Social Security Income and Household Savings: A New Model and Evidence

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Our motivation for this research is to contribute to the debate about the effect of expected social insurance income during retirement on private household saving, generated by Feldstein (1974) and several responses to it. We consider an alternative model to the Life Cycle Model and empirically test it for G7 and for 27 OECD countries. Our dependent variable is Household Saving Rates, whereas the dependent variables are the Gross Replacement Rates (GRR) and Interest Rate. We do not consider the effect of income simply because, for some countries -saving is a percentage of income. Neither, we consider the effect of income inequality on household savings, due to missing data for many countries. We test the null hypothesis, whether expected social insurance benefits in retirement displace household private savings. We reject the null. The main contribution of this research to the literature is that our new model removes the uncertainty of estimation of expected cash income in retirement. Despite plausible results we obtain, a more extensive GRR data would have been desirable.

Keywords: Social Insurance, Households' Private Savings and Social Insurance, Gross Replacement Rates, OECD Households' Saving Behavior, A New model, G7 Households' Saving Behavior, A New Model for Estimation of the Effect of Social Security Income on Household Savings

INTRODUCTION AND LITERATURE REVIEW

Martin Feldstein (1974), using the life Cycle Model and Time Series, proposed that social security benefits displace household private savings by about 50% in US. That work led to several other studies that questioned Feldstein's finding. The literature is 50-50 divided on that. Among them, the *Social Security Bulletin* publication by Louis Esposito (1978) considered four empirical studies of the effect of the US social security program on private saving and concluded that none of those studies support the hypothesis that the social security system decreases households' private saving. Because Esposito drew upon the research of Robert Barro, Michael Darby, Martin Feldstein, and Alicia Munnell, they were invited to comment on the conclusions the author drew from their work. Their comments are reported in "Social Security and Private Saving: Another Look," *Social Security Bulletin* (May 1979, Vol. 42 (5), pp. 33-40). In sum, Barro agrees with Esposito, Darby does not, and Feldstein suggests the need for "new data and new approach," stating that "Without new data or a new approach, the analysis of the time-series data would be stalled at this point." (P. 37). And Alicia Munnell agrees with Esposito. Overall, together, these scholars raise doubt about the conjecture that expected social insurance income during retirement offsets households' private savings.

Leimmer and Lesony (1982) also refute Feldstein's (et al, 1974) proposition. Overall, the literature is split 50-50 on acceptance of the proposition and raises serious questions about the assumptions of the Life Cycle Model, and the uncertainty of estimation of the stream of benefits, saving motivations among cultures and age groups, among others. We consider several key pieces of literature.

Gale (1998), uses a Life Cycle model for saving that accounts for shortcomings of previous studies. Gale uses data from the 1983 Survey of Consumer Finances (SCF), which contains interviews with a cross-section of 3,824 U.S. households, and a supplemental survey of 438 high-income households. Gale excludes farmers from his survey based on the fact that they have a different saving pattern from other households, ala Avery (1986) and Hubbard (1986). Gale concludes that the model embodies complete offset between pensions and other wealth. Gale also notes that consumption in each period depends on the present value of total consumption, but not allocation of compensation between wages and pension. In conclusion, Gale refutes the proposition that expected social insurance income offsets households' private savings.

Lesnoy and Leimer (1985) use a historical aggregate time series with sample data for US. They consider the debate since 1974 and observe that 50% of the literature reject the offset of household savings: Alicia Munnell (1974), Robert Barro (1978), Michael Darby (1979) contradicting Feldstein et al. 1974. They also consider the less technical guide to early debate including Selig Lesnoy and John Hambor (1975); Louis Esposito (1978); Dean Leimer (1980; Selig Lesnoy (1980) and the second paper by Barro, Darby and Munnell (1983). Lesnoy and Leimer concluded that in the context of the historical evidence they reviewed, found no support for Feldstein's hypothesis. (p. 14-15).

Furthermore, Lesnoy and Leimer, consider the theoretical factors affecting saving for retirement. They also note that the relationship between aggregate savings and individual savings is not simple in growing economies (aggregate saving is positive in growing economies). They comment that substitution of social security wealth, measured by its present value of future expected benefits, for ordinary wealth, raises a question about their asset substitution effect. They also suggest ambiguity of the effect of social security savings on private household saving, adding: "Many social scientists question the LIFE Cycle model." (P. 16) They express concerns about the assumptions of the Life Cycle Model, including the rationality of individuals for making rational, complex decisions.

Rocher and Stierle (2015), note that saving motives vary across cultures, and economies. That raises a host of issues in the Life Cycle Model and beyond, including the potential effect of interest rate on household savings. They suggest that higher interest rates may tend to increase household saving, on the one hand, and on the other hand, people may attempt to smooth their consumption and postpone their current consumption. Consequently, they may tend to save more and slow their consumption. Hence, the effect of interest rate on household savings is ambiguous. According to Rocher and Stierle, the sign of the coefficient for the interest rate could be either positive or negative.

Based on this body of literature and more to follow, we offer an alternative model to the Life Cycle Model, as we delineate below.

Attanasio and Brugiavini (2003) show age could also affect workers' decision about savings. They consider the effect of the 1992 Italian pension reform and measure the elasticity of household saving to changes in future pension entitlements. As they correctly note, "this elasticity is obviously related to the degree of substitutability between pension and bequeathable wealth." They find evidence that as the result of reduction in pension wealth, saving rates increase in their data. They find that worker age 35-45 are most likely to substitute private savings for pensions. We do not account for age in our model.

Rocher and Stierle (2015), suggest that "income distribution" can also affect savings. Explaining that countries with unequal income distributions (commonly measured by the Gini Coefficient) are likely to have higher saving rates. Households with higher disposable income tend to save more of their income than households at the lower end of the income distribution. At the aggregate level, this would suggest that income inequality tends to increase the household saving rate. In our model, we do not include the Gini Coefficient, due to missing data for many countries.

The key literature clearly questions the generalization that expected social security income displaces households' private savings and raise serious issues with the Life Cycle Model. With such background and the availability of Gross Replacement Rate data for measurement of expected social security income, we developed a new model for assessment of their effect on households' savings, and empirically validated it for the G7 and a group of 27 OECD countries. We tested the null hypothesis, whether expected social insurance benefits in retirement displace household private savings. We rejected the null hypothesis. Our results show no evidence that social security income displaces household private savings in the group of countries we considered, for the ten years (2004-2014) we considered. The rest of the paper is organized as follows.

In the section immediately following this section, we describe our Model, Data, and the rationale for using a Unit Root Test for determining if we needed to treat the data as nonstationary. We also elaborate on our model and estimations, which include other tests for determining our methodology. In that section, we also describe the results of our statistical analyses for G7 and the 27 OECD countries. We then report our Conclusion and Summary in the last section of the paper. In the Data Appendix (A-J), we report our counties' data, the results for all verification tests, and the regression results for G7 and 27 OECD group of countries.

THIS STUDY

The Model

As noted above, the Life Cycle model has several shortcomings on several fronts, including, uncertainty about future streams of retirement income.

We propose an alternative model for estimation of the effect of social insurance income on household saving that depends on individuals' expectation of their actual Gross Replacement Rates (GRR). Our model includes the rate of interest as a key variable. We do not include income in our model because some countries' measure of "household savings" is a percentage of income. Neither, we include the Gini Coefficient because the data were missing for many countries, nor do we include Age (suggested in the literature). Before conducting our regressions, we run a battery of tests to evaluate the nature of our data and validity of the model we use. Accordingly, we selected our model. Our estimation equation is presented below, in equation (1).

$$HS_i = \beta_{it} + \beta_1 GRR_{it} + \beta_2 LTIR_{it} + \varepsilon_{it} \tag{1}$$

The Data

The data for this study is from the OECD database, recorded in Appendix A. Gross Replacement Rates (GRR) are obtained from OECD's biennial report *Pension at a Glance*. Our dataset encompasses 27 OECD countries as a group for which data were complete for 2004-2014, and G7. Our 27 countries are: (1) Australia, (2) Austria, (3) Belgium, (4) Canada, (5) Czech Republic, (6) Denmark, (7) Finland, (8) France, (9) Germany, (10) Greece, (11) Hungary, (12) Ireland, (13) Italy, (14) Japan, (15) Korea, (16) Mexico, (17) Netherlands, (18) New Zealand, (19) Norway, (20) Poland, (21) Portugal, (22) Slovak, Republic, (23) Spain, (24) Sweden, (25) Switzerland, (26) United Kingdom, and (27) the United States. Accordingly, our data is a panel set.

As illustrated in Table A in the Appendix, household saving rates differ substantially among the OECD countries, and year to year in the period under consideration. In Table 1 (bellow) we report the Basic Statistics for the variables in our model. Household Saving Rate has a maximum value of +20.09% for Switzerland and the minimum value of -17.28 for Greece, both in 2014 (years are given in Appendix A). As recorded in Appendix A, the GRR also varies substantially among the OECD countries, with a maximum of 95.7 for Greece (2006-2010), and as low as 29% for Ireland (2010).

TABLE 1
BASIC STATISTICS FOR VARIABLES

Basic Statistic	Household Saving Rate	Gross Replacement Rate	Long Term Interest Rate
Minimum	-17.28	25.48	0.519
Median	4.06	52.55	4.04
Mean	4.63	54.37	4.11
Maximum	20.09	95.70	22.50

Preliminary Tests for Verification of Data

Before proceeding to our estimations, we conducted several tests to verify the nature of our data in order to develop our methodology. We first conducted a Unit-Root test to determine if our time series were stationary or not. Nonstationary data will cause inaccuracies in estimations. We elaborate on our procedure or the Unit Root Test below. The other preliminary tests are integrated into the discussion of the Model and Estimations, as they pertain to the selection of our methodology. We present our tests for multicollinearity and heteroscedasticity in sections designated for each.

Unit-Root Test

We used the Augmented Dickey Fuller (ADF) test which is set up as such for the variable y in equation (2):

$$\Delta y_t = \psi y_{t-1} + \varepsilon_t \tag{2}$$

Our null hypothesis is that $\psi = 0$, which indicates a unit root and that the variable is not stationary in our time series. The alternative is that $\psi < 0$, indicating a stationary variable. Equation (3) is our test statistic:

$$DF_\tau = \frac{\hat{\psi}}{se(\hat{\psi})} \tag{3}$$

Appendix B details the results of the ADF test. From the results, we see that all three variables (HS, GRR and LTIR) are stationary. Hence no treatment became necessary for using them in our model.

The Model and Estimations

In this section, we discuss our model and the preliminary tests we sued to validate it, followed by our report for its empirical verifications for both the G7 and 27 OECD groups.

Clearly, pension recipients are better able to optimize their savings during their working years, if they have information about their income replacement rate during retirement. Absence of an accurate measure of expected future social security income obviously weakens workers' estimation of their need for saving for retirement while they work. Such uncertainty plagues the Life Cycle Model.

With publication of the Gross Replacement Rate for 27 OECD member countries, we were able to develop a new model and empirically test it. Hypothetically, GRR information, improves household's foresight and enables them to plan for their retirement, assuming saving motivation is primarily precautionary for "old age." Thus, we abstract from other possible household motivations for saving and assume households' saving decisions are determined by information about their GRR for future income (with expectation of indexing for inflation).

We used a general estimation equation model for evaluating the effect of expected social security income on households' saving, given in equation (1).

Our dependent variable is the private Household Savings (HS), defined by OECD as the difference between household consumption expenditure from household disposable income, plus the change in the net equity of households in pension fund. Our independent variables are Gross Replacement Rate (GRR), defined as gross pension entitlement divided by gross-retirement earnings, Long-Term Interest Rate (LTIR), for which OECD uses government bonds that mature in ten years.

In equation (1), i indexes the G7 or the 27 OECD countries, and t the years, whereas β_1 and β_2 indicate the partial effects of Gross Replacement Rate and Long-Term Interest Rate, respectively, on Household Savings. The estimation equation also includes the intercept β_{it} and residuals ε_{it}.

Since our data consisted of panels, we evaluated three models commonly used for a panel data to determine the appropriate version for our data. With that objective, we considered the Pooled-OLS, Fixed-Effect and the Random-Effect Models. The Pooled-OLS assumes no specific effect between the panels, while the Fixed-Effect Model assumes such differences, and we allowed dummy variables for each country. The Random-Effect Model is a special case of the Fixed-Effect Model, which has random intercepts and partial pooling. Appendix C details the results of the three models we considered for the 27 OECD group.

From the Pooled-OLS Model, we observe that GRR has insignificant effect on household savings. From the Fixed-Effect Model, we observe that GRR has a small positive coefficient of 0.08. This means that as GRR increases by one percent, household savings would increase by 0.08 percent. Our Random-Effect Model shows a positive coefficient of 0.06 for GRR. This is less than its effect found in the Fixed-Effect Model.

Comparing the Pooled-OLS and Fixed-Effect Models, we saw that the R^2 for the Pooled-OLS was very low compared to the Fixed-Effect Model's, suggesting that the Fixed-Effect fits he better our data better.

Furthermore, we consider the Akaike Information Criterion (AIC) for those two models. The AIC for the Pooled-OLS is 973.57, while for the Fixed-Effect Model is 770.08. We report the results in Appendix D. A lower AIC indicates a stronger model. Therefore, we concluded that the Fixed-Effect Model fits our data better than the Pooled-OLS Model.

To compare the Fixed-Effect Model with the Random-Effect Model, we used the Hausman Test (Appendix E). The Hausman Test verifies the consistency of the Random-Effect Model when compared with the Fixed-Effect Model. The null hypothesis is that the random effect coefficients are consistent and will be more efficient than in the Fixed-Effect Model. The alternative will be that the Random-Effect coefficients are inconsistent. The test statistic for this test has a χ^2 distribution. With a P-value less than 0.05, we rejected the null hypothesis of the Hausman test and concluded that the random-effect coefficients were inconsistent. Hence, we determined that the fixed-effect model was the appropriate model for our empirical tests.

While the fixed-effect accounts for differences between the countries, we did not know if time influenced our estimation results or not. Our next test determined if it was necessary to include a measure for the time-effect into our model. We used an F-test to verify that. The null hypothesis for the F-test was "time." If time did not have a significant effect on our results, the alternative would have a significant effect. The result of this test is reported in Appendix F. With P-value greater than 0.05, we did not reject the null. This implied that "time" had no significant effect on household savings (HS) in our data.

With the above analyses, we concluded that the Fixed-Effect Model was the best fit for our panel data among the three commonly used models.

With three statistical diagnostic tests and robust results, we verified the validity of our model and estimations. We described the Unit-Root Test above; and report our test results for multicollinearity and heteroscedasticity below.

Multicollinearity

Since our model was multivariate, we made sure that none of our variables were collinearly related. Thus, we used the Variance Inflation Factor (VIF) test for collinearity. We report the result in Appendix G for the generalized Variance Inflation Factor for our independent variables. It is conventional standard that a VIF of less than 12 indicates absence of multicollinearity. From our results, we concluded that multicollinearity is not present in our data.

Heteroscedasticity

To test for heteroscedasticity, we used the Breusch-Pagan (BP) test. The BP test has the null hypothesis that a linear model is homoscedastic and an alternative hypothesis that it is heteroskedastic. The test statistic has χ^2 distribution. Appendix H details the BP test results. With P-value less than 0.05, we rejected the null. Thus, we accepted presence of heteroscedasticity in our Fixed-Effects Model.

To remedy the heteroscedasticity, we used heteroscedasticity-consistent standard errors. With this method, we constructed new coefficients for our Fixed-Effect Model. These new coefficients are detailed in Appendix I. With these new coefficients, we observed that GRR no longer had a significant coefficient.

First, we considered the G7 countries' panel data and conducted our regression with a fixed-effect. We report the results below.

The Effect of Social Insurance Income on Household Saving: The Case of G7 Group

We applied the fixed-effect model to examine the effect of the expected social security income, measured by GRR on the household's saving (HS) rates in G7 partition of the OECD data. The subgroup G7 are more heterogeneous in income, as wealthy and developed nations, with comprehensive social pension programs.

The results of the regression are detailed in Appendix J, where we show R^2 value of 0.82, with the coefficient of GRR being +0.11 (at 95% level of confidence). Our results show a negative sign for the LTIR—the long-term interest rate. The negative coefficient for interest rate suggests that household savings and LTIR move in the opposite direction. On the surface, this appears implausible and unexpected. Yet, ala Rocher and Stierle (2015), the effect of the interest rate on savings is ambiguous. According to them, higher interest rates may tend to increase households' saving on the one hand, and on the other hand, if they attempt to smooth their consumption by postponing current consumption, they may tend to save more and slow their consumption. Hence, the effect of interest rate on Household Savings could be unexpected, as in our regression (s).

Also, we observe that in a regular fixed-effect regression, the GRR does not have a significant effect on HS, but when accounting for heteroscedasticity, the heteroscedasticity-consistent coefficients results have a significant positive value for GRR at +0.11. Accordingly, an increase of one percent in GRR would increase the household saving rate (HS) by 0.11 percent. With confidence, we confirm that expected social insurance income does not replace the households' private saving in our sample. In fact, they are complements rather than being substitutes.

The Effect of Social Insurance Income on Household Saving: The Case of 27 OECD Group

Our model is the same as the one we used for G7. In Appendix C, we report our regression results for the Pooled-Panel data for the 27 OECD group. We show that R^2 is 0.84 and the coefficient for GRR is + 0.9 (with 95% significance), indicating that expected Social Security income is a complement to household savings, not a substitute. Again. we find a negative sign for the coefficient of the LTIR, as in the case of the G7 countries, where we referenced Rocher and Stierle (2015), for a discussion of ambiguity of the effect of interest rate on household savings.

SUMMARY AND CONCLUSION

With availability of Gross Replacement Rates (GRR) data, we have proposed a new model that removes the uncertainties of the Life Cycle model. We have empirically tested our model, examining the effect of GRR on household savings for the G7 and a group of 27 OECD countries. We have used a panel data for 2004-2014 (dictated by data availability). We have selected our model based on the results of a number of preliminary tests, including a Unit-Root test, AIC and F-tests, as well as tests for multicollinearity and heteroscedasticity, to ensure proper treatment of the data and validity of our estimation model.

We have concluded that generally households do not lower their private savings because of expectation of pension income neither in our data for the G7 nor for the group of 27 OECD countries.

Based on our findings, we refute the Feldstein's proposition, albeit a new model based on the Gross Replacement Rates (GRR) and a new data set and a new timeframe.

Although, our model and empirical evidence produce plausible results, we are aware of the limited time horizon we have investigated due to limited data points for the GRR. The extension of this study would include a larger data set when more GRR become available, although, we expect no major changes in the outcome of the estimations.

Our research has important policy implication as many countries grapple with revising their social security program, especially those with rising dependency ratio, due to rising longevity and falling birth rates.

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REFERENCES

Attanasio, O. P., & Brugiavini, A. (2003). "Social Security and Households' Saving." *The Quarterly Journal of Economics*, 118(3), 1075–1119.
Retrieved from *JSTOR*www.jstor.org/stable/25053931.

Barro, R. (1978). "The Impact of Social Security on Private Savings---*Evidence from the U.S. Time Series."* Washington, D.C. American Enterprise Institute.

Esposito, L. (1978). "Social Security and Private Saving: Another Look." *Social Security Bulletin*, May 1979/, 42(5), 33-40.

Feldstein, M. (1974, September-October). "Social Security, Induced Retirement, and Aggregate Capital Accumulation." *The Journal of Political Economy*, 82 (5), 905-926.

Feldstein, M. S. (1982). Social Security and Private Saving: Reply. *Journal of Political Economy*, 90(3), 630-642.

Feldstein, M., & Pellechio, A. (1979). "Social Security and Household Wealth Accumulation: New Microeconometric Evidence." *The Review of Economics and Statistics*, 61(3), 361–368.
Retrieved from *JSTOR*, www.jstor.org/stable/1926065.

Feldstein, M. (1979, May). "The Effect of Social Security on Private Savings: The Time Series Evidence." *Social Security Bulletin*, 42 (5), 36-39.

Gale, W, G. (1998). "The Effects of Pensions on Household Wealth: A Reevaluation of Theory and Evidence." *The Journal of Political Economy*, 106 (4), 706-723.

Leimer, D. R., & Lesnoy, S. D. (1982). "Social Security and Private Saving: New Time-Series Evidence." *Journal of Political Economy*, 90 (3), 606–629.
Retrieved from JSTOR, www.jstor.org/stable/1831373. Retrieved 9/20/17.

Lesnoy, S., & Leimer, D R. (1985, January). "Social Security and Private Saving: Theory and Historical Evidence." *Social Security Bulletin*, 48(1), 14-30.

Rocher, S., & Stierle, M. H. (2015). *Household saving rates in the EU: Why do they differ so much?* DISCUSSION PAPER 005 | SEPTEMBER 2015.

Slavov, S., Gorry, D., Gorry, A., & Caliendo, F. N. (2019, March). "Social Security and Saving: An Update." *Public Finance Review*, 47(2), 312-48

OECD. (2015). Pensions at a Glance 2015: OECD and G20 indicators*.* OECD Publishing, Paris. Social Security and Private Saving: Another Look. *Social Security Bulletin,* May 1979, 42(5), 33-40.

OECD. (2016). Household savings (indicator). doi:10.1787/cfc6f499-en. Retrieved February 16, 2016.

OECD. (2016). Long-term interest rates (indicator). doi:10.1787/662d712c-en. Retrieved February 16, 2016, from
http://heinonline.org/HOL/LandingPage?handle=hein.journals/ssbul42&div=48&id=&page
Retrieved 9/21/17.

DATA APPENDICES (A-J)

APPENDIX A
27 OECD COUNTRIES DATA

Country	Year	GRR	HS	LTIR	Country	Year	GRR	HS	LTIR
Australia	2004	40	1.5	5.591	Korea	2004	40.6	6.72	4.728
	2006	43.1	1.82	5.588		2006	66.8	5.47	5.152
	2008	41.6	10.01	5.818		2008	42.1	3.76	5.568
	2010	47.3	10.15	5.366		2010	42.1	4.66	4.773
	2012	52.3	10.26	3.379		2012	39.6	3.9	3.448
	2014	44.47	8	3.657		2014	39.27	6.97	3.186
Austria	2004	78.3	9.21	4.131	Mexico	2004	36	8.62	9.538
	2006	80.1	11.3	3.8		2006	35.8	9.1	8.388
	2008	80.1	11.95	4.358		2008	36.1	8.11	8.313
	2010	76.6	9.28	3.226		2010	30.9	8.77	6.9
	2012	76.6	9.22	2.373		2012	28.5	6.06	5.598
	2014	78.1	7.8	1.488		2014	25.48	6.39	6.014
Belgium	2004	40.7	8.88	4.063	Netherlands	2004	68.3	6.82	4.095
	2006	40.4	9.16	3.805		2006	81.9	3.85	3.781
	2008	42	10	4.398		2008	88.3	3.73	4.227
	2010	42	8.19	3.345		2010	88.1	4.89	2.99
	2012	41	6.36	2.963		2012	90.7	6.82	1.934
	2014	46.62	5.1	1.74		2014	90.49	8.21	1.455
Canada	2004	42.5	2.25	4.58	New Zealand	2004	37.6	-3.76	6.066
	2006	43.9	3.46	4.209		2006	39.7	-3.28	5.781
	2008	44.5	3.92	3.605		2008	38.7	-1.07	6.081
	2010	44.4	4.28	3.235		2010	38.7	3.03	5.603
	2012	45.4	4.98	1.873		2012	40.6	2.18	3.685
	2014	32.63	3.81	2.231		2014	40.07	1.05	4.304
Czech Republic	2004	44.4	4.85	4.821	Norway	2004	52.6	6.91	4.368
	2006	49.1	7.84	3.8		2006	59.3	-0.45	4.077
	2008	49.7	6.3	4.633		2008	59.3	3.64	4.458
	2010	50.2	7.61	3.884		2010	53.1	3.95	3.528
	2012	52.2	6.17	2.782		2012	52.5	7.12	2.102
	2014	49.02	5.71	1.576		2014	49.84	8.48	2.515

Country	Year	GRR	HS	LTIR	Country	Year	GRR	HS	LTIR
Denmark	2004	43.3	-2.23	4.305	Poland	2004	56.6	4.02	6.897
	2006	75.8	-1.73	3.812		2006	61.2	2.75	5.232
	2008	80.3	-4.18	4.281		2008	61.2	0.81	6.072
	2010	79.7	2.13	2.926		2010	59	2.38	5.782
	2012	78.5	0.74	1.403		2012	48.8	-1.11	4.999
	2014	67.8	-2.76	1.327		2014	43.08	-0.71	3.516
Finland	2004	71.5	3.02	4.109	Portugal	2004	66.7	2.71	4.144
	2006	63.4	-0.45	3.783		2006	54.1	0.36	3.915
	2008	56.2	-0.24	4.29		2008	53.9	-1.13	4.52
	2010	57.8	3.15	3.011		2010	53.9	1.34	5.396
	2012	54.8	0.71	1.883		2012	54.7	-0.46	10.547
	2014	55.79	-0.2	1.448		2014	73.8	-2.33	3.754
France	2004	52.9	10.95	4.099	Slovak	2004	48.6	0.34	5.026
	2006	51.2	9.38	3.798	Republic	2006	56.7	0.13	4.412
	2008	53.3	9.46	4.234		2008	56.4	0.78	4.723
	2010	49.1	10.35	3.118		2010	57.5	4.66	3.872
	2012	58.8	9.46	2.537		2012	65.9	1.74	4.553
	2014	55.39	9.55	1.667		2014	62.06	3.82	2.071
Germany	2004	45.8	10.11	4.037	Spain	2004	81.2	5	4.104
	2006	39.9	10.08	3.763		2006	81.2	1.39	3.784
	2008	43	10.48	3.984		2008	81.2	1.57	4.364
	2010	42	9.97	2.743		2010	81.2	3.69	4.25
	2012	42	9.26	1.495		2012	73.9	2.63	5.847
	2014	37.49	9.52	1.163		2014	82.11	3.88	2.722
Greece	2004	84	1.15	4.256	Sweden	2004	64.8	5.82	4.425
	2006	95.7	-0.05	4.07		2006	62.1	6.92	3.704
	2008	95.7	-3.84	4.803		2008	61.5	12.67	3.888
	2010	95.7	-6.9	9.092		2010	53.8	11.02	2.893
	2012	53.9	-10.91	22.498		2012	55.6	15.32	1.593
	2014	46.2	-17.28	6.929		2014	64.42	15.28	1.72
Hungary	2004	75.4	4.5	8.292	Switzerland	2004	58.2	13.7	2.74
	2006	76.9	6.28	7.116		2006	58.4	15.8	2.517
	2008	76.9	1.5	8.238		2008	58.3	16.67	2.897
	2010	75.8	3.58	7.282		2010	57.9	17.01	1.632
	2012	73.6	2.57	7.891		2012	55.2	18.47	0.647

Country	Year	GRR	HS	LTIR	Country	Year	GRR	HS	LTIR
	2014	58.7	4.91	4.81		2014	40.22	20.09	0.693
Ireland	2004	30.6	0.27	4.062	United	2004	37.1	0.52	4.882
	2006	32.5	-1.99	3.789	Kingdom	2006	30.8	-1.21	4.502
	2008	34.2	3.94	4.55		2008	30.8	-0.82	4.591
	2010	29	6.4	5.993		2010	31.9	6.1	3.624
	2012	36.7	3.48	5.992		2012	32.6	2.94	1.918
	2014	34.75	-0.4	2.264		2014	29.69	-1.91	2.569
Italy	2004	78.8	9.54	4.259	United States	2004	38.6	4.72	4.274
	2006	67.9	8.43	4.046		2006	41.2	3.44	4.792
	2008	67.9	7.74	4.681		2008	38.7	5.09	3.667
	2010	64.5	4.1	4.036		2010	39.4	5.82	3.214
	2012	71.2	1.84	5.493		2012	38.3	7.89	1.803
	2014	69.49	3.39	2.893		2014	35.17	4.97	2.541
Japan	2004	50.3	2.31	1.493					
	2006	34.4	1.31	1.741					
	2008	33.9	0.56	1.467					
	2010	34.5	2.15	1.148					
	2012	35.6	1.36	0.836					
	2014	35.07	-0.47	0.519					

APPENDIX B
AUGMENTED DICKEY-FULLER (ADF) TEST

Variable	DF_τ	p-value
HS	-5.09	<0.01
GRR	-4.79	<0.01
LTIR	-7.17	<0.01

APPENDIX C
THREE MODEL'S REGRESSION RESULTS FOR 27 OECD COUNTRIES

Variable	Pooled OLS Coefficient	Fixed Effect Coefficient	Random Effect Coefficient
Intercept	8.29*	4.38*	2.76
	(1.44)	(1.82)	(1.78)
GRR	-0.01	0.09*	0.06*
	(0.02)	(0.03)	(0.03)
LTIR	-0.80*	-0.29*	-0.37*
	(0.17)	(0.11)	(0.11)
R^2	0.13	0.84	0.11

* indicates significance of the coefficient at 0.05 level.

APPENDIX D
AIC TEST

Pooled OLS	973.57
Fixed Effect	770.08

APPENDIX E
HAUSMAN TEST

χ^2	10.74
P-value	<0.01

APPENDIX F
F-TEST FOR TIME EFFECT

F-stat	2.14
P-value	0.06

APPENDIX G
VARIANCE, INFLATION FACTOR (VIF)

Variable	VIF
GRR	7.81
LTIR	2.71

APPENDIX H
BRUESCH-PAGAN (BP)

BP stat	97.22
P-value	<0.01

APPENDIX I
HETEROSCEDASTICITY CONSISTENT COEFFICIENTS

Variable	Coefficient	Standard Error	P-value
GRR	0.09	0.05	0.07
LTIR	-0.30	0.01	< 0.0

APPENDIX J
G7 REGRESSION RESULTS

Variable Regression	Fixed-Effect Coefficient	Heteroskedastic-Coefficient
Intercept	0.33	0.33
GRR	0.11	0.11*
LTIR	-0.41	-0.41
R^2	0.82	

*indicates significant level at 0.05