An Analysis on the Effect of Old Age Dependency Ratio on Domestic Saving Rate

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Abstract

As continuously studied by numerous papers, demographic factors are expected to be crucial components that affect the saving rates of countries. This paper investigates the correlation between the domestic saving rates and the old age dependency ratio, by examining the data set of 15 high income countries from 1975 to 2010, based on hypothesis that old age dependency ratio is negatively correlated with the domestic saving rate. Other four explanatory variables, young age dependency ratio, short-term interest rate, unemployment rate, and GNI per capita, are also used as regressors in econometric models. The results of this paper, however, illustrate that the OADR has no significant effect on the domestic saving rates, while GNI per capita is found to be a sole factor that is statistically significantly correlated, consistently throughout the regression results.

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I. Introduction

Saving rate has been continuously investigated by economists, since it is regarded as one of crucial components that determines the long-term economic growth of countries. If consumption of any subject equals or exceeds production, no capital will be accumulated to generate or handle enough investment that is necessary for economic growth. Thus, failure to achieve sufficient saving rate will jeopardize the sustainability of growth, even when the economy is booming at the certain period.

While there are numerous factors, such as interest rates, size of real disposable income, consumer confidence, and etc., which affect the saving rates, this paper mainly examines and focuses on effects of demographic factors, especially the old age dependency ratio, on domestic saving rate, using various econometric approaches to figure out the correlation between independent variables and dependent variable. Thus, this paper explore how economic burdens due to increasing old age dependency ratio affects the saving rate of households, and, further, the saving rate of countries.

Historically, there have been many researches that explore the relationships between saving rates and demographic factors. Coale and Hoover (1958) introduced the youth-dependency thesis[1], which argues that higher ratio of the youth in population distribution will induce lower saving rate. Also, Fry and Mason (1982) and Mason (1988) state that presence of children induces households to increase consumption and decrease saving. The lower saving rate due to high youth-dependency ratio, however, has been somewhat mitigated in most developed

[1] Note that this paper uses the term 'young age dependency ratio' rather than youth-dependency ratio.

and rapidly developing countries, throughout the decades, as fertility rates have been gradually declined in most high-income countries.

Due to longer life expectancy and sustained lower fertility rate, characteristics which are seen in most developed and rapidly developing countries, old age dependency ratio (OADR) is gradually increasing, implying lower saving rate. Higgins and Williamson (1997) and Higgins (1998) point out that old age dependency ratio is also crucial component to explain saving rates, establishing theories that address negative correlation between old age dependency ratio and saving rate. This paper partly follows the argument of Higgins (1998), which connotes that the saving rate will be lower when old age dependency ratio is higher.

Moreover, life cycle hypothesis of saving proposed by Modigliani (1970) largely contributes to establish the argument of this paper. As stated by Modigliani (1970), individuals plan their consumption and tend to save for their lives after retirements to consume evenly over their entire lifetimes because people are believed to favor stable lives. Mainly because the labor supply is not smooth over time, individuals are less likely to save after their retirements when they earn no stable income. Thus, higher old age dependency ratio indicates larger proportion of population without stable earnings and lower saving rates.

In perspective of the model and method of research, however, this paper does not particularly follow a model or a method developed or used in researches and papers discussed above. While many researches generally include large number of countries in data set, this paper focuses more on 15 highly developed and rapidly growing countries. In process, countries with substantial missing values for any variable were excluded to maintain the data set to be balanced panel data set rather than unbalanced panel data set, as well. Also, to ensure the validity of research in relatively recent period, this paper focuses on data set from 1975 to 2010. Thus, our basic data set is country-level balanced panel data set of 15 countries, spanned over 36 years from 1975 to 2010. Each variable has 540 valid observations. The other contribution of this paper is that it also explores the data set with different time scale other than yearly values of data set. For each variable, by taking means of values of three consecutive years, this paper explores the correlation between dependent and independent variable more closely. In terms of explanatory variables, old age dependency ratio[2], young age dependency ratio[3], interest rate, unemployment rate, and income level are examined. Both pooled ordinary least square (OLS) regression and fixed effect regression are used as econometric methods to explore correlations between variables.

The empirical results of this paper indicate, however, demographic factors, including OADR, are not significantly correlated with the domestic saving rate. OADR has negative effect on domestic saving rate only in data sets without first differencing. Moreover, unemployment rate and short-term saving rate are not affecting the domestic saving rate as this paper proposes in section III. GNI per capita is the only factor that is significantly correlated with the domestic saving rate.

The following section will provide details of data set used in this paper. Section III will discuss the hypothesis of the paper. Section IV will show the model and method used in each regression. In Section V, the results of regression will be analyzed. Section VI will discuss potentially omitted variables. Section VII will conclude.

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[2] In this paper, old age dependency ratio is a value of population older than 65 years old divided by population between 15 and 64 years old.
[3] In this paper, young age dependency ratio is a value of population younger than 15 years old divided by population between 15 and 64 years old.

II. Variables and Data Set

In Section II, details of data set used in this paper are introduced. This paper examines country-level data set spanned from 1975 to 2010 of 15 highly developed or rapidly developing countries to verify the correlation between demographic factors and domestic saving rates. Data set is treated as a balanced panel data with 15 cross-sectional units and 36 time period, unless it is specifically notified in relevant regression analysis[4].

Domestic saving rate, which is the dependent variable of this research, is used to measure the saving behaviors of countries. The data set for domestic saving rate for each country is collected from World Bank. Although it is more effective to closely investigate the personal saving rate rather than domestic saving rate, which may accidently include savings of other economic subjects, this paper only regress domestic saving rate as main dependent variable, due to difficulty of collecting personal saving rates for countries. For few missing data set of domestic saving rate, they are gathered from OECD statistics department, as most of countries included in this paper are members of OECD. Rather than using gross domestic savings as stock data, this paper observes the ratio of gross domestic savings to Gross Domestic Production (GDP), to internally control the increase in domestic savings due to the increase in GDP of countries. The data set of GDP, which is used to calculate such ratio, is also collected from World Bank. The unit for saving rate in this paper is % (percent).

There are two demographic factors to be used as explanatory variables. Old age dependency ratio (OADR), which is the main explanatory variable of this paper, is defined as the

[4] In later parts of this paper, the data set are modified as 15 cross-sectional units and 12 time period by taking means of yearly data for three-year period, to perform a different type of regression, based on the argument that OADR does not significantly change annually. It is explained with details in relevant section.

ratio of population older than 65 years old to working population, which is defined as population between 15 and 64 years old. OADR is directly collected from United Nations Population Division. Young age dependency ratio (YADR), which is another demographic factor examined in this research, is the ratio of population younger than 15 to population between 15 and 64 years old. Similar to OADR, YADR is directly collected from United Nations Population Division. The unit for both OADR and YADR is % (percent), which is the same unit for our domestic saving rate.

Other than demographic factors, this paper also examines interest rate, unemployment, and income level as additional explanatory variables. For interest rate, this paper uses short-term interest rate, assuming savings of households are affected more strongly by short-term interest rate than long-term interest rate. Generally, interest rate is considered to be a huge factor that affects the savings of economic subject, therefore, it is difficult to accurately measure the effect of demographic factors without including interest rate as an explanatory variable. The data set of interest rate are gathered from World Bank, Global Financial Data, OECD statistics department, and other regional statistics departments for few countries. The sources of such data set include Statistics Belgium, Luxembourg National Statistics Institute, Statistics Norway, and Eurostat, offered by European Commission.

Unemployment rate is also considered to be an important factor because it affects the availability of saving for households. The data set of unemployment are largely collected from International Labour Organization (ILO), using ILOSTAT service offered by ILO. Unit for both short-term interest rate and unemployment is % (percent).

Lastly, GNI per capita is used as a measure of income in this paper. All of the data set for GNI per capita are collected from World Bank. The unit for GNI per capita is $ (dollar) for all countries examined in this paper, rather than LCUs. The data set for GNI per capita is adjusted to inflation by World Bank, which is the provider of data set.

III. Hypothesis

As previously mentioned in Section I, many researches have contributed to establish the basic argument of this paper. Thus, hypothesis that this paper is testing largely follows those of Coale and Hoover (1958), Mason (1988), and Higgins (1998).

The main hypothesis of this paper is that old age dependency ratio is negatively correlated with domestic saving rate, as economic burden due to larger proportion of non-working population hampers the economy from generating savings. Moreover, as life cycle hypothesis argued by Modigliani (1970) represents, elderly population is expected to save less than working-age population. This argument by Modigliani (1970) also contributes to establish the hypothesis of this paper: a negative correlation between OADR and domestic saving rate.

For young age dependency ratio, this paper assumes that it is also negatively correlated with domestic saving rates, as researched by Fry and Mason (1982) and Mason (1988). The presence of children naturally facilitates the consumption of households and impedes households from saving their income (Mason 1988). Economic burden due to higher young age dependency ratio is conceptually very similar to that due to higher old age dependency ratio, as both represent the ratio of non-working population to working population. Therefore, this paper assumes that YADR theoretically affects the domestic saving rates as OADR does.

This paper assumes the positive correlation between short-term interest rate and saving rate, because interest rate is a strong incentives for saver to save their income for larger future consumption. Similar to interest rate, GNI per capita is expected to be positively correlated with domestic saving rate. Assuming that households need to earn certain amount of income—namely I_0—for their current lives, the increase in income, which makes their incomes to be higher than I_0, may drive households to save more proportion of their income than before. Lastly, this paper assumes the negative correlation between unemployment rate and domestic saving rate, because higher unemployment rate weakens the availability for saving. As more households lose the sources of their income, it is difficult to assume that people save more when unemployment rate is higher.

IV. Models and Methods

This section introduces econometric models and methods that are used in this research. In this paper, several models and methods are employed to verify the correlation between dependent and independent variables in our balanced panel data set. In a process, the data set are slightly modified[5] to create appropriate forms for each regression. Details about the changed data set are also provided in relevant regression models and methods in this section. Moreover, such information is noted in the result of analysis in Section V when applicable.

[5] Two data sets are used in this paper. One is the original yearly data set, and the other is modified data set, which takes means of values of three years for each variable.

This paper regresses domestic saving rate, using pooled ordinary least square model. Fixed effect model, and random effect model. For each model, data set are regressed upon two different time scales. Therefore, two different data set are used for each model. Also, first difference is taken for several models to treat autocorrelation, when it is necessary. Thus, rather than sticking to one specific model or method, this paper employs various econometric techniques to explore the effects of demographic factors and other explanatory variables on domestic saving rates.

To briefly go over conceptual aspects of the models used in this paper, the general model for panel data set used in this paper is

$$y_{it} \quad = \quad x_{it}\beta + u_{it} \tag{1}$$

t = 1, 2, …, T, and *i* = 1, 2, …, I, where y_{it} is dependent variable and x_{it} are explanatory variables. The variable u_{it} denotes the residuals of model. In pooled ordinary least square model, this conceptual model is used.

For fixed effect model, α_i, which is an unobserved time-invariant individual specific effects, is added to the equation (1), generating,

$$y_{it} \quad = \quad x_{it}\beta + \alpha_i + u_{it} \tag{2}$$

t = 1, 2, …, T, and *i* = 1, 2, …, I, where we observe y_{it} and x_{it}. Again, in this equation (2), α_i denotes unobserved time-invariant individual specific effects and u_{it} denotes the error terms of model. In case of pooled ordinary least square model and fixed effect model, conceptually, no specific transformation to the general model need to be made.

In random effect model, however, the equation (2) should be transformed, because RE model in this paper uses GLS, based on assumption that $\bar{v}_i^{OLS} = (\alpha_i + u_{it})$ are serially correlated. To confirm the serial correlation of $\bar{v}_i^{OLS} = (\alpha_i + u_{it})$,

note,

$$
\begin{aligned}
\mathrm{E}\left(\bar{v}_{it}^{OLS}, \bar{v}_{i,t-s}^{OLS}\right) &= \mathrm{E}\left[(\alpha_i + u_{it})\left(\alpha_i + u_{i,t-s}\right)\right] \\
&= \mathrm{E}\,(\alpha_i^2 + \alpha_i u_{it} + \alpha_i u_{i,t-s} + u_{it}u_{i,t-s}) \\
&= \mathrm{E}\,(\alpha_i^2) \\
&= \sigma_\alpha^2
\end{aligned}
$$

and so,

$$
corr\left(\bar{v}_{it}^{OLS}, \bar{v}_{i,t-s}^{OLS}\right) = \frac{\mathrm{E}\left(\bar{v}_{it}^{OLS},\ \bar{v}_{i,t-s}^{OLS}\right)}{\sqrt{\sigma_{v_t}^2 \sigma_{v_{t-s}}^2}}
$$

thus,

$$
corr\left(\bar{v}_{it}^{OLS}, \bar{v}_{i,t-s}^{OLS}\right) = \frac{\sigma_\alpha^2}{\sigma_\alpha^2 + \sigma_u^2} \tag{3}
$$

for $s = 1, 2, 3, \ldots$, because $\sigma_{v_t}^2 = \sigma_{v_{t-s}}^2 = \sigma_\alpha^2 + \sigma_u^2$. Taking (3) into account to perform random effect model, transformation of the equation is done by multiplying $\lambda = 1 - (\frac{\sigma_u^2}{T\sigma_\alpha^2 + \sigma_u^2})^{1/2}$ to the individual average of the original equation (2). This transformation leaves us,

$$
\lambda\bar{y}_i = \lambda\bar{x}_i\beta + \lambda\bar{v}_i^{RE} \tag{3}
$$

where $\bar{\upsilon}_i^{RE}$, which is $(\alpha_i + u_{it})$, denotes residuals from random effect model. Subtracting equation (3) from equation (2),

$$y_{it} - \lambda\bar{y}_i \quad = \quad (x_{it} - \lambda\bar{x}_i)\beta + (v_{it}^{RE} - \lambda\bar{v}_i^{RE}) \tag{4}$$

Thus, by using OLS on transformed equation (4), this paper performs random effect GLS estimates to examine the correlation between dependent and independent variables.

In few regressions, the first differencing estimate is used to manage significantly high auto-correlations and to remove the individual effect. Subtracting data set of $t-1$ from data set of t in equation (2),

$$\begin{aligned} y_{it} - y_{i,t-1} \quad &= \quad (x_{it} - x_{i,t-1})\beta + (\alpha_i - \alpha_i + u_{it} - u_{i,t-1}) \\ \Delta y_{it} \quad &= \quad \Delta x_{it}\beta + \Delta u_{it} \end{aligned} \tag{6}$$

Equation (6), therefore, is the conceptual model for the regressions with first differencing estimators in this research.

Pooled ordinary least square estimator, fixed effect estimator, and random effect estimator are all performed using pre-defined commands in regression program called 'Gnu Regression, Econometrics and Time-series Library (GRETL).' For the first differencing method, the new data set are all generated by functions installed in GRETL. Other than the theoretical models for each estimator models above, the regression equation, which is used for GRETL in actual regression process, for domestic saving rate in this paper is shown below. This model uses the first data set.

$$DomSav_{it} \quad = \quad \beta_0 + \beta_1 OADR_{it} + \beta_2 YADR_{it} + \beta_3 Int_{it} + \beta_4 Unem_{it} + \beta_5 GNIper_{it} + u_{it} \tag{7}$$

where *i* = 1, 2, …, 15[6], which denote countries, and *t* = 1975, 1976, …, 2010[7], which indicate time period. β_0 denotes the constant of the equation. $DomSav_{it}$ is domestic saving rate, which is the dependent variable of this thesis, for country *i* at time *t*. $OADR_{it}$ is old age dependency ratio, which is the main explanatory variable of this paper. $YADR_{it}$ is young age dependency ratio, another demographic factor examined. Int_{it} denotes short-term interest rates for country *i* at time *t*. $Unem_{it}$ is unemployment rate and $GNIper_{it}$ is GNI per capita. And, β_1 through β_5 are coefficients for corresponding independent variables. Lastly, u_{it} indicates the residual terms in regression.

As discussed in previous sections, although this paper analyzes 36 time period from 1975 to 2010, some of regressions use only 12 time period, by taking means of values of three consecutive years to generate new data set. These regressions are based on belief that demographic factors do not substantially change frequently, compared to other variables examined in this research. In this case, the regression equation, which uses the second data set, is

$$DomSav'_{it'} \quad = \quad \beta_0 + \beta_1 OADR'_{it'} + \beta_2 YADR'_{it'} + \beta_3 Int'_{it'} + \beta_4 Unem'_{it'} + \beta_5 GNIper'_{it'} + u_{it'} \tag{8}$$

[6] Details about countries examined are in appendix of the paper.
[7] Different time period is used for several regressions and the details are explained in following paragraphs.

where *t'* = 1975-1977, 1978-1980, …, 2008-2010. Other notations of equation (8) are the same as equation (7), introduced previously. In this case, *t'* = 1975-1977 notes that the value is a mean of values of 1975, 1976 and 1977 for each variable. Therefore, the data set has 12 time period in regressions that use *t'* rather than *t*. Apostrophe[8] is indicated for each variable to easily distinguish which data set the regressions are using.

V. Econometric Results and Analysis

In this section, econometric results of regressions performed are provided. The summary statistics of variables examined in this paper are also provided. This paper employs three econometric models, pooled ordinary least square, fixed effect, and random effect, accompanied by first differencing methods, to regress domestic saving rates on five explanatory variables, OADR, YARD, short-term interest rate, unemployment rate, and GNI per capita.

Table 1 shows the summary statistics of the first data set used in regressions with 36 time period. Each variable has 540 observations, since there are 15 cross-sectional units. Note that units for all variables are % (percent), except for GNI per capita, which uses $ (dollar) as a unit.

Table 1: Summary Statistics for First Data Set, using the observations 1:01 - 15:36

Variable	Mean	Median	Minimum	Maximum
DomSav	24.6516	23.9616	11.2924	53.2301
OADR	21.1492	20.9196	11.6281	36.0183
YADR	29.7998	29.3263	20.7538	48.9255
Int	7.01022	6.17209	0.0289500	23.3050

[8] Apostrophe does not hold any specific meaning in this paper, except for notifying readers that the regressions are using our second data set in tables.

Unem	6.27039	5.80000	0.200000	16.4000
GNIper	21804.3	19599.5	5055.50	68021.7
Variable	**Std. Dev.**	**C.V.**	**Skewness**	**Ex. kurtosis**
DomSav	6.10693	0.247730	1.37612	3.76240
OADR	3.96187	0.187329	0.230205	0.00121148
YADR	4.65384	0.156170	0.637479	1.04318
Int	4.36188	0.622217	0.643114	-0.0574739
Unem	3.25842	0.519652	0.461042	-0.429189
GNIper	11768.7	0.539743	0.907369	0.825320
Variable	**5% Perc.**	**95% Perc.**	**IQ range**	**Missing obs.**
DomSav	16.3252	36.9311	5.87960	0
OADR	14.6502	27.3823	5.79951	0
YADR	21.6845	37.8846	5.69947	0
Int	0.810960	15.0098	6.29486	0
Unem	1.70000	12.0000	4.60000	0
GNIper	6755.00	41816.4	16863.1	0

Table 2 provides the summary statistics of the first data set, after taking the first differencing. Each variable has 525 valid observations, with 15 cross-sectional units and 35 time periods. Units for variables remain the same as in the table 1.

Table 2: Summary Statistics for First Data Set after taking first differencing, using the observations 1:01 - 15:36
(missing values were skipped)

Variable	Mean	Median	Minimum	Maximum
d_DomSav	-0.0457546	0.00869601	-7.16720	7.19650
d_OADR	0.178802	0.175709	-0.940957	1.37638
d_YADR	-0.343174	-0.287926	-1.54623	0.480874
d_Int	-0.198724	-0.140160	-5.71750	8.28250
d_Unem	0.0887886	0.00000	-4.70000	5.00000
d_GNIper	981.643	880.100	-11450.2	9709.70
Variable	**Std. Dev.**	**C.V.**	**Skewness**	**Ex. kurtosis**
d_DomSav	1.43697	31.4061	-0.363024	3.45869
d_OADR	0.270649	1.51368	0.312679	3.35761
d_YADR	0.382568	1.11479	-0.626664	0.00285298
d_Int	1.85446	9.33188	0.190091	1.11717
d_Unem	0.989578	11.1453	0.813317	4.87857
d_GNIper	1175.49	1.19747	-0.865092	35.6630
Variable	**5% Perc.**	**95% Perc.**	**IQ range**	**Missing obs.**

d_DomSav	-2.44742	2.18841	1.47820	15
d_OADR	-0.245606	0.593250	0.241413	15
d_YADR	-1.14223	0.185538	0.484034	15
d_Int	-3.40587	3.01492	2.04665	15
d_Unem	-1.17000	1.97000	1.00000	15
d_GNIper	-167.110	2437.52	598.150	15

Table 3 displays the summary statistics of the second data set used in regressions that examine 12 time period, taking means of values of three consecutive years from the first data set to create separate data set. For each variable, however, units remain the same as in the first data set.

Table 3: Summary Statistics for Second Data Set, using the observations 1:01 - 15:12

Variable	**Mean**	**Median**	**Minimum**	**Maximum**
DomSav’	24.6516	24.0453	11.7122	50.7663
OADR’	21.1492	21.0127	11.9814	34.6702
YADR’	29.7998	29.3291	20.7749	47.8457
Int’	7.01022	6.09235	0.0421567	19.1485
Unem’	6.27039	5.88333	0.333333	15.9333
GNIper’	21804.3	19901.0	5532.30	62168.4
Variable	**Std. Dev.**	**C.V.**	**Skewness**	**Ex. kurtosis**
DomSav’	6.02888	0.244564	1.39936	3.85797
OADR’	3.96022	0.187251	0.222494	-0.0338769
YADR’	4.64342	0.155821	0.625727	1.01213
Int’	4.14486	0.591259	0.547207	-0.408473
Unem’	3.17095	0.505702	0.410748	-0.459090
GNIper’	11733.1	0.538110	0.883238	0.686405
Variable	**5% Perc.**	**95% Perc.**	**IQ range**	**Missing obs.**
DomSav’	16.5321	37.0518	5.46289	0
OADR’	14.5951	27.4044	5.84766	0
YADR’	21.5257	37.8768	5.52853	0
Int’	1.56063	14.2274	6.40426	0
Unem’	1.76833	11.7300	4.85000	0
GNIper’	6888.09	41227.4	17638.1	0

Table 4 displays the summary statistics of the second data set, after taking the first differencing. Each variable has 165 observations, with 15 cross-sectional units and 11 time periods. Similarly, the units for variables are the same as in tables above.

Table 4: Summary Statistics for Second Data Set, after taking first differencing, using the observations 1:01 - 15:12
(missing values were skipped)

Variable	**Mean**	**Median**	**Minimum**	**Maximum**
d_DomSav'	-0.0785129	-0.139978	-4.65359	6.78385
d_OADR'	0.509622	0.502910	-1.94395	3.65396
d_YADR'	-1.01193	-0.842011	-3.92890	1.35247
d_Int'	-0.554442	-0.502673	-7.15139	5.77246
d_Unem'	0.200024	0.0666667	-4.30000	8.83333
d_GNIper'	3044.31	2703.93	-729.933	13107.6
Variable	**Std. Dev.**	**C.V.**	**Skewness**	**Ex. kurtosis**
d_DomSav'	1.97162	25.1120	0.373754	0.863840
d_OADR'	0.768722	1.50842	0.492940	2.98203
d_YADR'	1.10940	1.09632	-0.617360	-0.0336564
d_Int'	2.37694	4.28709	0.0532551	-0.120081
d_Unem'	1.79040	8.95094	0.915711	3.17077
d_GNIper'	1626.24	0.534192	2.70371	12.5047
Variable	**5% Perc.**	**95% Perc.**	**IQ range**	**Missing obs.**
d_DomSav'	-3.19108	3.25086	2.44124	15
d_OADR'	-0.699397	1.67556	0.722268	15
d_YADR'	-3.43974	0.584231	1.42805	15
d_Int'	-4.31263	3.39495	3.04100	15
d_Unem'	-2.71333	3.38667	1.83333	15
d_GNIper'	1294.12	5601.78	1354.43	15

Firstly, results of regressions using the first data set are introduced. The first model this employed is pooled ordinary least square (POLS). Domestic saving rate is regressed on explanatory variables, OADR, YADR, short-term interest rate, unemployment, and GNI per capita. Table 5 shows the results of the regression. The results show that all of explanatory variables are statistically significant at under 0.01% significance level. Moreover, as previously discussed in section III, all of variables meet the hypothesis of this paper. Demographic factors, which are OADR and YADR, are negatively correlated. Short-term interest rate, which is expected to be positively correlated, turns out to be consistent with the hypothesis. The coefficient of unemployment rate also indicates that unemployment is negatively correlated with domestic saving rate. Lastly, GNI per capita is positively correlated with the dependent variable, indicating increase in income may induce increase in saving rate. P-value for our F-statistics, which is near zero, connotes that the econometric equation we employ is valid. However, as pooled ordinary least square method generally over precisely measure the effect of independent variables on dependent variable, this model is not reliable enough. Moreover, significantly high rho-value insinuates that the first data set without first differencing has substantial auto-correlation problem.

Table 5: Pooled OLS, using 540 observations
Included 15 cross-sectional units
Time-series length = 36
Dependent variable: DomSav

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	41.0305	3.46402	11.8447	<0.00001	***
OADR	-0.398252	0.0716015	-5.5621	<0.00001	***
YADR	-0.294608	0.0684027	-4.3070	0.00002	***
Int	0.241328	0.0686589	3.5149	0.00048	***
Unem	-0.755885	0.0692775	-10.9110	<0.00001	***
GNIper	0.000177534	2.601e-05	6.8256	<0.00001	***

Mean dependent var	24.65158	S.D. dependent var	6.106926
Sum squared resid	14007.57	S.E. of regression	5.121660
R-squared	0.303167	Adjusted R-squared	0.296642
F(5, 534)	46.46483	P-value(F)	7.29e-40
Log-likelihood	-1645.289	Akaike criterion	3302.577
Schwarz criterion	3328.326	Hannan-Quinn	3312.648
rho	0.980828	Durbin-Watson	0.077698

For the second regression, the same data set are regressed by fixed effect model, as table 6 displays. In this model, OADR, short-term interest rate, and GNI per capita still follow the hypothesis made in section III. However, YADR is positively correlated with the domestic saving rate, indicating that the hypothesis is not consistent with the results. As substantially high rho-value, 0.872910, indicates, fixed effect model is not reliable.

Table 6: Fixed-effects, using 540 observations
Included 15 cross-sectional units
Time-series length = 36
Dependent variable: DomSav

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	16.2474	2.67113	6.0826	<0.00001	***
OADR	-0.410133	0.0600771	-6.8268	<0.00001	***
YADR	0.363467	0.0483596	7.5159	<0.00001	***
Int	0.123534	0.041123	3.0040	0.00279	***
Unem	0.0205803	0.0509308	0.4041	0.68632	
GNIper	0.000240866	1.62758e-05	14.7990	<0.00001	***

Mean dependent var	24.65158	S.D. dependent var	6.106926
Sum squared resid	3250.453	S.E. of regression	2.500174
R-squared	0.838300	Adjusted R-squared	0.832392
F(19, 520)	141.8860	P-value(F)	1.4e-191
Log-likelihood	-1250.872	Akaike criterion	2541.743
Schwarz criterion	2627.574	Hannan-Quinn	2575.311
rho	0.872910	Durbin-Watson	0.281563

Next regression, introduced in table 7, is based on random effect model, using the same data set as regressions above. Although some variables are consistent with the hypothesis and statistically significant, random effect also seems to be unreliable, considering Hausman test. The Hausman test rejects the null hypothesis, which argues that random effect model is consistent.

Table 7: Random-effects (GLS), using 540 observations
Included 15 cross-sectional units
Time-series length = 36
Dependent variable: DomSav

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	16.91	2.87947	5.8726	<0.00001	***
OADR	-0.409506	0.0602397	-6.7979	<0.00001	***
YADR	0.347417	0.0486924	7.1349	<0.00001	***
Int	0.122433	0.041535	2.9477	0.00334	***
Unem	0.000123936	0.051243	0.0024	0.99807	
GNIper	0.000238041	1.64209e-05	14.4962	<0.00001	***

Mean dependent var	24.65158	S.D. dependent var	6.106926
Sum squared resid	19595.32	S.E. of regression	6.052006
Log-likelihood	-1735.926	Akaike criterion	3483.851
Schwarz criterion	3509.601	Hannan-Quinn	3493.922

'Within' variance = 6.25087
'Between' variance = 16.0619
theta used for quasi-demeaning = 0.896027

Hausman test -
Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: Chi-square(5) = 19.9258
with p-value = 0.00129042

As seen in regressions above, the data set have significant auto-correlation problem. Therefore, by taking first differencing, this paper aims to have more reliable regression models. Table 8, Table 9, and Table 10 show the results of regressions, after taking first differencing. As the results of regressions in table 8 and table 9 below indicates, auto-correlation problem has been solved, using the first differencing method. All three regressions done with the first data set after taking first differencing tell us that demographic factors are not significantly correlated with domestic saving rate, while unemployment and GNI per capita are statistically significantly correlated with dependent variable. The coefficients of unemployment rate and GNI per capita show that the results are consistent with the hypothesis made in section III of this paper. It is notable that the signs of coefficients of unemployment and GNI per capita are consistent in regression results provided in table 8, table 9, and table 10. Unemployment seems to be negatively correlated with the domestic saving rate, while GNI per capita is positively correlated with the domestic saving rate. Moreover, as Hausman test in table 10 indicates, random effect model seems to be more reliable than fixed effect model. Considering all aspects of results, the random effect model in table 10 seems to be quite reliable to verify the correlation between OADR and domestic saving rate, and it is expected that OADR is not strongly correlated with domestic saving rate empirically.

Table 8: Pooled OLS, using 525 observations
Included 15 cross-sectional units
Time-series length = 35
Dependent variable: d_DomSav

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	-0.563204	0.104993	-5.3642	<0.00001	***
d_OADR	-0.116264	0.203535	-0.5712	0.56810	
d_YADR	-0.169024	0.148165	-1.1408	0.25449	
d_Int	-0.0167362	0.0329653	-0.5077	0.61189	
d_Unem	-0.322699	0.061349	-5.2601	<0.00001	***
d_GNIper	0.000515013	4.88217e-05	10.5488	<0.00001	***

Mean dependent var	-0.045755	S.D. dependent var	1.436972
Sum squared resid	789.5968	S.E. of regression	1.233443
R-squared	0.270245	Adjusted R-squared	0.263214
F(5, 519)	38.43946	P-value(F)	1.41e-33
Log-likelihood	-852.0753	Akaike criterion	1716.151
Schwarz criterion	1741.731	Hannan-Quinn	1726.167
rho	0.043926	Durbin-Watson	1.844659

Table 9: Fixed-effects, using 525 observations
Included 15 cross-sectional units
Time-series length = 35
Dependent variable: d_DomSav

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	-0.617832	0.116121	-5.3206	<0.00001	***
d_OADR	0.0944512	0.264426	0.3572	0.72110	
d_YADR	-0.218039	0.16209	-1.3452	0.17917	
d_Int	-0.0213774	0.0333706	-0.6406	0.52207	
d_Unem	-0.329029	0.0621061	-5.2979	<0.00001	***
d_GNIper	0.00051478	4.99223e-05	10.3116	<0.00001	***

Mean dependent var	-0.045755	S.D. dependent var	1.436972
Sum squared resid	777.4200	S.E. of regression	1.240744
R-squared	0.281499	Adjusted R-squared	0.254466
F(19, 505)	10.41326	P-value(F)	3.30e-26
Log-likelihood	-847.9956	Akaike criterion	1735.991
Schwarz criterion	1821.259	Hannan-Quinn	1769.380
rho	0.030873	Durbin-Watson	1.873694

Table 10: Random-effects (GLS), using 525 observations
Included 15 cross-sectional units
Time-series length = 35
Dependent variable: d_DomSav

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	-0.563204	0.104993	-5.3642	<0.00001	***
d_OADR	-0.116264	0.203535	-0.5712	0.56810	
d_YADR	-0.169024	0.148165	-1.1408	0.25449	
d_Int	-0.0167362	0.0329653	-0.5077	0.61189	
d_Unem	-0.322699	0.061349	-5.2601	<0.00001	***
d_GNIper	0.000515013	4.88217e-05	10.5488	<0.00001	***

Mean dependent var	-0.045755	S.D. dependent var	1.436972
Sum squared resid	789.5968	S.E. of regression	1.232256
Log-likelihood	-852.0753	Akaike criterion	1716.151
Schwarz criterion	1741.731	Hannan-Quinn	1726.167

'Within' variance = 1.53945
'Between' variance = 0.014545
theta used for quasi-demeaning = 0

Hausman test -
Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: Chi-square(5) = 5.09905
with p-value = 0.403913

To briefly note about the results about OADR, which is the main explanatory variable we examine, using the first data set, it is notable that OADR is negatively correlated with the high statistical significance, before taking the first differencing. However, since there is substantial issue of auto-correlation, first three results displayed in table 5, table 6 and table 7 are not fairly reliable. After taking the first differencing, it is suggested that OADR is not correlated with the domestic saving rate. The other significant result this paper figures out of six regressions performed is that GNI per capita, the measure of income, is statistically significantly correlated with the domestic saving rate in all of regressions performed. GNI per capita is positively correlated, as the hypothesis of this paper proposes.

The rest part of this section uses the second data set for regressions. The second data set are consisted of 15 cross-sectional units and 12 time periods. Since it is observed in most of previous regressions that OADR and YADR are not significantly correlated with domestic saving rate, this paper examines the correlation between variables by taking means of values of three consecutive years. The underlying logic is that, since demographic factors do not change frequently in yearly basis, exploring the averages of values of few years, rather than yearly data, may show clearer relationship between demographic factors and other variables in this paper.

The first regression using the second data set is in table 11. The results in table 11 are largely similar to results in table 5, where domestic saving rate is regressed with pooled ordinary least square model with the first data set of this paper. All of coefficients of individual variables suggest that the results are consistent with the hypothesis. However, substantially large rho-value weakens the reliability of the regression. Assuming that POLS tends to overestimate the correlation between dependent and independent variables, results in table 11 do not provide us a precise fact.

Table 11: Pooled OLS, using 180 observations
Included 15 cross-sectional units
Time-series length = 12
Dependent variable: DomSav'

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	40.7841	6.00664	6.7898	<0.00001	***
OADR'	-0.38567	0.123934	-3.1119	0.00217	***
YADR'	-0.313023	0.118549	-2.6405	0.00903	***
Int'	0.3145	0.132521	2.3732	0.01872	**
Unem'	-0.791976	0.123107	-6.4333	<0.00001	***
GNIper'	0.000188654	4.62472e-05	4.0792	0.00007	***

Mean dependent var	24.65158	S.D. dependent var	6.028884
Sum squared resid	4480.137	S.E. of regression	5.074240
R-squared	0.311404	Adjusted R-squared	0.291617
F(5, 174)	15.73764	P-value(F)	9.00e-13
Log-likelihood	-544.7096	Akaike criterion	1101.419
Schwarz criterion	1120.577	Hannan-Quinn	1109.187
rho	0.971593	Durbin-Watson	0.190841

Table 12, which is the result of regression using fixed effect model, suggests that OADR is negatively correlated with the dependent variable, as proposed in the hypothesis of this paper, with statistically significant p-value. Another demographic factor, YADR, is turned out to be positively correlated with the domestic saving rate, which is inconsistent with our hypothesis. GNI per capita, the measure of income, is expected to be positively correlated in this result. The rho-value has been significantly dropped in this model, but still, the value indicates that there is substantial auto-correlation.

Table 12: Fixed-effects, using 180 observations
Included 15 cross-sectional units
Time-series length = 12
Dependent variable: DomSav'

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	15.92	4.59826	3.4622	0.00069	***
OADR’	-0.409761	0.102589	-3.9942	0.00010	***
YADR’	0.373038	0.081754	4.5629	<0.00001	***
Int’	0.0980563	0.0815049	1.2031	0.23073	
Unem’	0.0780574	0.0903685	0.8638	0.38901	
GNIper’	0.000234102	2.89532e-05	8.0855	<0.00001	***

Mean dependent var	24.65158	S.D. dependent var	6.028884
Sum squared resid	923.0460	S.E. of regression	2.401882
R-squared	0.858128	Adjusted R-squared	0.841281
F(19, 160)	50.93568	P-value(F)	8.05e-58
Log-likelihood	-402.5339	Akaike criterion	845.0679
Schwarz criterion	908.9270	Hannan-Quinn	870.9600
rho	0.685296	Durbin-Watson	0.626823

Below are results of regressions using random effect model. In this model, Both OADR and YADR are statistically significant. While the coefficient of OADR highlights that OADR is negatively correlated to the domestic saving rate, the other demographic factor, YADR, is positively correlated with the dependent variable. The result contradicts the hypothesis of this paper. GNI per capita in random effect model notes that it is positively correlated with the domestic saving rate. The Hausman test, however, weakens such correlation, by indicating that fixed effect model is more efficient than random effect model. Similar to the results in previous regressions in table 5, table 6 and table 7, OADR is negatively correlated with domestic saving rate with high statistical significance. Moreover, the results insinuate that GNI per capita is positively correlated with domestic saving rate.

Table 13: Random-effects (GLS), using 180 observations
Included 15 cross-sectional units
Time-series length = 12
Dependent variable: DomSav'

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	17.7513	4.78984	3.7060	0.00028	***
OADR'	-0.407308	0.103676	-3.9287	0.00012	***
YADR'	0.327551	0.0836032	3.9179	0.00013	***
Int'	0.100743	0.0838842	1.2010	0.23139	
Unem'	0.0135233	0.0921211	0.1468	0.88346	
GNIper'	0.000227597	2.97516e-05	7.6499	<0.00001	***

Mean dependent var	24.65158	S.D. dependent var	6.028884
Sum squared resid	6347.195	S.E. of regression	6.022432
Log-likelihood	-576.0620	Akaike criterion	1164.124
Schwarz criterion	1183.282	Hannan-Quinn	1171.892

'Within' variance = 5.76904
'Between' variance = 16.0619
theta used for quasi-demeaning = 0.826994

Hausman test -
Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: Chi-square(5) = 21.1736
with p-value = 0.000751107

Table 14, table 15, and table 16 provide the results of regressions that are examined with the second data set, after taking the first differencing. As seen in table 14, demographic factors seem to be uncorrelated with the domestic saving rate. Unemployment rate and GNI per capita are statistically significantly correlated—less than 0.01 p-value—as seen in the results. Moreover, the coefficients of unemployment rate and GNI per capita insinuate that they are consistent with the hypothesis made in previous section. As noted by rho-value—0.115675—the problem of auto-correlation has been solved by taking first differencing.

Table 14: Pooled OLS, using 165 observations
Included 15 cross-sectional units
Time-series length = 11
Dependent variable: d_DomSav_

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	-2.0073	0.404478	-4.9627	<0.00001	***
d_OADR’	-0.116297	0.177305	-0.6559	0.51283	
d_YADR’	-0.214998	0.135886	-1.5822	0.11559	
d_Int’	-0.144653	0.0623738	-2.3191	0.02166	**
d_Unem’	-0.255657	0.0800552	-3.1935	0.00169	***
d_GNIper’	0.000572029	8.95826e-05	6.3855	<0.00001	***

Mean dependent var	-0.078513	S.D. dependent var	1.971617
Sum squared resid	440.3064	S.E. of regression	1.664098
R-squared	0.309337	Adjusted R-squared	0.287618
F(5, 159)	14.24272	P-value(F)	1.63e-11
Log-likelihood	-315.1007	Akaike criterion	642.2014
Schwarz criterion	660.8371	Hannan-Quinn	649.7663
rho	0.115675	Durbin-Watson	1.584229

In table 15, domestic saving rate is regressed on the first differenced individual variables. It is notable that YADR is negatively correlated with high statistical significance in this model. On the other hand, the main explanatory variable of this research, OADR has no significant correlation with the dependent variable, in this result. While the coefficient of short-term interest rate is statistically significant, the sign of coefficient states that the hypothesis of this papr is incorrect. The coefficients of unemployment and GNI per capita indicate that unemployment rate is negatively correlated with the domestic saving rate, and GNI per capita is positively correlated with the dependent variable. Substantially low rho-value notifies that the problem of auto-correlated has been solved in this model, which regresses the first differenced data set. R-square value, which is 0.366609, has been largely increased as well, compared to the previous model. Thus, more portion of variances of the domestic saving rate is now explained by the variances of independent variables.

Table 15: Fixed-effects, using 165 observations
Included 15 cross-sectional units
Time-series length = 11
Dependent variable: d_DomSav'

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	-2.22253	0.450729	-4.9310	<0.00001	***
d_OADR'	0.179351	0.238239	0.7528	0.45278	
d_YADR'	-0.321277	0.152267	-2.1100	0.03658	**
d_Int'	-0.171098	0.0643487	-2.6589	0.00872	***
d_Unem'	-0.28311	0.0826546	-3.4252	0.00080	***
d_GNIper'	0.000554894	0.000100497	5.5215	<0.00001	***

Mean dependent var	-0.078513	S.D. dependent var	1.971617
Sum squared resid	403.7947	S.E. of regression	1.668769
R-squared	0.366609	Adjusted R-squared	0.283613
F(19, 145)	4.417190	P-value(F)	9.53e-08
Log-likelihood	-307.9591	Akaike criterion	655.9183
Schwarz criterion	718.0372	Hannan-Quinn	681.1345
rho	0.004871	Durbin-Watson	1.722125

In Table 16, which is the result of the last regression performed by this paper, it is suggested that demographic factors do not affect the domestic saving rate significantly. As result of Hausman test in table 16 suggest, random effect model is more consistent than fixed effect model. Unemployment rate is negatively correlated with the dependent variable, as proposed in the hypothesis of this paper, and GNI per capita is positively correlated with the saving rate, also as presumed in section III.

Table 16: Random-effects (GLS), using 165 observations
Included 15 cross-sectional units
Time-series length = 11
Dependent variable: d_DomSav'

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	-2.0073	0.404478	-4.9627	<0.00001	***
d_OADR'	-0.116297	0.177305	-0.6559	0.51283	
d_YADR'	-0.214998	0.135886	-1.5822	0.11559	
d_Int'	-0.144653	0.0623738	-2.3191	0.02166	**
d_Unem'	-0.255657	0.0800552	-3.1935	0.00169	***
d_GNIper'	0.000572029	8.95826e-05	6.3855	<0.00001	***

Mean dependent var	-0.078513	S.D. dependent var	1.971617
Sum squared resid	440.3064	S.E. of regression	1.658890
Log-likelihood	-315.1007	Akaike criterion	642.2014
Schwarz criterion	660.8371	Hannan-Quinn	649.7663

'Within' variance = 2.78479
'Between' variance = 0.159145
theta used for quasi-demeaning = 0

Hausman test -
Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: Chi-square(5) = 8.16305
with p-value = 0.147476

VI. Conclusion

In the previous section, this paper provides the results of regressions with pooled ordinary least square model, fixed effect model, and random effect model. This section discusses the results of regression more thoroughly and suggests the summary of all the regressions performed in previous parts of this paper.

As studied by Coale and Hoover (1958), Mason (1988), and Higgins (1998), demographic factors are believed to be significantly correlated with the saving rates historically. Moreover, life cycle hypothesis of Modigliani (1966) also suggests the possible negative correlation between old age dependency ratio and saving rate, by stating that individuals prefer to spend their entire income evenly throughout their lives.

However, this paper finds that there is no significant correlation between domestic saving rate and old age dependency ratio, as seen in results of the regressions. In regressions where data sets are not first differenced, old age dependency ratio is consistently examined as a significant factor that is negatively correlated to the dependent variable. As data sets are first differenced, old age dependency ratio has no significant correlation in both the first and the second data set. Thus, it turns out that the hypothesis on the relationship between domestic saving rate and old age dependency ratio, made in section III of this paper, is not correct. The result seems to be different from other papers, including Higgins (1998), because this paper only examines 15 countries.

Young age dependency ratio and short-term interest rate are not statistically significantly correlated throughout this paper. Even in few cases where YADR or short-term interest rate are significantly correlated, the signs of coefficients are not consistent. The most notable result this paper finds is the correlation between the domestic saving rate and GNI per capita. GNI per capita is positively correlated, which is consistent with the hypothesis made in section III of this paper, in every regression this paper performed. All POLS model, fixed effect model, and random effect model projects that GNI per capita is positively correlated with domestic saving rate in both data sets we use.

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Appendix.

i. Countries examined in this paper are:

Australia	Finland	Luxembourg	Sweden
Austria	France	Netherlands	United Kindom
Belgium	Italy	New Zealand	United States
Canada	Japan	Norway	