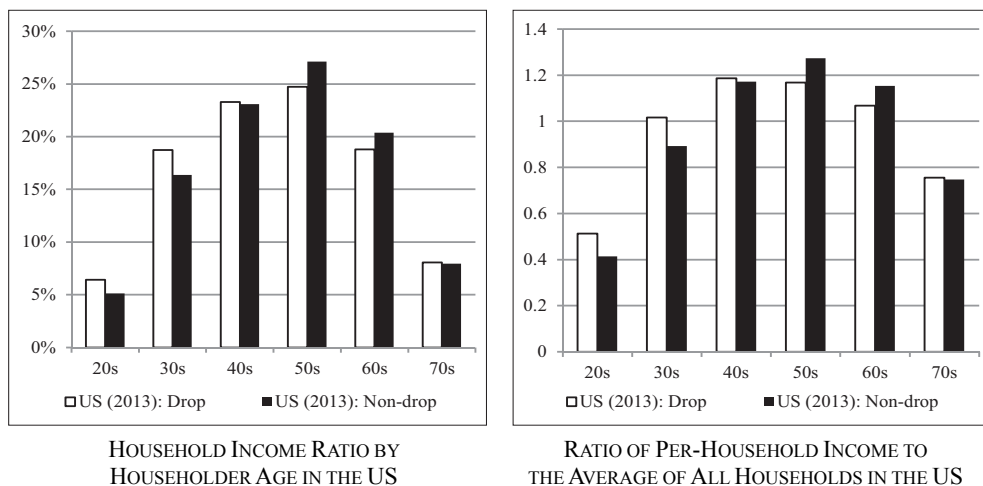


FIGURE A4

*Note:* Households with incomes in the top 1% are dropped (white bar). All sample households are included in the black bar.

*Source:* 2013 SCF

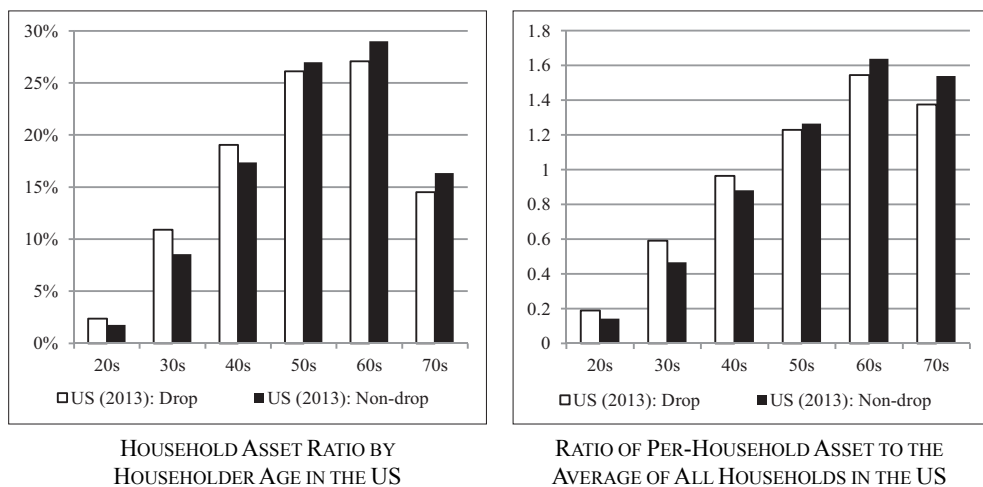


FIGURE A5

*Note:* Households with incomes in the top 1% are dropped (white bar). All sample households are included in the black bar.

*Source:* 2013 SCF

When I include the top 1% of high-income household samples, the household income ratio held by those in their 50-60s shows a slight increase. In addition, average incomes earned by those households also increase. I can draw the same qualitative interpretation when I compare the Korean household income distribution to that of the US without dropping the top 1% high-income samples.

When I calculate the household asset distribution by householder age with all

samples, household assets held by the older groups (50-70s) increase, indicating that the top 1% asset-rich households are those 50 or over. Hence, senior households, especially those in their 60-70s, in the US tend to have larger amounts of assets as compared to their counterparts in Korea, even when I used all SCF samples.

### C. Household Income Composition

In this section, I decompose household income according to sources in Korea and the US. As reported in Figure A6, there are several differences between Korea and the US. First, the proportion of wages earned by US households decreases significantly when they become older compared to that in Korea. The portion of wage income for those in their 20s is around 82% in Korea, which decreasing to 46% and 23% for those in their 60s and 70s, respectively. On the other hand, US households in their 20s earn income from wages at a rate of nearly 88%, which decreases to 46% and 16% for those in their 60s and 70s, respectively. Second, income from businesses constitutes a greater portion of Korean household income than in the US. That is, Korean households tend to have more self-employed (or private) businesses. This leads to an increase in the proportion of household debt for subsidizing and operating their private businesses, especially after the

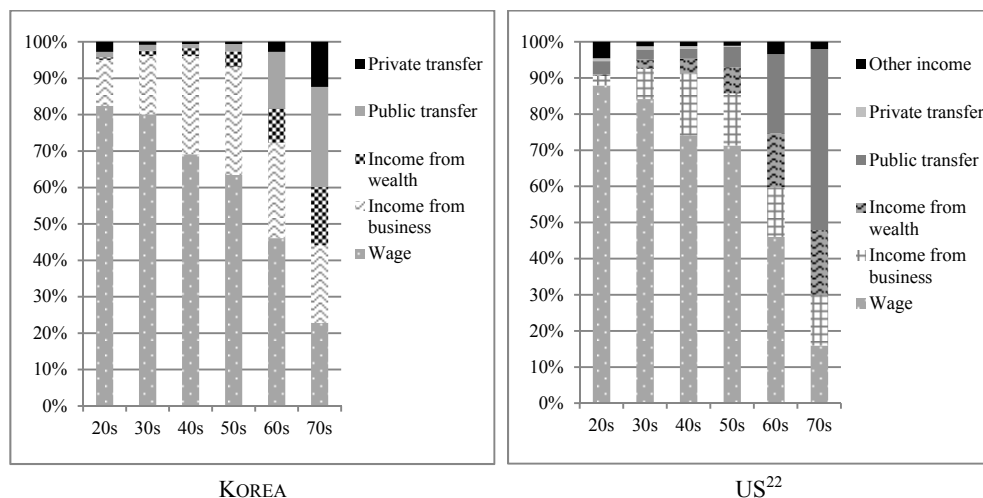


FIGURE A6. HOUSEHOLD INCOME COMPOSITION

Source: 2014 SHFLC and 2013 SCF

<sup>22</sup>Income categories in the SCF are not identical to those in the SHFLC. The categories in the SCF are more finely defined. Hence, I define income from business in the SCF as the sum of income from a sole proprietorship or farm and income from other businesses, investments, net rents, trusts, or royalties. I define income from wealth as the sum of income from non-taxable investments; income from other investments; and income from dividends; gains or losses from the sale of mutual funds, stock, bonds, or real estate. Public transfer income is defined as the sum of unemployment or worker's compensation; income from social security, annuities, pensions, and disability or retirement programs; and income from food stamps or other forms of welfare. Private transfers are the sum income from child support or alimony.



retirement age (not reported in this paper).<sup>23</sup> Third, the proportion of pension income (or public transfers) in Korea is much smaller than that in the US. Household income from public transfers accounts for 15% and 28% of income for those in their 60s and 70s, respectively, in Korea, whereas these levels are 22% and 50% in the US. Older people in Korea tend to depend more on income from their businesses or private transfers (or income transfers from their children) than their US counterparts.

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# Job Creation, Destruction, and Regional Employment Growth: Evidence from Korean Establishment-level Data<sup>†</sup>

By JANGHEE CHO, HYUNBAE CHUN, YOONSOO LEE, AND INSILL YI\*

*Using the Census on Establishments collected by Statistics Korea, we analyze how the patterns of job creation and destruction differ across counties (si-gun-gu). We measure aggregate employment changes due to establishment startups, expansions, contractions, and shutdowns for each county and quantify the role of such reallocations in explaining variation in employment growth across counties. Overall we find that both rates of net entry and job creation play an important role in explaining differences in net job creation rates across regions. Moreover, counties with high employment growth rates also tend to have high exit and job destruction rates, which suggests that an active process of job reallocation is a key source of regional employment growth.*

Key Word: Job Creation, Job Destruction, Entry and Exit, Regional  
Employment  
JEL Code: E24, O47, R11

## I. Introduction

Employment growth is a key measure of a region's economic performance. Using the Census on Establishments collected by Statistics Korea, we analyze how the patterns of job creation and destruction differ across counties (si-gun-gu in Korean). We measure aggregate employment changes due to establishment startups, expansions, contractions, and shutdowns for each county and quantify the role of such reallocations in explaining variation in employment growth across counties.

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Recent studies focusing on the role of entry, exit, and job growth of incumbents find that entry is important in explaining regional employment growth. Going back at least to Schumpeter, reallocations among firms, termed “creative destruction,” have been viewed as a necessary part of economic growth. Economic growth models emphasizing the role of creative destruction explain the link between job reallocations and economic growth (Davis and Haltiwanger 1992; Davis, Haltiwanger, and Schuh 1998). Previous studies find substantial variation in job creation and destruction across regions (e.g., Faberman 2002; Bauer and Lee 2010) or countries (Bertola and Rogerson 1997; Mortensen and Pissarides 1999). According to these studies, there is a strong correlation between a region’s employment growth and job creation and destruction rates. In particular, Jarmin, Haltiwanger, and Miranda (2013) find that both the entry and growth of young firms are crucial for employment growth of an economy. In this paper, we quantify the importance of entry and exit of establishments in accounting for variation in employment growth across counties.

We use establishment-level data from the Census on Establishments from 2001 to 2011 in order to examine the role of entry, exit, job creation, and destruction in explaining variation in employment growth rates across regions. Through investigating job creation and destruction patterns across geographic regions in Korea, this paper sheds light on issues related to the entry regulation and employment growth. By analyzing cross-regional variation in the job reallocation process, we can examine the role of firm dynamics in explaining regional employment growth.

While a number of studies examined the entry and exit of establishments and job creation and destruction patterns since the early 2000s, most have focused on the manufacturing sector (Kim 2004; Kim and Yoon 2011). Considering the decline in manufacturing and its share in aggregate employment, our study makes a meaningful contribution by examining the role of job creation and destruction in the service sector (Chun and Lee 2013). Given that most service industries are based at specific regions, understanding job creation and destruction patterns across regions is essential to understand the dynamics of service sector employment.

In section II, we introduce data and key measures. We examine job creation and destruction patterns at the province (si-do in Korean) level in section III and at the county level in section IV. In section IV, we also quantify the role of entry and exit as well as job creations and destructions in explaining the variation of employment growth rates across counties. We conclude in section V.

## **II. Data and Measures**

### *A. Data*

We use the Census on Establishments collected by Statistics Korea from 2001 to 2011. The Census on Establishments is an annual survey encompassing all establishments in Korea.<sup>2</sup> A business establishment, a unit of business at a single

<sup>2</sup>In addition to the establishment ID, we use the business register and other information in order to link

physical location that produces or distributes goods or provides services, is a unit of observation in the dataset.

In this study we follow OECD's DynEmp project (Criscuolo, Gal, and Menon, 2014) and Hwang *et al.* (2009) in classifying the service sector. In our paper, we exclude the following industries: Agriculture, forestry, and fishing (01~03; KSIC rev. 9 Code), Mining (05~08), Electric, gas, steam and water supply (35~36), Sewerage, waste management, materials recovery and remediation activities (37~39), Construction (41~42), Activities of households as employers (97~98), and Activities of extraterritorial organizations and bodies (99). After excluding the aforementioned industries, we label all industries except Manufacturing (10~33) as Services.

### B. Measuring Job Creation and Destruction

The purpose of this study is to examine the patterns of job creation, destruction, and net employment growth across geographic regions. The concepts of aggregate measures of job creation rates, job destruction rates, and net job creation rates are described in this section. We construct aggregate measure of job flows at the province level (major cities and provinces) and at the county level. The most basic concept is job creation, in which the number of employment of an establishment increases and job destruction, in which the number of employment of an establishment decreases.

First, we construct Gross Job Creation,  $C_{j,t}$  and Gross Job Destruction,  $D_{j,t}$  for each region  $j$  as follows:

$$(1) \quad C_{j,t} = \sum_{i \in S^+} \Delta E_{i,j,t}$$

$$(2) \quad D_{j,t} = \sum_{i \in S^-} \Delta E_{i,j,t}$$

Here,  $\Delta E_{i,j,t} = E_{i,j,t} - E_{i,j,t-1}$  measures changes in employment between  $t$  and  $t-1$  at establishment  $i$  and region  $j$ . The superscripts  $+$  and  $-$  in  $S$  refer to expanding and contracting establishments, respectively. Note that gross job creation includes job creation from births of new establishments and gross job destruction from deaths of existing establishments. For example, employment of an entering (birth) establishment  $i$  at  $t-1$  would be 0 (i.e.,  $E_{i,j,t-1} = 0$ ) and employment of exiting (death) establishment  $i$  at  $t$  would be 0 as well (i.e.,  $E_{i,j,t} = 0$ ). We will separately examine job creation (destruction) from birth (death) and job creation (destruction) from continuing establishments. An entrant (birth) is defined as an establishment that starts an economic activity at a given region

establishments over time. Establishments lacking such information as well as those with frequent entry and exit in a short time period are dropped from the sample. Moreover, by reporting average across sample years, we minimize measurement errors in entry and exit each year.

(county) in a given industry, the classification of which is based on 2-digit industry classification. For instance, if an establishment changes its main activity from shipbuilding to automobile manufacturing, we consider it as a birth in automobile manufacturing and a death in shipbuilding manufacturing. An exit (death) is defined as an establishment that terminates an economic activity at a given region (county) in a given industry, the classification of which is based on county-level geographic classification. For instance, if a store moves from Gangnam-gu to Mapo-gu, we consider it as a birth in Mapo-gu and a death in Gangnam-gu.<sup>3</sup>

Employment growth rate,  $g_{i,j,t}$ , for an establishment  $i$  in region  $j$  at time  $t$  is defined as follows, in which the establishment size is based on the average between  $t$  and  $t-1$ , (i.e.,  $X_{i,j,t} = (E_{i,j,t} + E_{i,j,t-1}) / 2$ ).

$$(3) \quad g_{i,j,t} = \frac{(E_{i,j,t} - E_{i,j,t-1})}{X_{i,j,t}}$$

We follow Davis, Haltiwanger, and Schuh (1998) to calculate weighted average of employment growth rate for a given group  $s$ , based on each industry in region  $j$ :

$$(4) \quad g_{j,t} = \sum_s \left( \frac{X_{s,j,t}}{X_{j,t}} \right) g_{s,j,t} = \sum_s \left( \left( \frac{X_{s,j,t}}{X_{j,t}} \right) \sum_{i \in s} \left( \frac{X_{i,j,t}}{X_{s,j,t}} \right) g_{i,j,t} \right)$$

where the average size of establishments in a region  $j$  is the sum of average size of establishments in each group.

$$(5) \quad X_{j,t} = \sum_s X_{s,j,t} = \sum_s \sum_{i \in s} X_{i,j,t}$$

Based on gross job creation and destruction derived above, we measure gross job creation rate,  $JCR_{j,t}$ , and gross job destruction rate,  $JDR_{j,t}$ . Gross job creation (destruction) rate is obtained by dividing gross job creation (destruction) by the average size of establishments in each region  $j$ .

$$(6) \quad JCR_{j,t} = \frac{JC_{j,t}}{X_{j,t}} = \sum_{i \in S^+} \left( \frac{X_{i,j,t}}{X_{j,t}} \right) g_{i,j,t}$$

$$(7) \quad JDR_{j,t} = \frac{JD_{j,t}}{X_{j,t}} = \sum_{i \in S^-} \left( \frac{X_{i,j,t}}{X_{j,t}} \right) |g_{i,j,t}|$$

<sup>3</sup>There had been several changes in administrative division codes at the county (si-gun-gu) level during the sample period. To construct county codes which are consistent over the sample period, we reclassified towns (eup-myeon-dong in Korean) based on the 2010 administrative division codes.

Net job creation rate,  $NJC_{j,t}$ , is obtained using the gross job creation and destruction rates as follows.

$$(8) \quad NJC_{j,t} = JCR_{j,t} - JDR_{j,t} = \frac{\Delta E_{j,t}}{X_{j,t}}$$

$$(9) \quad NJC_{j,t} = \sum_{i \in S} \left( \frac{X_{i,j,t}}{X_{j,t}} \right) g_{i,j,t}$$

Finally, gross job reallocation rate,  $GJR_{j,t}$ , and excess job reallocation rate,  $EJR_{j,t}$ , are given by the equations below.

$$(10) \quad GJR_{j,t} = JCR_{j,t} + JDR_{j,t}$$

$$(11) \quad EJR_{j,t} = GJR_{j,t} - |NJC_{j,t}|$$

### III. Job Creation and Destruction across Major Cities and Provinces

In this section, we describe net employment growth and job creation and destruction patterns across 7 major cities and 9 provinces. For notational purpose we hereafter refer to major cities and provinces as provinces. We also examine the differences in employment growth between manufacturing and service sectors through comparing job creation and destruction patterns.

TABLE 1—JOB CREATION, DESTRUCTION, AND NET JOB CREATION RATES BY PROVINCE

A. ALL INDUSTRIES			
Province	Job Creation Rate	Job Destruction Rate	Net Job Creation Rate
Seoul	0.346	0.325	0.021
Busan	0.273	0.261	0.012
Daegu	0.278	0.262	0.016
Incheon	0.302	0.281	0.021
Gwangju	0.294	0.270	0.024
Daejeon	0.284	0.255	0.029
Ulsan	0.239	0.213	0.026
Gyeonggi	0.320	0.276	0.044
Gangwon	0.246	0.228	0.018
Chungbuk	0.257	0.232	0.025
Chungnam	0.261	0.223	0.038
Jeonbuk	0.250	0.233	0.017
Jeonnam	0.238	0.227	0.011
Gyeongbuk	0.246	0.228	0.018
Gyeongnam	0.259	0.234	0.025
Jeju	0.258	0.231	0.027

## B. MANUFACTURING

Province	Job Creation Rate	Job Destruction Rate	Net Job Creation Rate
Seoul	0.363	0.420	-0.057
Busan	0.247	0.261	-0.014
Daegu	0.248	0.252	-0.004
Incheon	0.294	0.301	-0.007
Gwangju	0.244	0.221	0.023
Daejeon	0.247	0.236	0.011
Ulsan	0.154	0.143	0.011
Gyeonggi	0.297	0.274	0.023
Gangwon	0.234	0.224	0.010
Chungbuk	0.235	0.207	0.028
Chungnam	0.254	0.200	0.054
Jeonbuk	0.226	0.207	0.019
Jeonnam	0.226	0.214	0.012
Gyeongbuk	0.237	0.222	0.015
Gyeongnam	0.256	0.230	0.026
Jeju	0.266	0.247	0.019

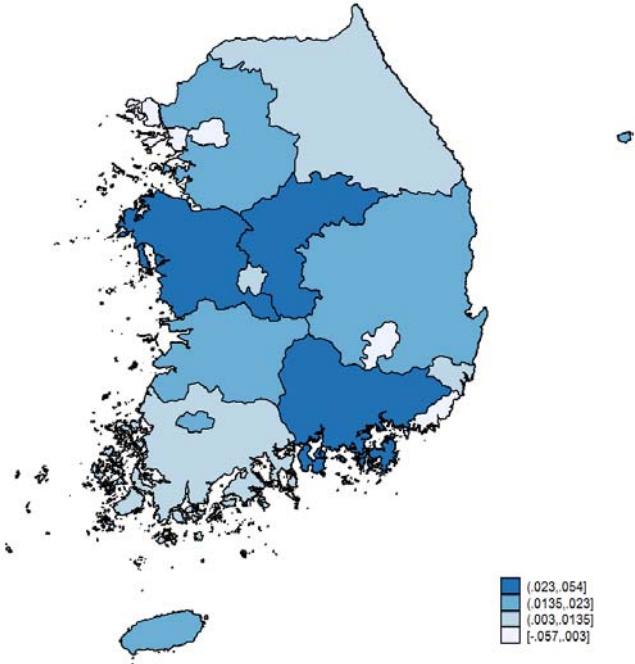
## C. SERVICES

Province	Job Creation Rate	Job Destruction Rate	Net Job Creation Rate
Seoul	0.343	0.314	0.029
Busan	0.280	0.262	0.018
Daegu	0.286	0.265	0.021
Incheon	0.305	0.273	0.032
Gwangju	0.302	0.278	0.024
Daejeon	0.289	0.258	0.031
Ulsan	0.290	0.254	0.036
Gyeonggi	0.330	0.277	0.053
Gangwon	0.248	0.229	0.019
Chungbuk	0.265	0.241	0.024
Chungnam	0.264	0.233	0.031
Jeonbuk	0.255	0.239	0.016
Jeonnam	0.240	0.231	0.009
Gyeongbuk	0.250	0.230	0.020
Gyeongnam	0.260	0.236	0.024
Jeju	0.257	0.229	0.028

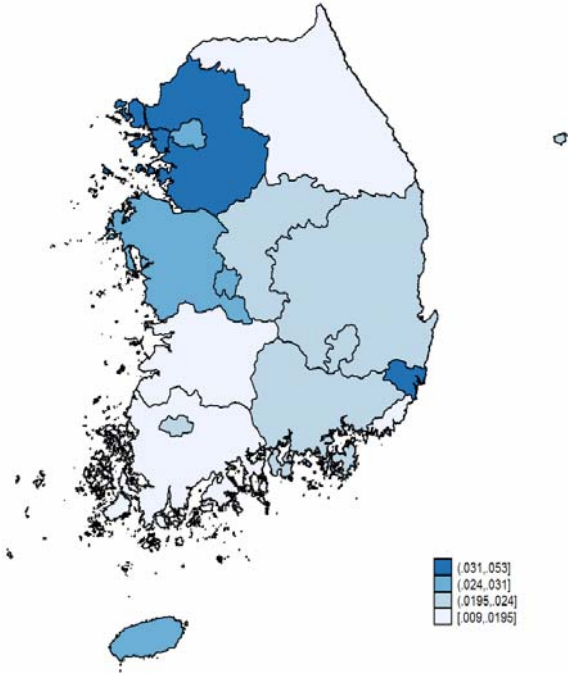
Table 1 and Figure 1 report job creation, job destruction, and net job creation rates by province, for all industries, manufacturing, and services, respectively. The map in Figure 1 exhibits net job creation rates by province for manufacturing and service sectors. In the Panel A of Table 1, Gyeonggi shows the highest net job creation rate of 4.4% while Jeonnam has the lowest at 1.1%. In the case of manufacturing in Panel B, Seoul shows the largest decline of net job creation rate of -5.7%, while Chungnam shows the highest growth of 5.4%. Major cities such as Seoul, Busan, Daegu, and Incheon all show negative net employment growth in manufacturing. In the service sector, Gyeonggi (5.3%) and Ulsan (3.6%) show the highest employment growth rates.

It is worth noting that in most provinces, the job creation and destruction rates are much higher than net job creation rates. This finding suggests that there has been very active reallocation in most areas. Moreover, job creation and destruction





A. MANUFACTURING



B. SERVICES

FIGURE 1. NET JOB CREATION RATES BY PROVINCE

rates are generally higher in areas with higher net job creation rates such as Seoul and Gyeonggi. In fact higher net employment growth rates involve not only higher job creation rates but also higher job destruction rates. We examine this pattern by using county-level data in more detail in section IV.

Table 2 breaks down job creation and destruction rates into job creation by continuing establishments vs. entrants and job destruction by continuing establishments vs. exiters. In all major cities and provinces, job creation rates for entrants are higher than those for continuing establishments. Job destruction rates of exiters are also higher than those of continuing establishments as well.<sup>4</sup> In other words, most job creation and destruction activities are accounted for by job flows among entering and exiting establishments. Moreover, job creation and destruction rates for continuing establishments do not show a substantial variation across regions.

In order to examine differences in entry and exit rates across regions, Table 3 reports entry, exit, and net entry rates by province for all industries. As discussed earlier, both entry and exit play an important role in explaining job creation and destruction. In the case of all industries, Gyeonggi shows the highest net entry rate (3.6%). With the exception of Ulsan with net entry rate of 2.1%, Gyeonggi's net entry rate is substantially higher than those in other provinces. The entry rate of Gyeonggi is also the highest at 25.2%.

Note that provinces with higher entry rates have higher exit rates as well. In fact, entry and exit rates are highly correlated, suggesting that higher job creation rates due to entry is likely to accompany higher job destruction rates due to exit. While high correlation between entry and exit rates and job creation and destruction rates across regions are well documented in studies from other countries (e.g., Lee, 2008), this study confirms such a relationship between entry and exit also holds in the case of Korea.

TABLE 2—JOB CREATION AND DESTRUCTION RATES FROM  
CONTINUING, ENTERING, AND EXITING ESTABLISHMENTS: ALL INDUSTRIES

Province	Job Creation Rate		Job Destruction Rate	
	Continuer	Entrant	Continuer	Exiter
Seoul	0.120	0.226	0.119	0.206
Busan	0.102	0.171	0.105	0.156
Daegu	0.100	0.178	0.103	0.159
Incheon	0.103	0.199	0.105	0.176
Gwangju	0.101	0.193	0.105	0.165
Daejeon	0.106	0.178	0.107	0.148
Ulsan	0.085	0.154	0.089	0.124
Gyeonggi	0.107	0.213	0.105	0.171
Gangwon	0.101	0.145	0.105	0.123
Chungbuk	0.102	0.155	0.102	0.130
Chungnam	0.107	0.154	0.102	0.121
Jeonbuk	0.105	0.145	0.108	0.125
Jeonnam	0.102	0.136	0.106	0.121
Gyeongbuk	0.098	0.148	0.100	0.128
Gyeongnam	0.098	0.161	0.098	0.136
Jeju	0.106	0.152	0.109	0.122

<sup>4</sup>Such a pattern is observed for both manufacturing and service sectors, although we do not report the results here. Results are available upon request.

TABLE 3—ENTRY, EXIT, AND NET ENTRY RATES BY PROVINCE: ALL INDUSTRIES

Province	Entry Rate	Exit Rate	Net Entry Rate
Seoul	0.228	0.224	0.004
Busan	0.188	0.188	0.000
Daegu	0.212	0.205	0.006
Incheon	0.234	0.219	0.015
Gwangju	0.219	0.205	0.014
Daejeon	0.217	0.204	0.012
Ulsan	0.208	0.187	0.021
Gyeonggi	0.252	0.217	0.036
Gangwon	0.172	0.165	0.008
Chungbuk	0.189	0.177	0.012
Chungnam	0.177	0.162	0.014
Jeonbuk	0.172	0.168	0.004
Jeonnam	0.152	0.156	-0.004
Gyeongbuk	0.174	0.167	0.007
Gyeongnam	0.188	0.176	0.012
Jeju	0.181	0.164	0.018

#### IV. Employment Growth and the Role of Job Creation and Destruction

Evidence from the previous section suggests that provinces with higher employment growth rates have higher net entry rates than those with lower employment growth rates. Moreover provinces with higher employment growth rates tend to have higher job destruction rates as well as higher job creation rates. Now, we examine the extent to which job reallocations account for variation in employment growth across provinces by analyzing job creation and destruction patterns at the more detailed geographic level, county (or si-gun-gu). First, we quantify the role of job creation and destructions in explaining the variation in employment growth rates across counties. Then, we perform a regression analysis to examine the role of entry, exit, net entry, job reallocation, and excess reallocation in employment growth. We consider the size of population, population flow, and the number of establishments, as emphasized by Acs and Armington (2006) and Hur (2007) as factors in the regression, as well.

##### *A. Patterns of Job Creation and Destruction across Counties*

Table 4 reports the number of counties in each province and the summary statistics of the number of establishments and employment for counties in each province. There are 249 counties in the sample and Gyeonggi (44) has the largest number of counties. A county in Seoul has on average about 27,000 establishments and about 132,000 workers, suggesting that the size of a county in Seoul is on average larger than counties in other provinces.

While we do not report all statistics at the county level due to space constraints, we find that net job creation rates across counties show larger variation than those observed among provinces in Table 1. For example, the net job creation rates vary from 14.9% in city of Hwasung in Gyeonggi to -1.0% in Dong-gu, Gwangju and

TABLE 4—NUMBER OF ESTABLISHMENTS AND EMPLOYMENT IN A COUNTY

Province	Number of Counties	Number of Establishments (in thousand)	Employment (in thousand)
Seoul	25	27.06 (9.88)	132.47 (87.19)
Busan	16	15.30 (6.99)	62.52 (27.31)
Daegu	8	20.80 (7.62)	80.03 (33.62)
Incheon	10	14.42 (9.41)	63.72 (45.64)
Gwangju	5	17.62 (6.84)	74.13 (29.01)
Daejeon	5	17.17 (5.10)	75.42 (22.62)
Ulsan	5	12.20 (6.89)	66.97 (29.10)
Gyeonggi	44	12.64 (5.72)	61.07 (33.86)
Gangwon	18	5.94 (5.65)	21.12 (22.24)
Chungbuk	13	7.08 (6.22)	30.84 (26.97)
Chungnam	17	6.92 (3.99)	30.28 (23.81)
Jeonbuk	15	7.50 (7.00)	29.30 (28.35)
Jeonnam	22	5.29 (5.12)	19.85 (19.59)
Gyeongbuk	24	7.03 (6.11)	29.62 (33.19)
Gyeongnam	20	9.80 (9.29)	43.75 (47.55)
Jeju	2	19.90 (13.06)	75.08 (53.54)
Total	249	11.94 (9.35)	53.28 (51.27)

*Note:* Numbers in the right two columns are county-level averages of the number of establishments and employment for each province. Numbers in parentheses are standard deviations.

city of Masan in Gyeongnam.

Table 5 reports summary statistics for job creation rates, job destruction rates, and net job creation rates for entering, exiting, and continuing establishments, respectively. Overall net job creation rates for continuing establishments are on average negative for all industries, manufacturing, and services. On the other hand, net job creation rates for entrants and exiters are positive and show higher standard deviation, which suggests that both entry and exit play an important role in employment growth. While such a pattern is observed both in manufacturing and services, the average net job creation rate for entrants and exiters is higher in services (2.6% in services versus 0.5% in manufacturing).

TABLE 5—JOB CREATION AND DESTRUCTION RATES FROM CONTINUING, ENTERING, AND EXITING ESTABLISHMENTS BY PROVINCE

## A. ALL INDUSTRIES

	Job Creation Rate		Job Destruction Rate		Net Job Creation Rate	
	Continuer	Entrant	Continuer	Exiter	Continuer	Entrant – Exiter
Mean	0.103	0.160	0.105	0.137	-0.002	0.022
Std. Dev.	0.010	0.047	0.009	0.038	0.006	0.019
Minimum	0.061	0.070	0.062	0.070	-0.025	-0.008
Median	0.103	0.158	0.105	0.133	-0.002	0.019
Maximum	0.133	0.310	0.137	0.253	0.024	0.101

## B. MANUFACTURING

	Job Creation Rate		Job Destruction Rate		Net Job Creation Rate	
	Continuer	Entrant	Continuer	Exiter	Continuer	Entrant – Exiter
Mean	0.101	0.163	0.108	0.158	-0.006	0.005
Std. Dev.	0.019	0.063	0.022	0.073	0.017	0.032
Minimum	0.041	0.049	0.041	0.044	-0.065	-0.106
Median	0.101	0.154	0.107	0.132	-0.006	0.006
Maximum	0.184	0.391	0.197	0.421	0.040	0.116

## C. SERVICES

	Job Creation Rate		Job Destruction Rate		Net Job Creation Rate	
	Continuer	Entrant	Continuer	Exiter	Continuer	Entrant – Exiter
Mean	0.105	0.161	0.107	0.135	-0.002	0.026
Std. Dev.	0.009	0.048	0.008	0.034	0.005	0.022
Minimum	0.076	0.070	0.087	0.070	-0.016	-0.015
Median	0.104	0.164	0.106	0.132	-0.002	0.020
Maximum	0.135	0.313	0.130	0.245	0.020	0.108

Figure 2 shows the distribution of job creation rates of continuing establishments and entering establishments. While job creation rates of continuing establishments are concentrated around 10%, job creation rates of entering establishments show much wider variation. Similarly, Figure 3 presents the distribution of job destruction rates for continuing establishments versus exiting establishments. Job destruction rates for exiters exhibit a wider variation than those for continuing establishments. The finding from the figures suggests that job creation by entrants and job destruction by exiters are more important factors than job flows among continuing establishments in explaining variation in employment growth rates across counties.

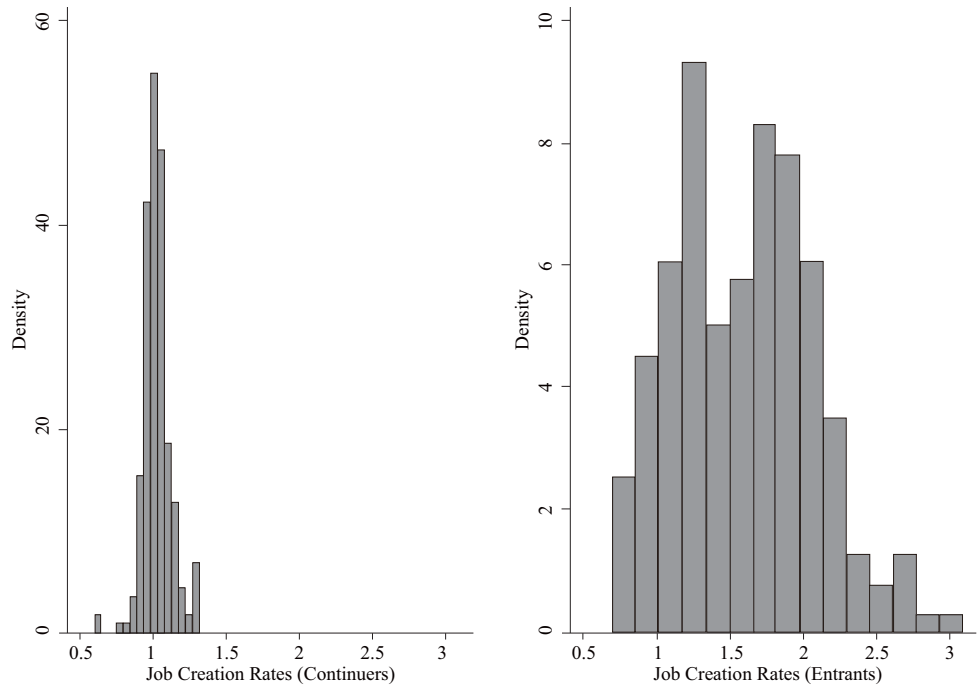


FIGURE 2. THE DISTRIBUTION OF JOB CREATION RATES: CONTINUERS VS. ENTRANTS

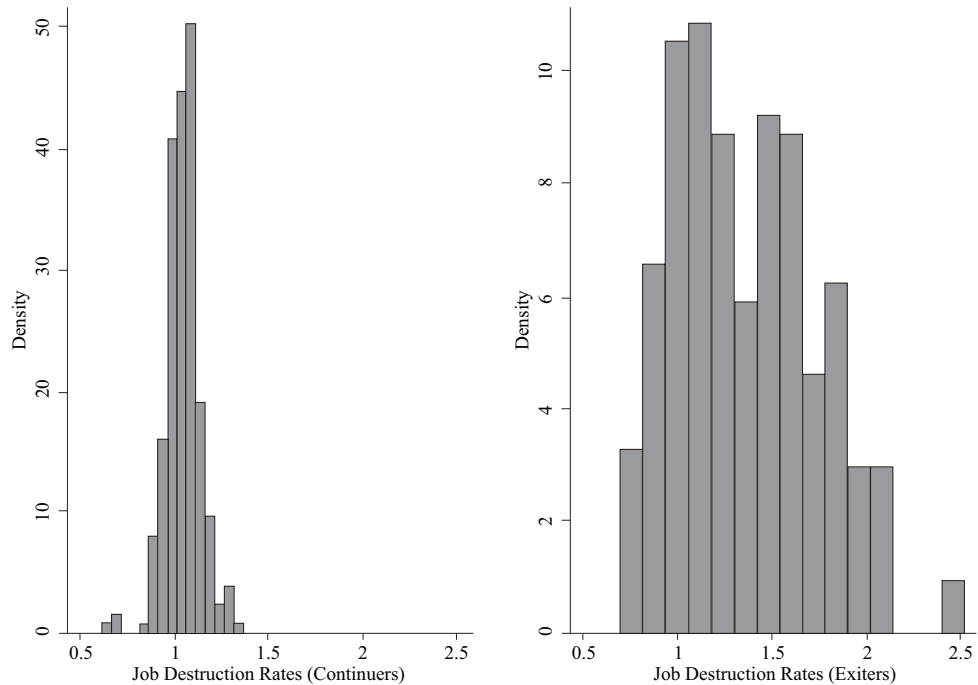


FIGURE 3. THE DISTRIBUTION OF JOB DESTRUCTION RATES: CONTINUERS VS. EXITERS

### B. *Quantifying the Role of Job Creation and Destruction in County-level Employment Growth*

To examine the extent to which job creation and destruction rates explain the variation of net employment growth rates across counties, we decompose the variance of employment growth rates across counties (Lee 2011).

First, in order to quantify the effect of job creation and destruction from entry and exit versus those from continuing, we decompose the variance of net job creation rates as follows. Similarly, net job creation rates can be decomposed into job creation rates and job destruction rates.

$$(12) \quad \begin{aligned} netjc_r &= enx\_netjc_r + con\_netjc_r \\ &= jc_r - jd_r \end{aligned}$$

In the equation above,  $r$  denotes a county and  $netjc_r$  denote net job creation rates for the county. The net job creation rate can be decomposed into that associated with entry and exit,  $enx\_netjc_r$  and that with continuing establishments,  $con\_netjc_r$ . In the second row of the equation, net job creation rate can be rewritten as job creation rate,  $jc_r$  minus job destruction rate,  $jd_r$ .

The variance of net job creation rates can be decomposed as follows.

$$(13) \quad \begin{aligned} 1 &= \frac{Var(netjc_r)}{Var(netjc_r)} = \frac{Cov(netjc_r, enx\_netjc_r + con\_netjc_r)}{Var(netjc_r)} \\ &= \frac{Cov(netjc_r, enx\_netjc_r) + Cov(netjc_r, con\_netjc_r)}{Var(netjc_r)} \\ &= \frac{Cov(netjc_r, enx\_netjc_r)}{Var(netjc_r)} + \frac{Cov(netjc_r, con\_netjc_r)}{Var(netjc_r)} \end{aligned}$$

This decomposition is equivalent to examining the coefficients from independently regressing “net job creation rates for entrants and exiters” and “net job creation rates for continuing establishments,” respectively, on net job creation rates. The results of this decomposition point to the importance of each component in accounting for differences in employment growth rates across counties. Table 6 reports the results of the decomposition for all industries, manufacturing, and services. On average, net job creation rates for entrants and exiters account for about 82% of variations in employment growth in all industries across counties. The remaining 18% is accounted for by net job creations by continuing establishments. While the role of net job creations by entry and exit is somewhat smaller in manufacturing (72%), it is larger in services (89%). This finding is consistent with those from other studies that entry and exit generally play more important roles in employment growth in service sectors than in manufacturing.

TABLE 6—ENTRANT-EXITER VS. CONTINUER: VARIANCE DECOMPOSITION OF NET JOB CREATION RATES

	$\frac{Cov(netjc_r, con\_netjc_r)}{Var(netjc_r)}$	$\frac{Cov(netjc_r, enex\_netjc_r)}{Var(netjc_r)}$
	Continuer's Effect	Entrant-Exiter Effect
All Industries	18.33	81.67
Manufacturing	27.97	72.03
Services	10.58	89.42

In a similar way, the variance of net job creation rates can be decomposed as the covariance with job creations and job destructions as follows.

$$\begin{aligned}
 (14) \quad I &= \frac{Var(netjc_r)}{Var(netjc_r)} = \frac{Cov(netjc_r, jc_r - jd_r)}{Var(netjc_r)} \\
 &= \frac{Cov(netjc_r, jc_r)}{Var(netjc_r)} - \frac{Cov(netjc_r, jd_r)}{Var(netjc_r)}
 \end{aligned}$$

The results of Table 7 show that the variation in job creation rates is much more important in explaining differences in employment growth rates across counties in all industries. In the case of manufacturing, however, job destruction rates account for virtually all the differences in employment growth rates across counties. This is in sharp contrast to services in which differences in job creation rates account for more than 150% of the variation in employment growth rates.

TABLE 7—JOB CREATION VS. JOB DESTRUCTION: VARIANCE DECOMPOSITION OF NET JOB CREATION RATES

	$\frac{Cov(netjc_r, jc_r)}{Var(netjc_r)}$	$\frac{Cov(netjc_r, jd_r)}{Var(netjc_r)}$
	Job Creation Effect	Negative Job Destruction Effect
All Industries	143.75	-43.75
Manufacturing	-8.33	108.33
Services	165.87	-65.87

### C. The Role of Dynamics in Employment Growth Rates

In a study examining the differences in employment growth rates across regions, Hur (2007) finds that net population flows and taxes are important factors in explaining the variation. This study focuses on the role of dynamics such as entry, exit, job creation, and job destruction. Under the hypothesis that job reallocations as well as entry and exit are closely related to employment growth, we examine five important dynamics measures: entry rate, exit rate, net entry rate, job reallocation rate, and excess reallocation rates. In addition, the regression equation includes the number of establishments and population to control for differences in the region's size:

$$(15) \quad netjc_r = \alpha + \beta Dyn_r + \gamma Z_r + \epsilon_r$$



TABLE 8—EFFECTS OF DYNAMICS MEASURES ON NET JOB CREATION RATES: ALL INDUSTRIES

	(1)	(2)	(3)	(4)	(5)
Entry Rate	0.370*** (0.065)				
Exit Rate		0.142** (0.060)			
Net Entry Rate			0.956*** (0.082)		
Reallocation Rate				0.160*** (0.035)	
Excess Reallocation Rate					0.125*** (0.032)
Net Rate of Population Influx	0.467*** (0.113)	0.878*** (0.098)	-0.022 (0.096)	0.683*** (0.107)	0.809*** (0.101)
Log No. of Establishments	-0.015*** (0.003)	-0.011*** (0.003)	-0.001 (0.002)	-0.015*** (0.003)	-0.014*** (0.003)
Log of Population	0.006* (0.003)	0.010*** (0.003)	-0.0004 (0.002)	0.008** (0.003)	0.008** (0.003)
Constant	0.016 (0.020)	-0.016 (0.022)	0.032** (0.013)	0.002 (0.021)	0.003 (0.023)
No. of Counties	249	249	249	249	249
R-squared	0.704	0.599	0.823	0.650	0.620
Control	province	province	province	province	province

Note: Standard errors are in parentheses.

\*\*\* Significant at the 1% level. \*\* Significant at the 5% level. \* Significant at the 10% level.

In the equation above,  $netjc_r$  is the net job creation rate of county  $r$  and  $Dyn_r$  represents the five variables of the dynamics.  $Z_r$  denotes county-specific characteristics such as county-level population, population flows, number of establishments, and province dummies.

The results of the regressions are reported in Tables 8-10 for all industries, manufacturing, and services, respectively. In Table 8, while all measures of dynamics are positively correlated with net employment growth rates, in all industries, entry has higher coefficients than exit does. Moreover, the coefficient of net entry is close to one, suggesting that net entry rates account for most changes in net job growth rates. Finally, we find that net population inflows are also positively correlated with net job changes.

It is worth noting some difference between the manufacturing and the service industry in the effects of dynamics on net job creation rates. In the case of manufacturing, the result of which is reported in Table 9, we find that exit rates are *negatively* correlated with net job creation rates. While the directions of correlations are opposite for entry and exit rates, the magnitudes are similar. Moreover, job reallocation rates and excess reallocations are not significantly correlated with net job creation rates. In the case of services, the results in Table 10 are similar to our finding for all industries. While all dynamics variables are positively correlated with employment growth rates, the coefficients are higher for entry and net entry. We also find that net population inflows, job reallocation rates and excess reallocation rates are positively correlated with net job creation rates.

TABLE 9—EFFECTS OF DYNAMICS MEASURES ON NET JOB CREATION RATES: MANUFACTURING

	(1)	(2)	(3)	(4)	(5)
Entry Rate	0.209** (0.081)				
Exit Rate		-0.219*** (0.078)			
Net Entry Rate			1.056*** (0.099)		
Reallocation Rate				0.0161 (0.045)	
Excess Reallocation Rate					0.018 (0.048)
Net Rate of Population Influx	0.482** (0.195)	0.830*** (0.172)	-0.053 (0.121)	0.704*** (0.189)	0.709*** (0.184)
Log No. of Establishments	0.014*** (0.005)	0.015*** (0.005)	-0.005 (0.004)	0.016*** (0.005)	0.016*** (0.005)
Log of Population	-0.020*** (0.006)	-0.006 (0.007)	-0.001 (0.004)	-0.016** (0.007)	-0.016** (0.006)
Constant	0.040 (0.049)	-0.029 (0.050)	0.015 (0.031)	0.011 (0.052)	0.013 (0.053)
No. of Counties	249	249	249	249	249
R-squared	0.488	0.482	0.716	0.460	0.460
Control	province	province	province	province	province

Note: Standard errors are in parentheses.

\*\*\* Significant at the 1% level. \*\* Significant at the 5% level. \* Significant at the 10% level.

TABLE 10—EFFECTS OF DYNAMICS MEASURES ON NET JOB CREATION RATES: SERVICES

	(1)	(2)	(3)	(4)	(5)
Entry Rate	0.404*** (0.060)				
Exit Rate		0.157** (0.061)			
Net Entry Rate			0.999*** (0.078)		
Reallocation Rate				0.175*** (0.033)	
Excess Reallocation Rate					0.134*** (0.030)
Net Rate of Population Influx	0.487*** (0.105)	0.928*** (0.088)	-0.004 (0.092)	0.720*** (0.100)	0.858*** (0.094)
Log No. of Establishments	-0.018*** (0.003)	-0.015*** (0.004)	-0.0005 (0.003)	-0.018*** (0.004)	-0.017*** (0.004)
Log of Population	0.010*** (0.003)	0.014*** (0.003)	0.0003 (0.003)	0.013*** (0.003)	0.013*** (0.003)
Constant	-0.002 (0.016)	-0.036** (0.018)	0.024* (0.013)	-0.018 (0.016)	-0.017 (0.018)
No. of Counties	249	249	249	249	249
R-squared	0.790	0.696	0.885	0.742	0.714
Control	province	province	province	province	province

Note: Standard errors are in parentheses.

\*\*\* Significant at the 1% level. \*\* Significant at the 5% level. \* Significant at the 10% level.

## V. Conclusion

In this paper we analyzed establishment-level data from the Census on Establishments to examine the patterns of entry, exit, job creation, and destruction and their roles in explaining variation in employment growth rates across counties in Korea. Overall both net entry and job creation play an important role in explaining differences in net job creation rates across counties. However, a high entry and job creation does not come without a cost. Most counties with higher growth rates also tend to have higher exit and job destruction rates. Overall an active process of job reallocations promotes employment growth, particularly in growing industries such as those in the service sector.

While this paper focuses on the role of firm dynamics measured in terms of entry and exit, further studies are necessary to understand the effect of differences in the industry composition and the characteristics of a county, such as human capital, population, and size distribution of firms. Industry composition needs to be considered because job creation and destruction rates vary across industries. While job creation and destruction rates are generally lower in manufacturing, they are expected to be much higher in construction and in some service industries such as professional, scientific and technical services or administrative and support. Moreover, it would be important to understand the relationship between industries in terms of employment growth. Future studies examining spillover effects between manufacturing and related service industries will help understand such dynamics in regional employment growth.

While some studies (Hopenhayn and Rogerson 1993) focus on the differences in labor market policy (such as firing costs and unionization), we do not expect that there exists a substantial difference in labor market policies across regions in Korea. In contrast, differences in age and size distribution of firms may drive some of differences in job creation and destruction rates across counties. Both theoretical and empirical studies on industry dynamics suggest that young or small firms are more likely to grow (Jovanovic 1982; Dunne, Roberts, and Samuelson 1989). Davis, Haltiwanger, and Schuh (1996) also find that job creation and destruction rates are higher for smaller or younger establishments. We intend to investigate the role of firm age and size associated with labor market policies in the regional job reallocation process in future work.

## APPENDIX

TABLE A1—ENTRY, EXIT, AND NET ENTRY RATES BY PROVINCE: MANUFACTURING

Province	Entry Rate	Exit Rate	Net Entry Rate	Corr (Entry Rate, Exit Rate)
Seoul	0.252	0.273	-0.020	0.881
Busan	0.203	0.207	-0.004	0.900
Daegu	0.222	0.218	0.004	0.895
Incheon	0.269	0.258	0.010	0.902
Gwangju	0.219	0.211	0.008	0.878
Daejeon	0.210	0.208	0.002	0.836
Ulsan	0.222	0.203	0.019	0.745
Gyeonggi	0.277	0.242	0.035	0.880
Gangwon	0.154	0.155	-0.001	0.871
Chungbuk	0.187	0.169	0.018	0.892
Chungnam	0.173	0.159	0.015	0.865
Jeonbuk	0.154	0.156	-0.002	0.860
Jeonnam	0.137	0.141	-0.004	0.821
Gyeongbuk	0.179	0.162	0.017	0.865
Gyeongnam	0.227	0.201	0.026	0.885
Jeju	0.174	0.163	0.011	0.759

TABLE A2—ENTRY, EXIT, AND NET ENTRY RATES BY PROVINCE: SERVICES

Province	Entry Rate	Exit Rate	Net Entry Rate	Corr (Entry Rate, Exit Rate)
Seoul	0.225	0.219	0.006	0.973
Busan	0.186	0.186	0.000	0.973
Daegu	0.210	0.203	0.007	0.941
Incheon	0.229	0.213	0.016	0.945
Gwangju	0.218	0.204	0.014	0.966
Daejeon	0.217	0.204	0.013	0.916
Ulsan	0.207	0.186	0.021	0.942
Gyeonggi	0.248	0.213	0.036	0.959
Gangwon	0.173	0.165	0.008	0.982
Chungbuk	0.189	0.177	0.011	0.957
Chungnam	0.177	0.163	0.014	0.954
Jeonbuk	0.174	0.169	0.004	0.955
Jeonnam	0.153	0.157	-0.004	0.955
Gyeongbuk	0.173	0.168	0.005	0.964
Gyeongnam	0.184	0.173	0.011	0.975
Jeju	0.182	0.164	0.018	0.982

TABLE A3—JOB CREATION AND DESTRUCTION RATES FROM  
CONTINUING, ENTERING, AND EXITING ESTABLISHMENTS: MANUFACTURING

Province	Job Creation Rates		Job Destruction Rates	
	Continuing	Entering	Continuing	Exiting
Seoul	0.112	0.251	0.132	0.288
Busan	0.091	0.156	0.097	0.164
Daegu	0.088	0.160	0.093	0.159
Incheon	0.090	0.204	0.093	0.208
Gwangju	0.087	0.157	0.078	0.143
Daejeon	0.095	0.152	0.092	0.144
Ulsan	0.055	0.099	0.059	0.084
Gyeonggi	0.099	0.198	0.096	0.178
Gangwon	0.101	0.133	0.107	0.117
Chungbuk	0.094	0.141	0.091	0.116
Chungnam	0.104	0.150	0.087	0.113
Jeonbuk	0.096	0.130	0.097	0.110
Jeonnam	0.096	0.130	0.100	0.114
Gyeongbuk	0.092	0.145	0.095	0.127
Gyeongnam	0.090	0.166	0.084	0.146
Jeju	0.103	0.163	0.113	0.134

TABLE A4—JOB CREATION AND DESTRUCTION RATES FROM  
CONTINUING, ENTERING, AND EXITING ESTABLISHMENTS: SERVICES

Province	Job Creation Rates		Job Destruction Rates	
	Continuing	Entering	Continuing	Exiting
Seoul	0.121	0.222	0.117	0.197
Busan	0.105	0.175	0.107	0.155
Daegu	0.103	0.183	0.106	0.159
Incheon	0.108	0.197	0.110	0.163
Gwangju	0.103	0.199	0.109	0.169
Daejeon	0.108	0.181	0.109	0.149
Ulsan	0.103	0.187	0.106	0.148
Gyeonggi	0.110	0.220	0.109	0.168
Gangwon	0.101	0.147	0.105	0.124
Chungbuk	0.105	0.160	0.106	0.135
Chungnam	0.108	0.156	0.109	0.124
Jeonbuk	0.107	0.148	0.111	0.128
Jeonnam	0.103	0.137	0.108	0.123
Gyeongbuk	0.100	0.150	0.102	0.128
Gyeongnam	0.102	0.158	0.105	0.131
Jeju	0.106	0.151	0.108	0.121

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## Real-time Impact Evaluation of a Capacity-Building Health Project in Lao PDR<sup>†</sup>

By KYE WOO LEE AND TAEJONG KIM\*

*This study presents a real-time impact evaluation of a human capacity-building health project in Laos, financed by a Korean aid agency and executed jointly by Laotian and Korean higher educational agencies. The project aims to improve the health status of Laotians by enhancing practicing doctors' clinical performance capacity, to be attained by advancing academic achievement at the University of Health Sciences (UHS) in Laos. Therefore, this real-time impact evaluation adopted the difference-in-differences regression analysis method, showing that the project improved the academic achievement of the UHS students who were taught by the project fellowship awardees more, compared to the UHS students who were taught by non-fellowship faculty members. It remains to be evaluated whether these UHS students taught by the project fellowship recipients would also perform better clinically in public hospitals in the future.*

Key Word: Real-Time Impact Evaluation, Human Resource Development, Aid, Health, Laos, Korea

JEL Code: H43, H51, H52, H81, I15, I23, O15, O22, O53

### I. Introduction

The purpose of this study is to evaluate the University of Health Sciences-Dr. LEE Jong Wook-Seoul Project, a joint Laotian-Korean venture intended to improve medical training in Lao PDR. The project, which ran from 2010 to 2013, was financed by the Korea Foundation for International Healthcare (KOFIH) and executed by Korea's Seoul National University College of Medicine (SNUCM) and the University of Health Sciences (UHS) in Laos. It was administered under the purview of the health ministries of Korea and Lao PDR.

The project sought to boost the teaching and research capacities of faculty at

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UHS, the sole higher educational institution dedicated to training medical professionals in Lao PDR, via overseas training fellowships. The aim was to improve the clinical performance of doctors at public hospitals and ultimately to achieve better health outcomes for Laotians. The project was inspired by a successful USAID-financed venture that offered SNUCM faculty members training fellowships at the University of Minnesota during Korea's development era (1954-61). About 70% (77 professors) of the total faculty of SNUCM were retrained at the University of Minnesota through the USAID-financed fellowship. As a result, they not only introduced new trends in medical education methodology and organizational culture to SNUCM, but they also diffused them to other universities in Korea, contributing to improved clinical performance at hospitals across Korea (Ministry of Strategy and Finance and KDI 2013).

This evaluation is unique in several ways. First, it was done in conjunction with the launch of the project in an attempt to provide real-time feedback to the project implementation agency. Health sector projects generally require years to complete, and evaluations done after completion provide useful lessons for future follow-on projects but not for current ones, potentially wasting both time and money.

Second, the evaluation research team was independent of the project implementation staff. The Impact Evaluation Lab of the KDI School of Public Policy and Management performed the analysis without being formally commissioned by the project financing or implementation agencies. Such a real-time impact evaluation by an independent entity has been advocated by several scholars and by the World Bank (World Bank 2014 and 2008, Thomas 2011, Lee 2011, Thomas and Tominaga 2010). However, it has not been done often. This study is, therefore, a rare pilot case in Korea.

Third, this study evaluates a health project that sought to improve the human capacity of UHS faculty members, rather than their equipment or physical infrastructure, as is often the case with development cooperation projects. Therefore, this project is similar to teacher education/training projects and technical assistance projects. With such projects, evaluations can be challenging since estimating project benefits in quantitative terms, using cost-benefit analyses or impact evaluation techniques, is difficult. Therefore, past evaluations of such projects have generally used qualitative or subjective analyses (e.g., statistical analysis of the trainers' or trainees' responses to such questions as whether the training program was useful or satisfactory). However, with such qualitative or subjective analyses, it is difficult to assure stakeholders that technical assistance programs are effective or efficient (SNUCM 2013, BMZ 2011, Marcano 2009, IMF 2005).

To overcome this deficiency, the current evaluation study adopts several innovative designs in pursuit of a more rigorous, evidence-based analysis. Given that the UHS project's ultimate goal is to improve the health of Laotians by enhancing the clinical knowledge and skills of hospital doctors, to be attained by advancing their academic achievement scores during their time as students at UHS, an evaluation should examine three hypotheses. The first of these determines whether the project improves UHS students' academic achievement scores. The second ascertains whether the improved academic scores of UHS students translate into better clinical performance of UHS graduates in hospitals. The third asks



whether the enhanced clinical knowledge and skills in fact improve the health status of Laotians. This evaluation focuses only on the first hypothesis, as the project aims to advance UHS students' academic achievement scores by providing select UHS faculty members with a one-year training fellowship at the SNUCM.

This evaluation therefore adopts the unique strategy of evaluating the effectiveness of the teacher training project. It does not evaluate capacity improvement in teachers directly; instead it assesses the performance output of the trained teachers. Specifically, the improved academic achievement of the students taught by trained teachers is used as a proxy for the improved capacity to teach by the trained teachers. Many evaluation studies conducted thus far have tried to measure the trained teachers' improved capacity itself without much objective or quantitative success. Therefore, for this evaluation, a project implementation dataset containing data on the academic achievement progress of UHS students before and after the initiation of the project was compiled. Here, the UHS students are divided into two groups: one group taught by UHS faculty members trained at SNUCM under the project's fellowship (the treatment group), and the other taught by UHS faculty members who have not received such training (the control group). A comparison of the academic achievement levels of the two groups before and after the project fellowship will show whether the treatment group has in fact made greater academic progress.

The evaluation team used the difference-in-differences regression analysis method to test the hypothesis that the project fellowship training improved the academic achievement levels of UHS students. The difference-in-differences regression analysis method confirmed that the academic improvement achieved by the UHS students taught by project-trained UHS faculty members (the treatment group students) exceeded that of the control group, who were not taught by project-trained faculty members. Various analyses support this finding, boosting the robustness of the test.

Although this project clearly helped to improve UHS students' academic achievement levels, there is no assurance that such an improvement will translate into better clinical performance by UHS graduates in hospitals. Thus, the evaluation team concludes that the ultimate objective of the project - improving the health status of Laotians - will likely not be attained solely by improving the human capacity of UHS faculty members and the academic achievement level of UHS students. Assurances with regard to achieving this objective will also require proof that the improved academic achievements of UHS students will translate into enhanced clinical performance by the same UHS students in hospitals upon their graduation. Such a test will have to be conducted as part of a conventional evaluation upon the completion of the implementation of the project.

The remainder of this study is organized as follows. The second section profiles the health statuses of Laotians and the status of UHS upon the inception of the project. The third section presents the results of the difference-in-differences regression analysis with the project implementation dataset, describing UHS students' academic achievement levels. The final section provides concluding remarks and recommendations.

## II. The Status of Lao People's Health and UHS

### A. The Health Status of Lao People

Lao PDR is classified by the U.N. as one of the least developed countries, with a 2013 per capita GNI of approximately \$1,460. Although the total fertility rate now stands at 3.1 children and has been declining, Lao PDR has a young population with a median age of 21 years and with about 38% under the age of 15. Approximately two-thirds of the population lives in rural areas with a relatively sparse density (26 per square kilometer).

Total health expenditure per capita is estimated at \$84. The health status of the population can be characterized as follows: a high mortality rate of 72 per 1,000 children under 5, a low rate of immunization against measles of approximately 50% of children aged 12-23 months, and an HIV prevalence rate of 0.1% of the population aged 15-49. Topping all causes of deaths, acute respiratory infections account for 20% of all deaths among children under 5 years of age. In addition, nearly 61% of children under age 5 suffer from diarrhea and receive oral rehydration therapy. The maternal mortality rate is also high at 220 per 100,000 live births.

### B. The University of Health Sciences

The University of Health Sciences (UHS) is the sole institution of higher medical education in Lao PDR, and is a part of the Lao Ministry of Health. Before its reorganization in May of 2007, the faculty of UHS belonged to the National University of Laos under the Ministry of Education.

Currently, UHS has seven faculty groups, or divisions, including the Faculty of Basic Sciences and the Faculty of Medicine, the mainstay of medical education at UHS. It should be noted that the Dr. LEE Jong-Wook-Seoul Project is mainly partnering with these two faculty groups. Future collaborations between SNUCM and UHS may involve other faculty groups as well.

TABLE 1—UHS PROFILE

Faculty	Length of training	Degree/Diploma	Student Intake per Year	Student Enrollments (2009-2010)	Number of Professors
Basic Sciences	3 years or 1		~ 600	1,151	29
Medicine	6 years	Bachelor	~ 300	787	26
Dentistry	6 years	Bachelor	~ 100	558	47
Pharmacy	5 years	Bachelor	~ 100	734	28
Nursing	3 years	Higher level diploma	~ 100	692	28
Medical Technology	3 years	Mid-level diploma	~ 150	566	44
Post-graduate	1.5 or 3 years	Master Residency	~ 6-15	218	13
Total				4,706	215

Source: KDI School (2014)

In the academic year of 2009-2010, the total UHS student enrollment stood at 4,706, and the total faculty members stood at 215. The durations of the degree programs and the sizes of the student body and faculty vary across the constituent faculty groups. The details are presented in Table 1.

The number of incoming students has increased rapidly in recent years due to government policy. As a result, for the academic year of 2010-2011, there were 161 sixth-year students in the Faculty of Medicine, whereas there were nearly 400 first-year students in the Faculty of Basic Science. The upsurge in student enrollment is mainly due to increases in the numbers of special students not selected through the competitive entrance examination. Except for the obligation to pay tuition and fees at a rate seven times higher, special students, who accounted for 55% of the total number of enrolled students in 2010, are treated equally to regular students.

UHS adopted a new integrated curriculum in 2002 with support from the Canadian government. The new curriculum aims to train doctors so that they are capable of “working in hospitals or any other community facilities in Laos, with the adequate knowledge, skills and attitudes necessary to improve the health of people.” Under the curriculum, fourth-year and fifth-year students spend their mornings at central hospitals for clinical training, while fifth-year students engage in in-field community practice for one month. In the sixth year, students receive day-long clinical training at hospitals. The quality of hospital services is poor, and it is difficult for students to learn good practices. Moreover, too many students are assigned to each professor to realize effective learning. On average, approximately 32 students are assigned per professor for clinical training, and occasionally the professors are unavailable to students.

The current educational environment at UHS can be described as minimal and in need of a major upgrade. A comparison between UHS and SNUCM in terms of basic aspects is striking. There are 55 professors in the combined faculty of the Basic Science and Medicine departments at UHS, whereas there are 503 professors at SNUCM. There are approximately 39 students per professor at UHS, much greater than the ratio of 1.3 at SNUCM. Classrooms are scarce at UHS, and the existing classrooms are inadequate for large classes because they have a flat floor. There are only a few laboratories with limited equipment and small class size capacities. The library has about 4,000 vintage books in different languages, and it can accommodate only 50 students in its reference room.

### **III. Impact of the Project Fellowship on UHS Students' Academic Scores**

#### *A. Methodology*

Since schooling at UHS lasts at least six years, an excessive amount of time beyond the project implementation period would be required to test whether the UHS faculty members trained under the project indeed improved the clinical performance level of UHS graduates.

However, it takes relatively less time during the project to test whether the project-trained UHS faculty members improved their students' academic

achievement levels. We therefore measured the project's impact on UHS students' academic achievement levels during the project implementation period.

For this test, we used a quasi-scientific trial design. The UHS students taught by the project-trained UHS faculty members were designated as a treatment (experimental) group. The students taught by UHS faculty members not trained under the project were designated as a control group. The academic achievement levels of these groups before and after the project were compared.

The difference-in-differences (DID) regression analysis method was used for the comparison. In addition, the fixed effects of the specific course and year observed were also controlled. The model used for the DID analysis method was as follows:

$$(1) \quad Grade_{ijt} = a + bTC_{ijt} + c F\_Year_{ijt} + d (TC_{ijt} * F\_Year_{ijt}) + fG_{ijt} + gS_{ijt} + hAge_{ijt} + k Experience_{ijt} + E_{ijt}$$

The nomenclature is as follows:

*Grade<sub>ijt</sub>* : The dependent variable represents the academic achievement of student *i* (1 to 5th-year students) for subject course *j* taken in year *t* (the official range is 0.0-4.0),

*TC* : A dummy variable representing either the treatment or the control group (treatment group=1; control group=0),

*F\_Year* : A dummy variable representing either before or after the LEE Fellowship year (before= 0 for 2008-2009, 2009-2010, 2010-2011; after=1 for 2011-2012, 2012-2013, depending on the year the courses were offered),

*G* : A dummy variable representing the gender of the students (male=1; female=0);

*S* : A dummy variable representing the status of the students (regular status=1; special status=0)

*Age* : Age of student *i* taking course *j* during *t* year,

*Experience* : Teaching experience (number of years) of instructors teaching course *j* during year *t*,

*a* : the constant term,

*b, c, d, f, g, h* and *k* : Coefficient of the independent variables, and

*E* : error term.

The key coefficient of this DID model is “d” of the interaction term (*TC\*F\_Year*). If it is positive, the trained faculty helped improve the students' grades.

The model was estimated with the pooled ordinary least squares method while controlling for the specific effects of each course and year, as the data are not panel data in a strict sense. Each student observed in different years does not represent the same student, and the years observed differ for each course.

### B. Data and Sources

Altogether, 16 UHS faculty members received project training in 2010-2011 and 2011-2012. Of these, 10 faculty members taught courses upon their return. They taught 19 subject courses as part of a teaching team before (2008-2009, 2009-2010, and/or 2010-2011) and after (2011-2012 and/or 2012-2013) the training. During the period under review, all courses offered at UHS were taught by a team-teaching method. The remaining six faculty members, who did not teach either before or after the Dr. LEE Fellowship award, were excluded from the definition of the treatment group.

The UHS faculty members who did not receive training taught approximately 23 courses as part of a teaching team before and after the project period (excluding those courses offered for sixth-year students and languages and social science courses). These types of courses tended to be taught by more experienced faculty members who were not considered for the Dr. LEE Fellowship, with a focus on improving the capacity of relatively young faculty members first. In fact, only one course was eligible for the control group, as the data representing students' characteristics were not available for the remaining courses.

All data were sourced from the UHS administration during 2010-2013.

The descriptive statistics are as follows:

TABLE 2—DESCRIPTIVE STATISTICS

#### ALL SAMPLES (TREATMENT AND CONTROL)

Variable	Obs	Mean	Std. Dev.	Min	Max
TC	17598	0.969883	0.170914	0	1
F_year	17598	0.297591	0.457212	0	1
TC *F_year	17598	0.276736	0.447398	0	1
Grade	17212	2.178422	0.854028	0	4
Age	17068	23.00451	4.935232	14	51
Gender	17598	0.443062	0.496762	0	1
Status	17549	0.370904	0.483061	0	1
Experience	17598	4.857787	2.140159	1	8
Zscore	17212	0.021672	1.004739	-2.54118	2.16471

#### TREATMENT GROUP ONLY (TC=1)

Variable	Obs	Mean	Std. Dev.	Min	Max
TC	17068	1	0	1	1
F_year	17068	0.285329	0.451584	0	1
TC *F_year	17068	0.285329	0.451584	0	1
Grade	16683	2.177576	0.854762	0	4
Age	17068	23.00451	4.935232	14	51
Gender	17068	0.443051	0.496761	0	1
Status	17019	0.366943	0.481985	0	1
Experience	17068	4.760214	2.099139	1	8
Zscore	16683	0.020677	1.005604	2.54118	2.16471

TABLE 2—DESCRIPTIVE STATISTICS (*CONTINUED*)

## CONTROL GROUP ONLY (TC=0)

Variable	Obs	Mean	Std. Dev.	Min	Max
TC	530	0	0	0	0
F_year	530	0.692453	0.461914	0	1
TC *F_year	530	0	0	0	0
Grade	529	2.205104	0.830863	1	4
Age	0				
Gender	530	0.443396	0.497255	0	1
Status	530	0.498113	0.500469	0	1
Experience	530	8	0	8	8
Zscore	529	0.053063	0.977487	-1.36471	2.16471

*C. Estimation Results*

The results of the estimation are summarized in the following table. Equation (1) was estimated first without controlling for the fixed effects of each course and year (1B).

In the estimation of the model without course and year fixed effects controlled (1B), the coefficients of all variables were significant, except for the age variable, which was deleted by the computer program during the estimation process due to possible multi-collinearity or missing observations. During the entire period observed, male students achieved less than female students, regular students performed better than special students, the grades of the treatment group declined, students taught by more experienced instructors performed worse, and the grades of all groups after the fellowship period declined at the one percent significance level. However, when those factors were controlled, the grades of the treatment group were higher after the fellowship award relative to those of the control group by 0.29 percentage points at the one percent significance level. Therefore, we can attribute the higher grades of the treatment group to the Dr. LEE fellowship.

In the estimation of Equation (1) with course and year fixed effects controlled (1A), coefficients did not change significantly. The coefficient “d” of the interactive term changed from 0.29 to 0.33 with the same degree of significance, indicating that the treatment group (students taught by former Dr. LEE Fellows) had higher scores after the initiation of the fellowship program in 2010. All other coefficients maintained the same sign and degree of significance, except that the gender variable coefficient become more significant at the one percent level, the *F\_Year* variable became statistically insignificant, meaning that the scores of all students (the treatment and control groups combined) did not change before and after 2010, and the TC variable was deleted due to the time-invariable nature of the variable. Therefore, the robustness of our estimation of Equation (1) was enhanced when it was tested with and without controlling for course and year fixed effects.

TABLE 3—ESTIMATION RESULTS OF THE DIFFERENCE-IN-DIFFERENCES REGRESSION ANALYSIS

Variables	(1A) with fixed effects controlled	(1B) without fixed effects controlled
TC		-0.243*** (0.0679)
F_Year	-0.0724 (0.0843)	-0.338*** (0.0800)
TC*F_Year	0.328*** (0.782)	0.294*** (0.0812)
Gender	-0.0388*** (0.0133)	-0.0302** (0.0131)
Status	0.203*** (0.0139)	0.219*** (0.0136)
Experience	-0.0124 (0.0141)	-0.00676** (0.00310)
Constant	2.475*** (0.0599)	2.398*** (0.0721)
Observations	14,913	17,165
R-squared	0.074	0.018

Note: The dependent variable is the students' grade scores for each of 20 subject courses. Robust standard errors are in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Course and year fixed effects are controlled in the regression but are not reported in the table.

#### D. Further Robustness Tests of the Estimation Results

It is important to note several caveats pertaining to this study thus far. First, up to this point, only one course is considered as a control group due to the difficulty in obtaining data on each student's characteristics during the period before the Dr. LEE Fellowship was offered. We can increase the number of subject courses taught by the control group (non fellows). Instead of observing individual students' academic achievement levels, therefore, the average score in each of all subject courses offered by UHS can be observed before and after the Dr. LEE Fellowship award (except for the language and social studies courses). We can also control for the fixed effects of the course and year observed.

Second, we can refine the definition of the treatment group. The basic estimation model would define the treatment group as the courses taught by the former Dr. LEE Fellowship awardees as part of the teaching team (TC). Another way to define the treatment group is to use the share of the former Dr. LEE Fellowship awardees out of the total number of teachers on the teaching team for each course (SFT). Still another way is to define the treatment group as the share of former Dr. LEE Fellowship awardees' teaching hours out of the total number of team teaching hours for each course (SFH). We can then observe each course once before 2010-2011 (either 2008 or 2009) and once after 2010-2011 (either 2012 or 2013) when the LEE Fellowship was awarded, depending on the year each course was offered. The revised models, therefore, can be specified as follows.

$$(2) \quad \text{Average Score}_{jt} = a + bTC_{jt} + c F\_Year_{jt} + d (TC_{jt} * F\_Year_{jt}) + E_{jt}$$

$$(3) \quad \text{Average Score}_{jt} = a + bSFT_{jt} + c F\_Year_{jt} + d(SFT_{jt} * F\_Year_{jt}) + E_{jt}$$

$$(4) \quad \text{Average Score}_{jt} = a + bSFT_{jt} + c F\_Year_{jt} + d(SFH_{jt} * F\_Year_{jt}) + E_{jt}$$

All courses offered by the UHS were included (a total of 46 courses), excluding social studies and language courses. They were divided into 24 treatment group courses taught by the Dr. LEE Fellowship beneficiaries and 22 control group courses taught by the non-fellows. However, the treatment group courses (TCs) are expressed here by “1” if the course was taught by Dr. LEE Fellowship recipients (Equation (2)) as well as by the share of the Dr. LEE Fellowship recipients out of the total number of team teaching members for each treatment course (SFT) (Equation (3)), or the share of hours taught by the Dr. LEE Fellowship awardees out of all team teaching hours for each course (SFH) (Equation (4)). The average grades (scores) of the treatment and control group courses were observed one year in each case before the Fellowship award (either 2008-2009, 2009-2010, or 2010-2011) and once after the Fellowship award (either 2011-2012 or 2011-2013), depending on the courses offered. The basic DID model to control for the fixed effects of each course and year was used to confirm whether the grades (scores) of the treatment group courses increased more than those of the control group courses since the Dr. LEE Fellowship award. All of the other variables of the models are defined in the manner of Equation (1). A summary of the statistics is given below.

TABLE 4—DESCRIPTIVE STATISTICS (BASIC TC MODEL: EQUATION (2))

When a Treatment Group is Defined as  
Those Courses Taught by Dr. LEE Fellowship Awardees (TC),  
It Has a Value of One. The Control Group Has a Value of Zero.

ALL SAMPLES (BOTH TREATMENT AND CONTROL GROUPS)

Variable	Obs	Mean	Std. Dev.	Min	Max
F_Year	92	0.5	0.50274	0	1
Score	92	2.375611	0.380398	1.56936	3.36861
TC	92	0.521739	0.502264	0	1
TC*F_Year	92	0.26087	0.441515	0	1

TREATMENT GROUP ONLY (TC=1)

Variable	Obs	Mean	Std. Dev.	Min	Max
F_Year	48	0.5	0.505291	0	1
Grade	48	2.260593	0.245847	1.83958	2.85821
TC	48	1	0	1	1
TC*F_Year	48	0.5	0.505291	0	1

CONTROL GROUP ONLY (TC=0)

Variable	Obs	Mean	Std. Dev.	Min	Max
F_Year	44	0.5	0.505781	0	1
Grade	44	2.501085	0.457483	1.56936	3.36861
TC	44	0	0	0	0
TC*F_Year	44	0	0	0	0



TABLE 5—DESCRIPTIVE STATISTICS (EQUATION (3)):

When a Treatment Group is Defined as  
a Positive Share of the Dr. LEE Fellowship Recipients out of the Total Number of  
Team Teaching Members for Each Treatment Course (SFT),  
the Control Group Has a Value of Zero.

## BOTH TREATMENT AND CONTROL GROUPS

Variable	Obs	Mean	Std. Dev.	Min	Max
F_year	92	0.5	0.50274	0	1
Score	92	2.375611	0.380398	1.56936	3.36861
Share_tch (SFT)	92	0.09622	0.117534	0	0.6
F_year*SFT	92	0.050284	0.103871	0	0.6

## TREATMENT GROUP ONLY

Variable	Obs	Mean	Std. Dev.	Min	Max
F_year	48	0.5	0.505291	0	1
Score	48	2.260593	0.245847	1.83958	2.85821
Share_tch (SFT)	48	0.184422	0.100669	0.071429	0.6
F_year*SFT	48	0.096378	0.127877	0	0.6

## CONTROL GROUP ONLY

Variable	Obs	Mean	Std. Dev.	Min	Max
F_year	44	0.5	0.505781	0	1
Score	44	2.501085	0.457483	1.56936	3.36861
Share_tch (SFT)	44	0	0	0	0
F_year*SFT	44	0	0	0	0

TABLE 6—DESCRIPTIVE STATISTICS (EQUATION (4)):

When the Treatment Group is Defined as a Positive Share of  
Dr. LEE Fellowship Awardees' Teaching Hours Out of  
the Total Number of Team Teaching Hours for Each Course (SFH),  
the Control Group Has a Value of Zero.

## BOTH TREATMENT AND CONTROL GROUPS

Variable	Obs	Mean	Std. Dev.	Min	Max
F_year	92	0.5	0.50274	0	1
Score	92	2.375611	0.380398	1.56936	3.36861
Share_hr (SFH)	78	0.084315	0.124387	0	0.37931
F_year*SFH	78	0.042157	0.097654	0	0.37931

## TREATMENT GROUP ONLY

Variable	Obs	Mean	Std. Dev.	Min	Max
F_year	48	0.5	0.505291	0	1
Score	48	2.260593	0.245847	1.83958	2.85821
Share_hr (SFH)	34	0.193428	0.119819	0.033898	0.37931
F_year*SFH	34	0.096714	0.129674	0	0.37931

TABLE 6—DESCRIPTIVE STATISTICS (EQUATION (4)) (CONTINUED)

CONTROL GROUP ONLY					
Variable	Obs	Mean	Std. Dev.	Min	Max
F_year	44	0.5	0.505781	0	1
Score	44	2.501085	0.457483	1.56936	3.36861
Share_hr	44	0	0	0	0
F_year*SFH	44	0	0	0	0

TABLE 7—ESTIMATION RESULTS OF THE DID ANALYSIS WITH THE TC, SFT, AND SFH VARIABLES

Dependent variable	Average Grade of Each of Courses					
	(2A)	(2B)	(3A)	(3B)	(4A)	(4B)
Independent Variables	With Fixed Effects Controlled	Without Fixed Effects Controlled	With Fixed Effects Controlled	Without Fixed Effects Controlled	With Fixed Effects Controlled	Without Fixed Effects Controlled
F_Year	0.0105 (0.0974)	-0.0408 (0.107)	0.0975 (0.0792)	-0.00663 (0.0991)	0.129 (0.103)	0.0100 (0.108)
TC (course with Fellow teacher)	-	-0.370*** (0.106)				
TC*F_Year	0.205** (0.0895)	0.254* (0.149)				
Share of Fellow Teacher (SFT)			-1.684 (1.213)	-1.490*** (0.513)		
F_Year*SFT			1.068** (0.456)	1.131* (0.665)		
Share of Fellow Hour (SFH)					-	-0.910* (0.508)
F_Year*SFH					0.671 (0.415)	0.892 (0.719)
Constant	2.653*** (0.148)	2.521*** (0.0762)	2.343*** (0.295)	2.465*** (0.0716)	2.006*** (0.170)	2.435*** (0.0760)
No. of Observations	92	92	92	92	78	78
R-squared	0.873	0.145	0.874	0.108	0.874	0.053

Note: Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Course and year fixed effects are controlled in the regression, but are not reported in the table.

The estimation results of the DID analysis with TC, SFT, and SFH variables are presented in table 7. As shown in model (1) or (2), the average score of the treatment group courses (TC) were lower than that of the control group courses. However, after the LEE Fellowship training opportunity was given during 2010-2011, the grades of the treatment group (courses taught by Dr. LEE fellows trained at SNUCM) were higher than those of the control group courses (taught by non-fellows) by 0.205 or 0.254 percentage points at the one or five percent significance levels ( $TC*F\_Year$ ). Therefore, we can attribute the treatment group's higher grades after the LEE Fellowship award to the training program at SNUCM.

Moreover, when the treatment group was defined in a more refined way (models

3-6), the coefficient of the interactive terms ( $F\_Year*SFT$  and  $F\_Year*SFH$ ) becomes greater. This means that since the LEE Fellowship award, the average grades of the treatment group courses have become higher (by 1.068 or 0.671) than those of the control group courses. Therefore, the robustness of the estimation results based on each student's achievement score (equation (1)) has been confirmed positively. (Only when the SFH variable was used, the coefficient of the interactive term was not significant statistically even at the 10% level.).

#### IV. Conclusions and Recommendations

In early 2011, a KDI School research team launched a real-time impact evaluation of the University of Health Sciences (UHS)-Dr. LEE Jong Wook-Seoul Project. The design of the project is based on the premise that the project's final outcome, i.e., improvements in the health status of Laotians, will be achieved by enhancing the clinical performance capacity of the practicing doctors, to be attained by increasing academic achievement scores at UHS.

Therefore, the main focus of the real-time impact evaluation was to assess whether the project's one-year fellowship training of select UHS faculty members at SNUCM has indeed resulted in advancing the academic achievement scores of the UHS students during the project implementation.

Our real-time impact evaluation team conducted difference-in-differences regression analyses and showed that the project improved UHS students' academic achievement levels. In the analysis of the academic achievement scores of students in their first through their fifth years obtained before and after the Dr. LEE fellowship training periods, the UHS students did achieve a greater advancement in the courses taught by the project fellowship recipients as compared to other subjects taught by the non-fellows, even after controlling for the students' gender, age, and status, and for the fixed effects of years or courses.

It remains to be determined several years after the project has been implemented whether these UHS students taught by the LEE fellowship recipients would perform better clinically in public hospitals compared to UHS students taught by non-fellows in the future. The follow up project (the Second UHS-LEE Jong-Wook-Seoul project) should finance the collection of data on the academic achievement and clinical performance levels of UHS graduates working at public hospitals who were taught by SNUCM-trained faculty members so that a rigorous ex-post impact evaluation can be carried out in due course.

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