

The Saving-Investment Correlation Puzzle is Still a Puzzle

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Abstract

This paper tests empirically the significance of cyclical shocks—productivity, fiscal and terms of trade shocks—in explaining a high time-series correlation between saving and investment. I run a panel regression with newly constructed saving and investment data controlled for cyclical shocks. I also test the role of country differences—the size of GNP and the size of the non-traded sector. The estimation results reveal that neither business cycle shocks nor country differences can explain the high saving-investment correlation. This result contradicts previous simulation studies which claimed that a high time-series saving-investment correlation naturally arises with business cycle shocks. The saving-investment correlation puzzle remains a puzzle after all.

JEL classification: F32; F41

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1. Introduction

Time-series and cross-sectional data concerning saving and investment demonstrate that the two variables are highly correlated.¹ These results have been interpreted as evidence of low international capital mobility, thereby contradicting the fact that the international capital market has been rapidly integrated. This observation has created a puzzle in international finance.

Since the early 1990s, an increasing number of simulation studies based on dynamic stochastic general equilibrium (DSGE) models have suggested various specifications of shocks and economic structures that can generate a high time-series correlation between saving and investment even under a complete capital market. These studies argue that certain shocks move saving and investment in the same direction and produce a high time-series correlation.²

This paper empirically tests the role of these business cycle shocks to explain a high positive association between saving and investment. The relationship between saving and investment is measured by the coefficient from the regression of domestic investment on domestic saving—“the savings retention coefficient.”³ I use newly constructed saving and investment data controlled for business cycle shocks to estimate the regression coefficient. Specifically, I use residuals from the regressions of saving and investment on various shocks—productivity, fiscal and terms of trade (TOT) shocks.⁴ A decrease in the regression coefficient that results

¹For example, see Feldstein and Horioka (1980) and Murphy (1984) for cross-sectional evidence. Time-series evidence can be found in Obstfeld (1986, 1995) and Bayoumi (1989).

²See Finn (1990), Mendoza (1991), Backus, et al. (1992) and Baxter and Crucini (1993).

³This regression coefficient measures the fraction of an exogenous increase in national saving that remains at home. Feldstein and Bacchetta (1991) and Obstfeld (1995) used the same measure.

⁴For the use of these shocks in a model, see, for example, Obstfeld (1982), Svensson and Razin (1983),

from controlling a certain shock indicates that this shock is capable of explaining the positive saving-investment relationship. I also explore whether the distinction between global and local shocks produces any significant change in the results.

For empirical regressions, I use the maximum likelihood estimation method using panel data from nineteen OECD countries. The use of panel data enables me to run sub-country regressions to investigate the effects of country differences, the size of GNP and the size of the non-traded sector, on the saving-investment relationship.⁵ By using the saving and investment data controlled for shocks in the sub-country regressions, I can examine simultaneously the effects of both business cycle shocks and country differences. Unlike previous empirical studies that have analyzed one or the other of these factors separately, this paper adopts a unified framework and examines the relative significance of all factors.

The estimation results reveal that the business cycle shocks cannot explain the high positive saving-investment relations. In particular, after extracting the effects of productivity shocks from saving and investment data, the saving retention coefficient drops only from 0.69 to 0.64. This result contradicts the conclusion in Baxter and Crucini (1993) that the high saving-investment correlation arises naturally with persistent productivity shocks. The combination of all three shocks drives the coefficient further down but it still remains significantly above zero.

Turnovsky and Sen (1991), Backus, et al. (1992) and Baxter and Crucini (1993). Other shocks claim to have effects on the saving-investment correlation: income distribution shocks in Ghosh and Pesenti (1995), taste shocks in Stockman and Tesar (1995), and price changes of intermediate goods such as oil price shocks in Svensson (1984). I exclude income distribution shocks and taste shocks due to the difficulty in constructing accurate data for these variables. In addition, I do not include oil price shocks since the import of oil occupies a large portion of the total import and the general import price in many OECD countries and therefore TOT shocks can reflect the changes in oil prices.

⁵Baxter and Crucini (1993) and Tesar (1993) analyzed the effects of the country size and the nontraded sector on the time-series saving-investment correlation.

Another important result finds that global shocks have significant effects on the saving-investment relationship. The coefficient drops to 0.48 in case of global productivity shocks. This observation is consistent with the empirical results in Glick and Rogoff (1995) that global shocks have insignificant effects on the current account but significant effects on investment. Neither country difference examined in this paper explains the positive association between saving and investment. All of these results suggest that the saving-investment correlation puzzle remains a puzzle.

The remainder of this paper is structured as follows. Section 2 explains the estimation method and the data. Section 3 reports the estimation results and gives theoretical explanations for the role each factor plays in deriving the high saving retention coefficient. Section 4 offers my conclusions.

2. Estimation Method and Data

Despite a large volume of cross-sectional empirical works, a relatively small number of empirical tests have used a time-series estimation because one, the coefficient of a country-by-country time-series regression of investment on saving is insignificant in most cases and too different across countries; and two, since the time-series data of saving and investment are nonstationary, the least squares estimation which uses level data generates a spurious regression problem.

In this paper, I overcome these problems by adopting a panel data analysis based on the results of unit root and cointegration tests. Panel data analysis increases the significance of the regression coefficient and directly incorporates country specific effects. To

address the nonstationary problem, I perform unit root and cointegration tests and select the appropriate type of data for the regression, level or first difference.⁶

Table A1 of the appendix reports the Phillips Z_t unit root test results for Y, C, I, G and S of nineteen countries: Both S and I are nonstationary in all cases. With first differences, I reject the null hypothesis of unit root in all cases but ΔS and ΔI in Finland and ΔI in Spain at a 5% significance level and in almost all cases at a 10% significance level. In most countries, Y, C , and G are $I(1)$ processes at a 10% significance level except Y in Finland and Spain, C in Finland and Germany, and G in the U.S. All three shocks are stationary except fiscal shocks in the U.S. at a 5% significance level, which become stationary at a 10% significance level.

In table A2 of the appendix, I report the first-order autoregressive parameters ($\hat{\gamma}$) and test statistics from the ADF and the Phillips Z_t cointegration tests of saving and investment for each country. With the ADF test, I cannot reject the null hypothesis of no cointegration in any of the nineteen countries. Using the Phillips Z_t test, I can reject the null hypothesis of no cointegration at a 5% significance level in only one country, Austria. This result supports the use of the stationary time-series estimation method with first differences of saving and investment instead of the cointegrating regressions.

For the panel regression of ΔI on ΔS , I use the maximum likelihood estimation (MLE) calculated by iterating the seemingly unrelated regression (SUR) with equality restrictions

⁶Some have attempted to circumvent these problems by detrending the data or expressing saving and investment as fractions of output. Detrending the data, however, results in incorrect inferences if an inappropriate detrending method is used. Using the share data may cause a spurious regression if the orders of integration of output, saving and investment are different.

using newly computed covariances and system equation estimates from the GLS estimation.⁷ I set a maximum of 20 iterations, but all the results converge before reaching this limit. Since the number of time-series observations in the regression is not large enough for the asymptotic efficiency of the GLS estimation, I use the MLE throughout the paper.

The GLS estimation uses the SUR with equality restrictions across the equations excluding a constant term:

$$\Delta I_{it} = \alpha_i + \beta \Delta S_{it} + u_{it}. \quad (2.1)$$

where α_i denotes the country specific constant term and β is subject to equality restriction.⁸

I use the annual data of nineteen OECD countries from 1960 to 1992.⁹ The data for saving and investment are constructed from the International Financial Statistics. Productivity shocks are defined as the percentage change in productivity. For the productivity measure, I use Solow residuals derived from the Cobb-Douglas production function. Fiscal shocks are defined as the percentage change in unexpected government spending for which I use the residuals from the regression of the government spending growth rate on the predicted annual GNP growth rate and the previous year's net government debt growth rate. TOT shocks are defined as the percentage change in TOT—export price/import price.¹⁰

⁷Glick and Rogoff (1995) used the same estimation method.

⁸I use the Lagrange Multiplier tests for cross-country heteroscedasticity and cross-country correlation in the error term. The test statistics that are not reported in the paper show that there exist strong evidence for both. I correct the cross-country heteroscedasticity and correlation by using the estimates of cross-country covariances based on the residuals derived from the individual country OLS regressions. In addition, I use the t-test for the within-country autocorrelation in the error term assuming AR(1) error structure. The estimated AR(1) coefficient is 0.33 and I can reject the null hypothesis of AR(1) error structure.

⁹I exclude Turkey, Iceland, Luxembourg, Norway and Sweden due to the lack of the data. Luxembourg is traditionally omitted from the sample in most saving-investment analysis. It is such an extreme outlier that its addition reduces the regression coefficients to insignificant numbers.

¹⁰In order to correctly compare the coefficients of different shocks in the regression, I control the differences in units by defining shocks as percentage changes instead of first differences.

Detailed explanations of the data are in appendix.

3. Estimation Results

I estimate the saving retention coefficient from the regression of ΔI on ΔS using the MLE method described in section 2. Model 0 in table 1 reports the saving retention coefficient without controlling any shocks. The estimated coefficient is 0.69 which is the benchmark value in this paper.¹¹

3.1. Business Cycle Shocks

In order to construct the saving and investment data controlled for cyclical shocks, I run the regressions of ΔS and ΔI on each shock with a lag structure using the MLE method. The unit root test results support the use of these shocks as regressors in the estimation since they have the same order of integration as the first differences of aggregate supply and demand variables.

$$\Delta Z_{it} = \alpha_i + \beta_0 shock_{it} + \beta_1 shock_{it-1} + \beta_2 shock_{it-2} + residuals_{it} \quad (3.1)$$

where $\Delta Z = \Delta S$ and ΔI .¹²

I include lagged variables up to time $t-2$ because shocks at $t-3$ are insignificant in most cases. Using these residuals, I derive the saving retention coefficient after controlling shocks.

¹¹The coefficient differs according to the estimation method. The coefficient from the OLS estimation with stacked data is 0.91. The GLS estimation using the SUR produces the coefficient of 0.87.

¹²All shocks are multiplied by the mean of each country's real GNP over the estimation period. We therefore interpret the coefficients as being the change of the left-hand-side variable as a percentage of the average GNP in response to a one percent increase in each shock.

Table 1 reports the newly estimated saving retention coefficients with different number of lags in the shock process. Models 1 to 3 report the estimation results after controlling productivity, fiscal, and TOT shocks, respectively, while model 4 controls all three shocks at the same time. Values of βs for each model are reported in table 2. Table 2 also reports the estimates of βs for ΔY , ΔC , and ΔG .

3.1.1. Productivity Shocks

Most simulation studies using DSGE models have shown that persistent productivity shocks can generate a high correlation between saving and investment. Suppose a country faces positive productivity shocks, then its consumption grows but not as much as the increase in output and households end up saving the remaining output—permanent income hypothesis. Its investment increases as the marginal product of capital rises due to positive productivity shocks and this in turn results in a positive correlation between saving and investment.¹³

However, the estimated saving retention coefficients in table 1 contradict this theory. Model 1 in table 1 reports that the saving retention coefficient decreases only from 0.69 to 0.64 after controlling productivity shocks up to time $t - 2$. If productivity shocks explain the high saving-investment correlation, the coefficient should decrease significantly.

Detailed analysis of how each shock affects output and expenditures is reported in table 2. The estimated values of βs of the model 1 indicate that productivity shocks

¹³Using two-country incomplete market models, Baxter and Crucini (1995) and Kim (1997) generated a high saving-investment correlation from persistent but not permanent productivity shocks. Backus, et al. (1992) and Baxter and Crucini (1993) demonstrated that positively correlated and temporary productivity shocks can produce a positive saving-investment correlation even under complete financial markets. In an overlapping generations model of a small open economy, Finn (1990) showed that positively autocorrelated productivity shocks can generate a high saving-investment correlation.

positively affect saving and investment. A rise in productivity initially has positive and significant effects on output, consumption, and investment but these effects diminish over time. Because consumption increases less than output, saving, in turn, increases. However, these effects are not strong enough to reduce the saving retention coefficient significantly.

3.1.2. Fiscal Shocks

In a two-good infinite-horizon model, Turnovsky and Sen (1991) examined the effects of permanent and temporary changes in government expenditures on various macroeconomic variables. A permanent rise in government spending directed towards a domestic good increases employment and output both in the short run and over time. Despite the transitional rise in the domestic real interest rate, investment is stimulated by the increase in Tobin's q , leading to a higher equilibrium capital stock. Along the transitional adjustment path, consumption and leisure are both below their respective initial starting levels which leads to a high correlation between saving and investment. However, the result highly depends on the specification of shocks.

Model 2 in table 2 shows that an increase in government spending has negative effects on saving and investment. The negative effects on aggregate saving is due to the increase in G , while the effects on investment is much less significant compared to the case of productivity shocks. This is reflected in the estimated saving retention coefficient in table 1. The coefficient decreases only to 0.65 after controlling fiscal shocks.

The estimation result also rejects the existence of the current account targeting policy, another channel through which government can affect the relationship between saving and

investment. If a government targets on the current account balance, then whenever the deficit (or surplus) in the current account exceeds a predetermined level, the government adjusts public sector's saving and investment to restore the current account back to the target level. This leads to a high correlation between saving and investment.

3.1.3. Terms of Trade Shocks

The effect of TOT on saving and current account has been an issue since the 1950s in Harberger, Laursen, and Metzler (HLM). HLM postulate that real income and saving fall with a TOT deterioration. However, this argument depends on a static theory and has been reconsidered by many papers following the intertemporal approach with forward looking savings behavior.¹⁴

By adopting a Uzawa-type utility function, Obstfeld (1982) showed that the deterioration of the TOT can increase saving. In his model, the deterioration of the TOT lowers the target level of real wealth. To retain the target level, the economy must accumulate foreign wealth and hence, save. Svensson and Razin (1983) analyzed the effects of the TOT of final and intermediate goods on saving and investment. A temporary deterioration in the TOT of final goods lowers the discount factor. The lower discount factor in turn increases investment but has ambiguous effects on consumption. The deterioration in TOT also lowers the real value of domestic output in terms of consumption and eventually lowers consumption. Therefore, saving can be positively correlated with investment. However, the theoretical predictions are inconclusive since the results highly depend on the specification of shocks

¹⁴See Obstfeld and Rogoff (1995) for details.

and the structure of the model economy.

Empirical results in model 3 of table 2 confirm the ambiguous predictions in theories. An improvement in TOT increases saving but decreases investment and both effects are insignificant. One interesting observation is that effects on output presents J-curve effect, an initial decrease followed by a significant increase with a time lag. It takes time for the production sector to reflect the benefit of an improvement in TOT. The saving retention coefficient in table 1 decreases only to 0.59.

3.1.4. All Three Shocks and Country Specific Coefficients

Model 4 in table 1 reports the saving retention coefficient after controlling all three shocks at the same time. The coefficient decreases to 0.64, 0.58, and 0.42 as the number of lags increases.¹⁵ These coefficients are lower than those in the previous cases with a single shock but the absolute value is still significantly above zero.

Table 3 presents the saving retention coefficients estimated without equality restrictions on the coefficient. Although the saving retention coefficients are different across countries, they are significant in most cases and decrease after controlling cyclical shocks. Especially, the coefficients decrease after controlling all three shocks in 17 out of 19 countries. However, only four countries present near zero coefficients and other countries still show high saving retention coefficients.

¹⁵The use of multiple shocks in the same regression can be rationalized by low correlations among shocks. The average correlations between productivity and fiscal shocks, productivity and TOT shocks, and fiscal and TOT shocks are -0.03 and -0.004, and -0.11, respectively. The standard deviations of correlations in all three cases are around 0.2.

3.1.5. Global Shocks

Using the data of G-7 countries, Glick and Rogoff (1995) performed the structural estimation of the effects of local and global productivity shocks on current account and investment. They demonstrated that investment responds positively and significantly to both local and global productivity shocks but that current account responds negatively and somewhat significantly to local shocks with little or no response to global shocks. This implies that global productivity shocks increase both saving and investment and produce a high correlation. If shocks are positively correlated across countries, individual countries cannot rely on international capital markets to smooth their levels of consumption, and savings and investment for individual countries as well as for the system as a whole would be positively correlated.

Table 4 reports the saving retention coefficients after controlling global shocks only. Global shocks are constructed as the GNP-weighted average of the shocks over nineteen countries.¹⁶ The estimation results in all cases confirm the conclusion by Glick and Rogoff (1995). Especially, global productivity shocks reduce the saving retention coefficient most significantly. When the lag number is two, the coefficient drops to 0.48, a significant decrease from 0.64 with domestic shocks: Global productivity shocks explain around 30% of the saving-investment relations. Similarly, in two other cases, global shocks produce significantly lower saving retention coefficients than domestic shocks do—0.59 and 0.49 with fiscal and TOT shocks, respectively, with the lag number of two.

¹⁶The weights are constructed from each country's share in total GNP of nineteen countries in each year, where local currency GNP figures are converted to dollars by the average dollar exchange rates during the estimation period.

3.2. Country Differences

3.2.1. Country Size

Baxter and Crucini (1993) demonstrated by simulation works that the time-series saving-investment correlation in a large country is higher than the correlation in a small country. A country with a large share of the world output is likely to have a relatively large share of the world's total saving and investment. While small countries take the world interest rate as given, changes in the investment and savings behavior of large countries will have an impact on the world interest rate. For example, an increase in the national saving of a large country lowers the world interest rate and therefore increases the investment of all countries. As a result, the saving-investment correlation of a large country tends to be high.

In table 5, I analyze the effects of country size on the saving retention coefficient. I sort nineteen countries into three groups according to the size of the average real GNP denominated in the U.S. dollar and run a separate regression with each country sample.¹⁷ The theory posits that the saving retention coefficient increases with the country size. However, in all cases with and without controlling cyclical effects, the saving retention coefficient does not have any relationship with the country size.¹⁸ In models 1 and 4, the saving retention coefficient even decreases as the country size increases. This result refutes the previous studies that have shown a positive relationship between time-series

¹⁷Large countries include U.S., France, Japan, Italy, U.K., and Germany. Medium countries include Spain, Canada, Australia, Greece, Netherlands, Belgium, and Switzerland. Small countries include Portugal, Denmark, Austria, Finland, New Zealand, and Ireland.

¹⁸Baxter and Crucini (1993) presented that large countries have higher saving-investment correlations than small countries using a sample of eight OECD countries. Since my data includes nineteen OECD countries, the coefficients of model 0 in table 5 can be considered more general than their results. In fact, all eight countries in Baxter and Crucini (1993) are included in large or medium country groups in my sample.

saving-investment correlations and country size.

3.2.2. Size of the Non-traded Sector

Tesar (1993) showed that the saving-investment correlation can be high even under perfect capital mobility when agents face stochastic fluctuations in the output of non-traded goods. She used a two-country, two-sector production model, where non-traded goods make up a significant share of the total output, and showed that preferences over the consumption of traded and non-traded goods and over the intertemporal allocation of consumption may result in an optimal portfolio biased towards claims on domestic output. In a dynamic setting, such preferences are consistent with relatively low correlations among consumptions across countries and a high correlation between saving and investment.

Table 5 presents the sub-country regression results when I sort nineteen countries into three groups using the average of $-(\text{import} / \text{GNP})$ in the 1980s as the proxy of the size of the non-traded sector.¹⁹ I assume that the smaller the relative size of the import sector, the larger the non-traded sector. The regression results in all cases show that there is no positive relationship between the size of the nontraded sector and the saving-investment correlation. The results even show that the correlation in the medium-sized countries is the highest in all cases.

¹⁹I use the same proxy which Wong (1990) used for estimating the size of the non-traded sector. Large countries include U.S., Japan, Australia, Portugal, Spain, and Italy. Medium countries include France, U.K., Canada, New Zealand, Germany, Finland, Greece. Small countries include Switzerland, Denmark, Austria, Netherlands, Ireland, and Belgium.

4. Conclusion

Many theoretical and empirical papers have attempted to explain the high time-series saving-investment correlation using various factors. However, most works have been confined to analyzing a single factor in a separate framework and have not examined the relative significance of one factor against another in explaining the high correlation between saving and investment.

In this paper, I incorporated two groups of factors into a single framework—business cycle shocks and country differences—and analyzed how each factor contributes to explaining the observed high time-series saving-investment correlation. The major findings are as follows: First, I found that the business cycle shocks cannot explain the high saving-investment correlation. Even after controlling all three shocks, the saving retention coefficient remains well above zero. This result contradicts the previous simulation studies that have demonstrated that business cycle shocks, especially productivity shocks, are responsible for the high saving-investment correlation.

Second, I confirm the significant role of global shocks in explaining the high saving-investment correlation. The saving retention coefficients drop further with global shocks than with domestic shocks in all cases. This result is consistent with the empirical results in Glick and Rogoff (1995) that global shocks have positive effects on investment but almost no effects on current account. However, the saving retention coefficients still remain positive.

Finally, country differences in the size of GNP and the non-traded sector do not explain the high saving-investment correlation as opposed to the simulation results in Baxter and Crucini (1993) and Tesar (1993). All these estimation results lead to the conclusion that the

high saving retention coefficient, after controlling all the relevant factors, addresses another saving-investment correlation puzzle.

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Table 1. Saving retention coefficient^a

# of lags in shocks	Model 0	Model 1 (Productivity Shocks)	Model 2 (Fiscal Shocks)	Model 3 (TOT Shocks)	Model 4 (All Three Shocks)
0		0.75	0.70	0.68	0.64
1	0.69	0.70	0.70	0.70	0.58
2		0.64	0.65	0.59	0.42

a. In model 0, I report the saving retention coefficient from the regression of ΔI on ΔS without controlling any shock. In models 1 to 3, I report the saving retention coefficient from the regression of the residuals of ΔI on the residuals of ΔS , where the residuals are derived from the regressions of ΔI and ΔS on each shock with various time lags (0, 1, and 2). In model 4, I report the saving retention coefficient after controlling all three shocks together with various time lags (0, 1, and 2).

All the regressions are estimated by the MLE method described in section 2..

All the correlation coefficients are significant with the 1 percent level.

Table 2. Effects of shocks on $\Delta Y, \Delta C, \Delta G, \Delta S,$ and ΔI^a

ΔZ	Coefficients	Productivity Shocks	Fiscal Shocks	TOT Shocks
ΔY	β_0	0.32**	0.04**	-0.02**
	β_1	0.10**	-0.02*	-0.04*
	β_2	0.05**	-0.07**	0.08**
ΔC	β_0	0.11**	0.003	0.03**
	β_1	0.03**	-0.003	0.07**
	β_2	-0.01	-0.03**	0.001
ΔG	β_0	-0.01**	0.13**	-0.01**
	β_1	0.003	0.02**	0.001
	β_2	0.003	0.01**	0.01**
ΔS	β_0	0.13**	-0.10**	0.02**
	β_1	0.06**	-0.05**	-0.06**
	β_2	-0.02**	-0.01	0.04**
ΔI	β_0	0.20**	-0.03**	-0.04**
	β_1	0.005	-0.03**	-0.02**
	β_2	-0.02**	0.03**	-0.06**

a. I report the coefficients of current and lagged shocks, βs , in the following pooled time-series regression:

$$\Delta Z_{it} = constant_i + \beta_0 shock_{it} + \beta_1 shock_{it-1} + \beta_2 shock_{it-2} + residual_{it}$$

All shocks are multiplied by the mean of each country's real GNP over the estimation period. We therefore interpret the coefficients as being the change of the left-hand-side variable as a percentage of the average GNP in response to a one percent increase in each shock.

All the regressions are estimated by the MLE method described in section 2.

*. Significant with the 5 percent level.

** . Significant with the 1 percent level.

Table 3. Estimates of country-specific saving retention coefficient^a

Country	Model 0	Model 1 (Productivity Shocks)	Model 2 (Fiscal Shocks)	Model 3 (TOT Shocks)	Model 4 (All Three Shocks)
Australia	0.62**	0.60**	0.91**	0.28**	0.34**
Austria	1.55**	0.44**	1.86**	1.77**	1.35**
Belgium	0.19**	-0.01	0.10*	0.25**	-0.15**
Canada	0.90**	1.43**	0.99**	0.63**	1.03**
Denmark	0.63**	0.20*	0.65**	0.58**	0.38**
Finland	1.35**	1.50**	1.51**	1.49**	1.35**
France	0.40**	-0.11	0.50**	0.47**	-0.16**
Germany	0.44**	0.35**	1.05**	0.11**	0.18**
Greece	0.47**	0.25**	0.80**	-0.31**	0.05
Ireland	0.93**	0.19**	0.31**	0.88**	0.22**
Italy	1.73**	1.46**	1.78**	1.21**	1.35**
Japan	1.24**	1.09**	1.20**	0.95**	0.98**
Netherlands	0.47**	0.44**	0.49**	0.52**	0.17**
New Zealand	0.58**	0.52**	0.34**	0.96**	0.54**
Portugal	0.53**	0.30**	0.37**	0.28**	1.18**
Spain	0.86**	0.80**	0.64**	0.67**	0.28**
Switzerland	1.15**	0.88**	1.20**	1.09**	0.55**
U.K.	0.86**	0.52**	0.98**	0.75**	0.16**
U.S.	0.26**	0.17**	0.58**	-0.04	0.04*

a. The reported numbers are the saving retention coefficients from the regressions of ΔI on ΔS without an equality restriction on the coefficients across countries. The definitions of models are in table 1. The number of lags in shocks is set at 2.

All the regressions are estimated by the MLE method described in section 2.

*. Significant with the 5 percent level.

** . Significant with the 1 percent level.

Table 4. Effects of global shocks on saving retention coefficient^a

# of lags in shocks	Model 0	Model 1 (Productivity Shocks)	Model 2 (Fiscal Shocks)	Model 3 (TOT Shocks)	Model 4 (All Three Shocks)
0		0.59	0.65	0.68	0.56
1	0.69	0.51	0.63	0.59	0.52
2		0.48	0.59	0.49	0.43

a. The saving retention coefficient is derived from the regression of the residuals of ΔI on the residuals of ΔS , where the residuals are derived from the regressions of ΔI and ΔS on global shocks only.

All the regressions are estimated by the MLE method described in section 2..

All the correlation coefficients are significant with the 1 percent level.

Table 5. Effects of country differences on saving retention coefficient^a

Size of GNP^b

	Model 0	Model 1	Model 2	Model 3	Model 4
Large	0.84	0.56	0.84	0.79	0.57
Medium	0.76	0.60	0.77	0.72	0.61
Small	0.84	0.66	0.78	0.88	0.66

Size of Non-Traded Sector^c

	Model 0	Model 1	Model 2	Model 3	Model 4
Large	0.83	0.50	0.84	0.84	0.51
Medium	0.97	0.73	1.00	0.86	0.71
Small	0.55	0.53	0.52	0.56	0.53

a. I perform separate regressions, including the country specific effects, for each group of countries. The number of countries in each group—large, medium, small—is 6, 7, and 6, respectively.

b. Groups are selected according to the size of the average real GNP denominated in the U.S. dollar.

c. Groups are selected according to the size of the nontraded sector which is approximated by the average of $-(\text{import}/\text{GNP})$ in the 1980s.

<APPENDIX>

Data

The data for saving and investment, annual from 1960 to 1992, is taken from International Financial Statistics (IFS), IMF. Saving is defined as the GNP (line 99a) plus net unilateral transfers (line 77afd plus 77agd) minus government spending (line 91f) and consumption (line 96f). In the case of Spain, there are substantial statistical discrepancies in national accounts and these are corrected by defining the GNP endogenously as $C + I + G + CA$, where CA denotes the current account (line 77ad). Investment is gross fixed capital formation (line 93e) plus change in stocks (line 93i). For the U.S., the government spending is line 91ff less 93gf and the gross fixed capital formation is derived by adding private and government gross fixed capital formations (line 93ee plus 93gf).

I convert the data in different currency units to a common currency unit, the U.S. dollar. I also convert Y , G , and I to real values using GDP deflator and C using CPI (line 64) since CPI better reflects the price of consumption goods. I use the GNP deflator instead of the GDP deflator for Japan and Germany.

Productivity shocks are defined as the annual percentage change in productivity. For the measure of productivity, I use Solow residuals derived from the Cobb-Douglas production function assuming fixed capital stock, $A_t = Y_t/L_t^\alpha$. Glick and Rogoff (1995) argue that adjusting for capital inputs should not produce radically different results since, if one explores US data, short-term movements in capital are small relative to short-term movements in labor. One might argue that the problems in constructing comparable capital stock measures in cross-country data are so severe that attempts to adjust for capital inputs are not that reliable.

The value of α , the share of labor in manufacturing output, for G-7 countries are from Stockman and Tesar (1995), and for other countries α is assumed to be 0.6. The employment data is taken from IFS (line 67) or Labor Force Statistics, OECD. For Belgium and Portugal, I use Labor Force Statistics instead of IFS. Industrial production data comes from IFS (line 66) or Industrial Statistics Yearbook, UN. For Denmark, New Zealand, Portugal, and Switzerland, I use the Industrial Statistics Yearbook instead of IFS.

Fiscal shocks are defined as the percentage change in unexpected government spending because the use of aggregate government spending as fiscal shocks may cause an endogeneity problem with other macroeconomic variables. To construct data for the unexpected change in government spending, I assume that policymakers determine the growth rate of government spending at the start of a fiscal year considering the predicted annual GNP growth rate and the previous year's net government debt growth rate.

I also test other variables in policy reaction function such as the inflation rate and the unemployment rate. However, these variables produce insignificant coefficients and in some cases incorrect signs. The data for government debt is constructed using government surplus in national currencies from IFS (line 80). Assuming policymakers have static expectations in predicting the GNP growth rate, I run the country-by-country OLS regression of the growth rate of real government spending at time t on the growth rates of real GNP and real net government debt at time $t-1$ and use the residuals as data for unexpected government

spending.

The following estimation results are not reported in the paper: GNP growth rates have positive and significant effects on government spending in most countries, which shows that governments increase their spending when the economy is expected to grow. The growth rates in net government debt have negative effects on government spending in many countries but they are insignificant. A negative coefficient implies that governments reduce their spending when the level of debt grows at a faster rate.

TOT shocks are defined as the percentage change in TOT—export price/import price. Export and import prices are unit values of exports and imports from IFS (line 74, 75), respectively. For Portugal, Australia, Sweden, and Switzerland, I use export and import prices instead of unit values.

Table A1. Unit Root Tests

Country		Y	C	G	S	I
Australia	$\hat{\gamma}$	0.63	0.42	0.74	0.78	0.51
	Z_t (L)	-3.00	-4.20**	-2.69	-2.35	-2.72
	Z_t (D)	-5.22**	-6.23*	-4.00*	-4.20**	-5.92**
Austria	$\hat{\gamma}$	0.82	0.71	0.92	0.74	0.71
	Z_t (L)	-1.98	-2.28	-1.62	-2.31	-2.36
	Z_t (D)	-5.14**	-7.09**	-3.82*	-5.71**	-5.69**
Belgium	$\hat{\gamma}$	0.88	0.91	1.01	0.67	0.78
	Z_t (L)	-1.70	-1.68	-0.54	-2.44	-2.21
	Z_t (D)	-5.43**	-3.63*	-3.18	-8.12**	-6.00**
Canada	$\hat{\gamma}$	0.74	0.80	0.73	0.64	0.67
	Z_t (L)	-2.45	-2.40	-2.63	-2.63	-2.41
	Z_t (D)	-3.91**	-3.58*	-4.29**	-4.84**	-5.55**
Denmark	$\hat{\gamma}$	0.77	0.79	1.00	0.92	0.76
	Z_t (L)	-2.19	-2.03	-0.17	-1.19	-2.13
	Z_t (D)	-5.20**	-5.19**	-4.95**	-4.27**	-5.16**
Finland	$\hat{\gamma}$	0.81	0.82	0.86	0.83	0.74
	Z_t (L)	-2.24	-2.20	-1.61	-1.89	-2.22
	Z_t (D)	-1.95	-2.47	-6.55**	-3.14	-3.20
France	$\hat{\gamma}$	0.88	0.85	0.87	0.83	0.79
	Z_t (L)	-1.72	-1.42	-1.90	-2.01	-2.10
	Z_t (D)	-4.03*	-6.38**	-4.27**	-4.54*	-5.15**
Germany	$\hat{\gamma}$	0.84	0.89	0.98	0.84	0.69
	Z_t (L)	-1.94	-1.86	-0.75	-1.39	-2.58
	Z_t (D)	-4.01*	-2.96	-3.96*	-5.61**	-4.36**
Greece	$\hat{\gamma}$	0.91	0.93	0.75	0.57	0.84
	Z_t (L)	-1.19	-1.06	-2.38	-3.01	-1.70
	Z_t (D)	-5.54**	-4.88**	-4.76**	-6.31**	-5.57**
Ireland	$\hat{\gamma}$	0.99	0.73	0.82	1.07	0.79
	Z_t (L)	-0.82	-2.73	-2.26	0.50	-1.91
	Z_t (D)	-3.66*	-3.68*	-3.33	-4.70**	-4.67**

Table A1. Unit Root Tests (continued)

Country		Y	C	G	S	I
Italy	$\hat{\gamma}$	0.64	0.72	0.85	0.93	0.66
	Z_t (L)	-2.60	-2.66	-1.66	-0.51	-2.28
	Z_t (D)	-5.03**	-4.65**	-5.66**	-6.35**	-7.78**
Japan	$\hat{\gamma}$	0.92	0.70	0.82	0.98	0.84
	Z_t (L)	-1.40	-2.57	-2.50	-0.54	-1.98
	Z_t (D)	-3.88*	-4.93**	-3.95*	-4.13**	-3.63*
Netherlands	$\hat{\gamma}$	0.91	0.92	0.97	0.87	0.79
	Z_t (L)	-1.62	-1.62	-0.85	-1.56	-2.13
	Z_t (D)	-4.17**	-3.34	-4.41**	-4.76**	-4.83**
New Zealand	$\hat{\gamma}$	0.82	0.82	0.81	0.60	0.73
	Z_t (L)	-1.96	-1.76	-1.33	-2.98	-2.34
	Z_t (D)	-5.21**	-4.31*	-6.20**	-5.58**	-5.33**
Portugal	$\hat{\gamma}$	0.75	0.97	1.02	0.82	0.72
	Z_t (L)	-2.55	-0.71	-0.14	-1.86	-2.73
	Z_t (D)	-3.66*	-4.68**	-5.30**	-4.20**	-3.59*
Spain	$\hat{\gamma}$	0.89	0.88	0.95	0.77	0.85
	Z_t (L)	-1.96	-1.96	-0.59	-2.17	-2.16
	Z_t (D)	-2.82	-3.68*	-6.78**	-3.83*	-3.17
Switzerland	$\hat{\gamma}$	0.80	0.88	0.80	0.78	0.75
	Z_t (L)	-2.33	-2.01	-2.43	-2.25	-2.59
	Z_t (D)	-3.83*	-3.14	-4.15**	-4.38**	-3.73*
U.K.	$\hat{\gamma}$	0.78	0.84	0.74	0.51	0.68
	Z_t (L)	-2.34	-2.07	-2.51	-2.89	-2.54
	Z_t (D)	-3.86*	-3.56*	-4.14**	-5.78**	-4.35**
U.S.	$\hat{\gamma}$	0.65	0.81	0.88	0.65	0.64
	Z_t (L)	-2.80	-2.24	-2.00	-2.70	-2.36
	Z_t (D)	-4.44**	-3.62*	-2.93	-5.15**	-5.92**

Table A1. Unit Root Tests (continued)

Country	Productivity Shocks	Fiscal Shocks	TOT Shocks
Australia	-8.72**	-4.30**	-5.15**
Austria	-4.58**	-6.55**	-6.71**
Belgium	-7.01**	-5.47**	-5.42**
Canada	-4.74**	-4.19**	-3.98*
Denmark	-9.36**	-6.01**	-6.85**
Finland	-4.73**	-6.84**	-4.68**
France	-7.37**	-3.97*	-6.69**
Germany	-5.16**	-5.38**	-4.84**
Greece	-5.67**	-5.54**	-6.74**
Ireland	-5.15**	-5.31*	-6.36**
Italy	-6.57**	-5.56**	-5.03**
Japan	-4.90**	-4.76**	-4.85**
Netherlands	-8.02**	-7.38**	-6.62**
New Zealand	-5.02**	-5.81**	-4.62**
Portugal	-4.60**	-7.47**	-4.10**
Spain	-6.56**	-6.78**	-3.96**
Switzerland	-4.88**	-5.25**	-6.88**
U.K.	-5.43**	-4.30**	-4.87**
U.S.	-5.42**	-3.40	-5.56**

a. I report the test statistics of the Phillips Z_t unit root test. The null hypothesis that the variable y_t has a unit root is $H_0 : \hat{\gamma} = 1$ in $y_t = \hat{\alpha} + \hat{\beta}t + \hat{\gamma}y_{t-1} + \hat{u}_t$. $Z_t(L)$ and $Z_t(D)$ are test statistics with level and first differenced data, respectively. $\hat{\gamma}$ is the estimate of the first order autoregressive parameter.

I include a constant term and time trend in the fitted regression and the bandwidth is determined automatically by Gauss COINT program. The critical values are -3.17 with a 10% critical level, -3.46 with a 5% critical level, and -4.09 with a 1% critical level.

*. Reject H_0 at a 5% significance level.

** . Reject H_0 at a 1% significance level.

Table A2. Cointegration Tests of Saving and Investment^a

Country	ADF test		Phillips Z_t test	
	$\hat{\gamma}$	statistic	$\hat{\gamma}$	statistic
Australia	0.42	-1.66	0.54	-2.54
Austria	0.20	-2.77	0.24	-4.47*
Belgium	0.77	-2.43	0.85	-2.03
Canada	0.69	-2.46	0.81	-1.98
Denmark	0.74	-1.69	0.80	-1.89
Finland	0.74	-1.92	0.74	-2.44
France	0.40	-2.09	0.57	-2.38
Germany	0.70	-2.12	0.70	-2.70
Greece	0.48	-2.36	0.52	-2.97
Ireland	0.71	-2.00	0.74	-2.34
Italy	0.52	-2.44	0.56	-3.10
Japan	0.78	-2.06	0.81	-2.19
Netherlands	0.61	-2.84	0.74	-2.55
New Zealand	0.66	-1.84	0.72	-2.15
Portugal	0.44	-3.08	0.65	-2.79
Spain	0.50	-2.83	0.74	-2.28
Switzerland	0.10	-3.89	0.42	-3.74
U.K.	0.50	-2.81	0.63	-2.92
U.S.	0.41	-3.06	0.74	-2.28

a. The first column is the Augmented Dickey-Fuller (ADF) test statistics and the second column is the Phillips Z_t test statistics. Both constant term and time trend are included. I set the number of lagged first difference terms in the ADF test at two. The bandwidth in Z_t test is automatically selected by Gauss COINT program. For both ADF and Z_t tests, the critical values are -3.92 (5%) and -4.50 (1%).

*. Reject H_0 at a 5% significance level.

** . Reject H_0 at a 1% significance level.