The Feldstein-Horioka fact

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Abstract

This paper shows that general equilibrium effects can partly rationalize the high correlation between saving and investment rates observed in OECD countries. We find that once controlling for general equilibrium effects the saving-retention coefficient remains high in the 70's but decreases considerably since the 80's, consistently with the increased capital mobility in OECD countries.

JEL Classification: C23, F32, F41.

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1 Introduction

The Feldstein-Horioka puzzle is one of the six major puzzles in International Macroeconomics (Obstfeld and Rogoff, 2000). Domestic saving and investment rates are highly correlated both within and between OECD countries: in years when and countries where saving is high, so is investment. This fact seems incompatible with the Intertemporal Theory of the Current Account. Assuming perfect capital mobility, such a theory predicts that the determinants of saving and investment are not the same. Hence, countries should borrow and lend abroad whenever they need to invest or disinvest, without being constrained by domestic saving decisions. Feldstein and Horioka (1980) interpreted their finding as evidence of low capital mobility among OECD countries. However, in the decades following the publication of Feldstein and Horioka results, capital mobility among OECD countries has kept on increasing while the correlation between saving and investment rates has only slightly decreased[1].

On the other hand, the Intertemporal Theory of the Current Account fails to consider general equilibrium effects and the latters, it has been argued, could provide an explanation for the puzzle (see Ventura, 2003). Since the world, as a whole, is a closed economy, world saving and investment have to be equal. Consequently, a common shock which, say, positively affects saving decisions of most countries, tends to create imbalance in world capital markets and decreases the world interest rate. This, in turn, increases world investment and generates a positive correlation between saving and investment in all countries.

Partial equilibrium predictions of the theory are more likely to hold, then, in response to idiosyncratic sources of fluctuations whose effect on world capital markets is likely to be negligible. Since global shocks are acknowledged to be an important

[1]This finding is relatively robust for OECD countries as a whole. However, some studies have found evidence of a reduction of the correlation between saving and investment limited to specific groups of countries and sub-periods (for a survey, see Coakley, Kulasi, and Smith, 1998). Recently, Blanchard and Giavazzi (2002) finds that the correlation between saving and investment rates has decreased in the 90's but only in euro area countries

force driving the world business cycle (see, for example, Gregory and Head, 1999; Kose, Otrok, and Whiteman, 2003), general equilibrium effects should reconcile theory and evidence. However, general equilibrium explanations of the Feldstein-Horioka finding never found adequate empirical support since the saving-investment correlation does not decrease when controlling for global shocks (see, for example, Glick and Rogoff, 1995; Ventura, 2003). Consequently, a belief has risen that the high saving - investment correlation can only be explained by introducing frictions in international good or financial markets (Ventura, 2003; Obstfeld and Rogoff, 2000, are two examples of this view).

This paper revisits the general equilibrium explanation and shows that, unlike what claimed by existing empirical studies, it does help to rationalize the puzzle. Previous attempts to control for the effects of global shocks in saving and investment regressions assume homogeneity of their transmission mechanisms across countries. However, there are no theoretical reasons to focus only on global shocks that have homogeneous effects. In fact, also global shocks with heterogenous effect can create imbalance on the world capital market, unless the nature of the heterogeneity is such that the effect in a group of countries is perfectly offset by the opposite effect in the rest of the world.

We propose a new methodology, factor augmented panel regression, to isolate idiosyncratic sources of fluctuations. It improves on existing studies since countries are allowed to react with specific sign and magnitude to global shocks. We show that the homogeneity restriction is rejected by the data and biases the estimation of the saving-retention coefficient. Indeed, allowing for heterogeneous propagation mechanism of global shocks, the saving-retention coefficient drops significantly from the 80's on, consistently with the increase in capital mobility across OECD countries.

The structure of the paper is the following. In section 2, we review commonly used methods to control for global sources of fluctuations and propose the novel factor augmented panel regression. Section 3 presents empirical results. Section 4 concludes.

2 General Equilibrium and the saving-retention coefficient

Many studies document the existence of strong cross country linkages in macroeconomic fluctuations (for a survey see Kose, Otrok, and Whiteman, 2003). This suggests that international fluctuations are driven by few common sources which can generate positive correlation between saving and investment through general equilibrium mechanisms. Such positive correlation is not in contradiction with the partial equilibrium Intertemporal Theory of the Current Account, whose predictions are conditional on idiosyncratic (country specific or regional) shocks which, not affecting all the countries, are unlikely to generate imbalance in the world capital market.

Formally, consider the following representation for saving ($S_{j,t}$) and investment ($I_{j,t}$) rates[2] of country j at time t:

$$S_{j,t} = \lambda^S_{1,j} f_{1,t} + \ldots + \lambda^S_{r,j} f_{r,t} + S^{id}_{j,t} \tag{1}$$

$$I_{j,t} = \lambda^I_{1,j} f_{1,t} + \ldots + \lambda^I_{r,j} f_{r,t} + I^{id}_{j,t} \tag{2}$$

where $f_{i,t}, i = 1, \ldots, r$ are few global factors affecting saving and investment rates of all countries while $S^{id}_{j,t}$ and $I^{id}_{j,t}$ are the idiosyncratic components of saving and investment rates that are assumed to be driven by non pervasive (idiosyncratic) shocks. The factor loadings $\lambda^S_{i,j},\ \lambda^I_{i,j}$ $(j = 1, \ldots, N,\ i = 1, \ldots, r)$ are country specific and capture the heterogeneity in the transmission mechanisms of global shocks. In particular, each variable can react with a specific sign and intensity to the global factors $f_{i,t}$ $(i = 1, .., r)$[3].

For the reasons outlined above, the Intertemporal Theory of the Current Account refers to idiosyncratic components of saving and investment rates. We consider the

[2] Saving and investment rates are computed, respectively, as the ratio of saving and investment to GDP

[3] Heterogeneous dynamic responses of saving and investment rates of each country are also allowed since some factors can be the lagged version of others. For example, a model with one global factor with contemporaneous and lagged effects is a particular case of (1) and (2) with $r = 2$ and $f_{2,t} = f_{1,t-1}$.

following relationship

$$I^{id}_{j,t} = \alpha_j + \beta S^{id}_{j,t} + \varepsilon_{j,t} \qquad (3)$$

where β is the saving-retention coefficient conditional to idiosyncratic shocks or, in terms of long run fluctuations,

$$\frac{1}{T}\sum_{t=1}^{T} I^{id}_{j,t} = \bar{\alpha}_j + \beta_L \frac{1}{T}\sum_{t=1}^{T} S^{id}_{j,t} + \bar{\varepsilon}_j \qquad (4)$$

Equations (1) and (2) imply that (3) and (4) can be rewritten in terms of observable saving and investment rates as

$$I_{j,t} = \alpha_j + \beta S_{j,t} + \delta_{1,j} f_{1,t} + \ldots + \delta_{r,j} f_{r,t} + \varepsilon_{j,t} \qquad (5)$$

and

$$\frac{1}{T}\sum_{t=1}^{T} I_{j,t} = \bar{\alpha}_j + \beta_L \frac{1}{T}\sum_{t=1}^{T} S_{j,t} + \delta^L_{1,j} \frac{1}{T}\sum_{t=1}^{T} f_{1,t} + \ldots + \delta^L_{r,j} \frac{1}{T}\sum_{t=1}^{T} f_{r,t} + \bar{\varepsilon}_j \qquad (6)$$

where $\delta_{i,j} = \left(\lambda^I_{i,j} - \beta\lambda^S_{i,j}\right)$ and $\delta^L_{i,j} = \left(\lambda^I_{i,j} - \beta_L\lambda^S_{i,j}\right)$. Notice that the coefficients $\delta_{i,j}$ and $\delta^L_{i,j}$ can vary along the cross section dimension since they are function of factor loadings of domestic saving and investment rates in different countries. Assume, for example, that $\beta = 0$ or $\beta_L = 0$, in equation (3) and (4); in that case, the $\delta_{i,j}$'s or $\delta^L_{i,j}$'s would be equal across countries only if the $\lambda^I_{i,j}$ were equal across countries or, in other words, if the response of the investment rates to common shocks was the same in all countries.

Let us investigate the consequences of equation (5) and (6) for the methodologies commonly used in the Feldstein-Horioka debate. We argue that, indeed, all of them are not robust to the introduction of heterogeneity in the transmission mechanisms of global shocks.

In their seminal paper, Feldstein and Horioka performed the following "long run" regression:

$$\frac{1}{T}\sum_{t=1}^{T} I_{j,t} = \mu + \beta_L \frac{1}{T}\sum_{t=1}^{T} S_{j,t} + \bar{\eta}_j \tag{7}$$

Temporal aggregation averages out from the data short and medium run fluctuations. Therefore, the long run regression (7) is able to control for short and medium run effects of global shocks on saving and investment. On the other hand, time aggregation does not average out the long run effects of global factors. Whenever these effects are significantly different across saving and investment rates in different countries, the country specific long run effect of global shocks $\left(\delta_{1,j}^{L}\frac{1}{T}\sum_{t=1}^{T} f_{1,t} + \ldots + \delta_{r,j}^{L}\frac{1}{T}\sum_{t=1}^{T} f_{r,t}\right)$ will not be captured by the constant term μ and, hence, will be contained in the error $\bar{\eta}_j$. Since observed saving is also affected by global shocks, the estimation of β_L is not consistent.

Estimation methods alternative to the long run regression of Feldstein and Horioka have been proposed in order to investigate the relation between saving and investment rates and, invariably, they end up with results that point to a high correlation. Let us start considering the consequences of estimating β by a "baseline panel regression" or, more precisely,

$$I_{j,t} = \alpha_j + \beta S_{j,t} + \eta_{j,t} \tag{8}$$

when the data generating process is given by (1) and (2). From (5) it can be easily seen that the error term $\eta_{j,t}$ contains the common factors and is correlated with the regressors. Then, the estimates based on equation (8) are not consistent.

A method generally proposed to correct for this problem consists in adding time dummies to the "baseline panel regression" (8) by specifying the following regression equation

$$I_{j,t} = \alpha_j + \gamma_t + \beta S_{j,t} + \zeta_{j,t} \tag{9}$$

where γ_t is the so called "time effect"[4]. However this method is not always appropriate.

[4] For an application of this methodology to the Feldstein - Horioka debate, see, for example, Ventura (2003).

In fact, comparing equation (9) with equation (5), it is possible to see that time effects can properly capture comovement only if each global factor has the same effect across countries (i.e. $\delta_{i,j} = \delta_{i,h}$ for each j, h). Otherwise, the estimate of β remains inconsistent. Again, this specification doesn't take into account the possibility of heterogeneous transmission mechanisms of global shocks[5].

In conclusion, if global shocks propagate heterogeneously across countries, the relationship between idiosyncratic components of saving and investment rates cannot be consistently estimated by the regressions commonly used in Feldstein and Horioka type of analysis. However, equation (5) suggests that we can relax the homogeneity assumption by plugging directly the common factors into the baseline panel regression, without imposing any restriction on the country specific coefficients ($\delta_{i,j}, j = 1, \ldots, N, i = 1, \ldots, r$). The idea is to control for the factors that affect all countries, for example oil shocks or global productivity shocks, and, hence, could create imbalance on the world capital market. In addition, we could control for those variables that are mainly affected by global shocks and capture the closed economy constraint for the world economy, for example world investment and world interest rate. This approach is problematic since global shocks or variables like the world interest rate are actually unobservable.

Our approach consists in extracting the global factors directly from saving and investment rates by cross country aggregation. In fact, since the idiosyncratic components are driven by non pervasive (country specific or regional) shocks, by worldwide aggregation they are averaged out and what survives are only the factors affecting saving and investment rates in all countries. More precisely, as shown by Forni, Hallin, Lippi, and Reichlin (2000) and Stock and Watson (2002), the components of the factor model in (1) and (2) are identified and the unobserved global factors ($f_{i,t}, i = 1, \ldots, r$) can be

[5] Idiosyncratic components of saving and investment can also be estimated as the deviation of saving and investment from their OECD wide counterparts as Ostergaard, Sorensen, and Yosha (2002) that studies the excess sensitivity of consumption in US states and provinces. However, it can be shown that this methodology is equivalent to estimate equation 9 with time dummies as in Ventura (2003).

estimated, provided that the number of countries under analysis is large. Hence, we plug estimated factors in equation (5), obtaining the following *factor augmented panel regression*:

$$I_{j,t} = \alpha_j + \beta S_{j,t} + \delta_{1,j}\hat{f}_{1,t} + \ldots + \delta_{r,j}\hat{f}_{r,t} + \varepsilon_{j,t} \tag{10}$$

In order to implement this methodology, we need to estimate r, the number of global factors and the global factors $f_{1,t}, \ldots, f_{r,t}$ themselves.

Forni and Reichlin (1998) and Pesaran (2006) have proposed to estimate the common factors by means of cross country aggregates, such as the global investment rate[6]. As pointed out above, data aggregates converge to the common factors as the cross-sectional dimension increases, because the idiosyncratic components are averaged out. However, this approach may be problematic if there is more than one common factor. Forni, Hallin, Lippi, and Reichlin (2000) and Stock and Watson (2002) have proposed to estimate the common factors, $f_{1,t} \ldots, f_{r,t}$, by means of the first r principal components. Consistency of this estimator is achieved as both the number of series and observations increase. These estimates are robust with respect to some form of non-stationarity in the data[7]. Moreover, the estimated factors can be considered as they were known provided that the number of countries is not too small relative to the sample size[8].

For what concerns the number of the common factors, r, there have been different proposals essentially based on the percentage of variance explained by each principal component. A rule of thumb proposed in Forni and Reichlin (1998) suggests to retain only principal components that explain more than a certain threshold percentage of the panel variance. Bai and Ng (2002) formalize this idea by constructing a criterion based on a data-dependent threshold.

[6] Computed as the ratio of global investment to global GDP

[7] For time varying factor loadings and structural breaks see Stock and Watson (2002) while for unit roots in the factors see Bai (2004).

[8] More formally, authors'calculations based on Bai (2003) and Bai and Ng (2006) show that factors can be treated as known if the number of countries is larger than the square root of the sample size since there is no generated regressor problem (Pagan, 1984; Bernanke and Boivin, 2003; Bai and Ng, 2006)

Finally, while studying in depth the heterogeneity in the transmission mechanisms of global shocks, we maintain throughout this and next section the assumption of a fixed saving retention coefficient (β) across countries. Such coefficient is meant to provide an overall assessment of the correlation between saving and investment left over after properly controlling for global shocks, that is all we need to evaluate the general equilibrium explanation of the Feldstein - Horioka puzzle.

3 Empirics

3.1 Global fluctuations

This section studies the features of the International Business Cycles focusing on their implications for the saving and investment debate. Our database consists in annual data on saving and investment rates of 23 OECD countries for the period 1970 - 2004[9]. The extent of cross-country linkages can be measured by the correlation of domestic saving and investment with respect to their OECD wide counterpart. By regressing domestic saving and investment rates onto the global OECD investment rates, we capture a remarkable 48% of the variance, on average[10]. An other option is to look at OECD wide aggregates that maximize the explainable variance. Principal components of the covariance matrix of the data have this property.

INSERT TABLE 1 HERE

In table 1, we show that the first principal component explains 53% and the second principal component about 13% of the variance of domestic saving and investment rates, on average. Then, at least two principal components explain more than 10% of the panel variance and capture, overall, about 66% of the panel variance. Consequently, the rule

[9] More details on data sources can be found in the data appendix at the end of the paper.

[10] It is worth noticing that the difference between OECD wide saving and investment is insignificant since the OECD countries as a whole can be seen as a closed economy.

of thumb proposed by Forni and Reichlin (1998) would suggest at least two common factors[11]. On the other hand, the Bai and Ng (2002) criterion proves inconclusive in our panel. These results show that cross country linkages in saving and investment rates of OECD countries are strong. Following Forni, Hallin, Lippi, and Reichlin (2000) and Stock and Watson (2002), we can conclude that the factor model representations (1) and (2) describe well our data.

Moreover, the global factors have also a strong long run effect on saving and investment rates of OECD countries: one aggregate accounts for more than 67% of the long run panel variance[12]. In addition, by looking at the percentage of the variance of domestic saving and investment rates explained by global factors, it is evident how their impact varies considerably across countries (see Figures 1 and 2).

INSERT FIGURES 1 and 2 HERE

These findings are consistent with Kose, Otrok, and Whiteman (2003), who highlight both strong persistence and heterogeneity in the transmission mechanisms of global shocks. This suggests that, in order to properly control for general equilibrium effects, it is important to take into account that countries react with specific sign, magnitude and lag structure to global shocks.

As stressed in section 2, aggregates like those used above provide consistent estimates of the global factors for large sample size and cross section dimension. Given the existence of two global factors, a single aggregate like the OECD investment rate is not sufficient to fully capture the effect of global shocks. Hence, the first two principal components are the most appropriate estimators.

On the other hand, principal components have an important drawback with respect to aggregates like, say, the global OECD saving or investment rate: they miss a clear

[11] Since the third principal component explains about 10% of the panel variance, we perform robustness checks of our empirical results assuming three common factors

[12] The aggregate we consider is the first principal component of the spectral density matrix at frequency zero. It is worth noting that the latter represents the covariance matrix of the sample mean.

intuition. While well suited to assess the strength of cross country linkages and to estimate the factor space, in general they do not have an economic interpretation. In order to get an intuition on the nature of the principal components, we look at their relation with economic aggregates. In Figure 3, we plot the first principal component and the Global OECD investment rate.

INSERT FIGURE 3 HERE

These two aggregates are very similar and their correlation coefficient is 0.94. A good candidate for the second principal component should be a variable mainly driven by common shocks and not collinear with the global investment rate. For example, the Global OECD Saving rate is not appropriate because it satisfies the first but not the second requirement. The world interest rate, on the other hand, is a good candidate because, given its role in clearing the world capital market, it is expected to react to shocks that tend to create imbalances between world investment and saving. Unfortunately, a measure of the world interest rate is not available and its construction is problematic (see Barro, 1991). For this reason we use two proxies, the long run US interest rate and the average long run interest rate of the G7 countries. The correlation between the second principal component and US long run interest rate is 0.86 while, for the average of the G7 long run interest rates, it is 0.75. In Figure 4, we plot these variables against the second principal component.

INSERT FIGURE 4 HERE

It is apparent how the two proxies of the world interest rate and the second principal component have similar dynamic behavior and, notably, they peak at the same time at the beginning of the $80's$. These results highlight the ability of our estimates of the common factors to capture the global forces driving prices and quantities in the world capital market.

3.2 Saving-Investment regressions

In this subsection, we present results on the Feldstein - Horioka puzzle. We analyze the whole sample $1970-2004$ and the three subsamples $1970-1979, 1980-1989$ and $1990-2004$ since we aim to study how the relation between saving and investment rates has been affected by the fast process of integration of financial and good markets in OECD countries. Our results are summarized in table 2. In order to investigate the effects of misspecification of the number of global factors, we consider two different specifications for the factor augmented panel regression, equation 10. The first with only one factor estimated by the Global OECD Investment rate (Equation $10a$), the other with two common factors estimated by principal components (Equation $10b$).

INSERT TABLE 2 HERE

Consider, first, results for the sample $1970-2004$. It is evident that, once controlling for general equilibrium effects, the Feldstein - Horioka puzzle is de-emphasized. Both "long run" and "baseline panel" regressions further document the puzzle: the estimated saving - retention coefficient is high and significant. On the other hand, no matters how we control for global comovements, the coefficient is significantly reduced, even if it remains statistically different from zero. This is a clear evidence of the relevance of general equilibrium effects for explaining the correlation of saving and investment. However, if not properly taken into account, the heterogeneity of the transmission mechanism of global shocks biases upwards the estimated saving retention coefficient. In fact, in terms of point estimates, the coefficient is smaller for the factor augmented panel regressions (Equations $10a$ - b)[13]. The mis-specification of the number of factors is another source of upward bias: the saving-retention coefficient estimated by controlling for one factor (Equation $10a$) is higher than that estimated by controlling for two

[13]Indeed, the homogeneity restriction $\delta_{i,j} = \delta_{i,h}$, $(i = 1, 2)$, for each country (j, h) in equation $10b$ is strongly rejected by the data (see Table 3 at the end).

factors (Equation 10b). Notice that the high number of significant coefficients (δ's) on the second principal component in Equation 10b provides further evidence that the OECD wide investment rate is not able, alone, to account for the effects of global shocks on saving and investment rates in OECD countries. On the other hand, by means of principal components we are able to fully capture the closed economy constraint on aggregate saving and investment without relying on specific unobservable variables such as the world interest rate. However, further research is needed to give a structural interpretation to our estimates of the global factors.

Results from sub-samples allow us to analyze the evolution over time of the saving - retention coefficient[14]. From the baseline regression we would conclude that the estimated saving-retention coefficient in the $80's$ decreased relative to the $70's$ but then it stabilized, remaining high and significant. When controlling for global comovement, we observe a marked reduction in the correlation between saving and investment rates. In particular, using the appropriate number of aggregates and taking heterogeneity of transmission mechanisms of global shocks into account, a clear break in the 80's appears: the saving - retention coefficient is high in the 70's and, then, significantly drops becoming insignificantly different from zero in the last 25 years[15].

It is worth noticing that the temporal path in our estimates of the saving - retention coefficient is consistent with the widely documented evolution in the degree of international capital mobility that was low during the 70's and has been steadily increasing since the early 80's.

[14] The common factors in equation 10 are computed by estimating the first two principal components in each subperiod under analysis. However, qualitative results do not change if we estimate factors on the whole sample. This is not surprising, given the robustness of principal components estimators to some forms of parameter instabilities (Stock and Watson, 2002).

[15] We performed two sets of robustness checks. First, results in table 2 refer to the full cross-section of countries. However, Mexico and Korea were not part of the OECD for a large span of our sample. However, excluding Mexico and Korea from our panel does not affect the results. Second,we performed regression 10b considering also a specification with three common factors. Except for a reduction of the correlation in the $70's$ relative to the specification with two global factors, the results are not affected by the inclusion of the third factor.

Summing up, the empirical evidence suggests that, as originally claimed by Feldstein and Horioka in their seminal paper, the Intertemporal Theory of the Current Account failed to explain the relation between saving and investment rates before the 80's. Instead, from the 80's on, the relation between saving and investment has become closer to what predicted by the Intertemporal Theory of the Current Account. Given the partial equilibrium nature of this theory, if we do not isolate idiosyncratic sources of fluctuations taking heterogeneous responses of saving and investment rates to global shocks into account, this fact remains hidden.

4 Conclusions

This paper shows that, unlike what claimed by previous studies, general equilibrium effects can partly rationalize the high correlation between saving and investment rates observed in OECD countries. We develop a factor augmented panel regression that enables to isolate idiosyncratic sources of fluctuations. Contrary to existing studies, our approach allows for heterogeneous responses of saving and investment rates to global shocks. Empirical results show that the homogeneity restriction that is usually imposed biases upwards the estimated correlation between saving and investment rates. Relaxing this assumption we find that the correlation among saving and investment rates decreases over time becoming very small in the last two decades. This finding is consistent with the empirical evidence that international capital mobility has increased in the last decades.

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Tables and Figures in main text

TABLES

Table 1: **Share of the overall panel variance explained by static principal components.**

	1st	**2nd**	**3rd**	**4th**	**5th**
Marginal	0.5292	0.1293	0.0998	0.0549	0.0371
Cumulative	0.5292	0.6585	0.7583	0.8132	0.8503

Table 2: **Regression results**

	Sample			
Type of Regression	**70-04**	**70-79**	**80-89**	**90-04**
Long Run regression (Eq. 7)	**0.60** [0.11]	**0.61** [0.13]	**0.62** [0.10]	**0.50** [0.11]
Baseline (Eq. 8)	**0.60** [0.03]	**0.60** [0.13]	**0.37** [0.08]	**0.34** [0.05]
Time Effects (Eq. 9)	**0.42** [0.03]	**0.62** [0.06]	**0.32** [0.07]	**0.29** [0.05]
G.I. rate (Eq. 10a)	**0.34** [0.03]	**0.53** [0.06]	**0.28** [0.07]	**0.23** [0.05]
2 Factors (Eq. 10b)	**0.29** [0.04]	**0.52** [0.11]	**0.14** [0.11]	**−0.03** [0.07]

FIGURES

Figure 1: **Domestic Saving. Percentage of variance explained by the first two factors.**

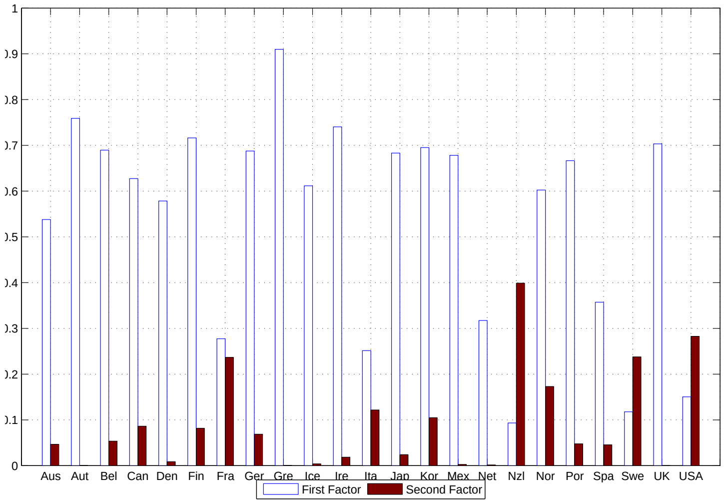


Figure 2: **Domestic Investment. Percentage of variance explained by the first two factors.**

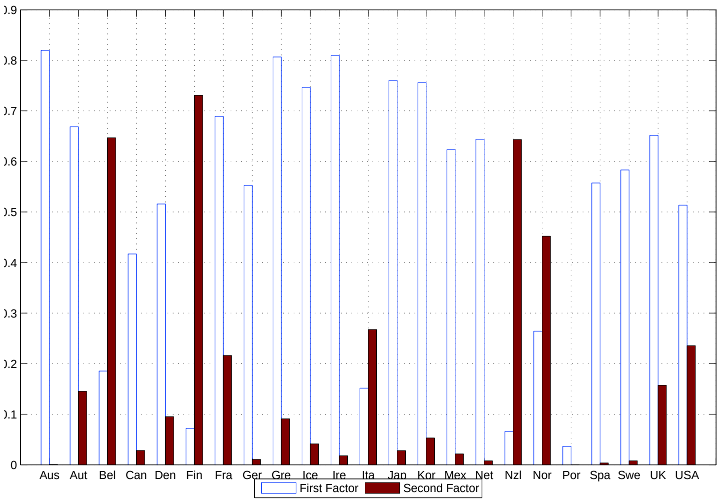


Figure 3: **First Principal Component**

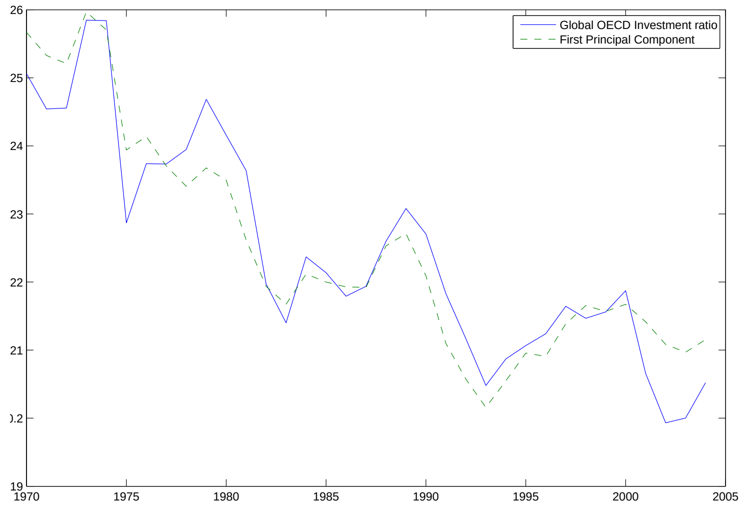
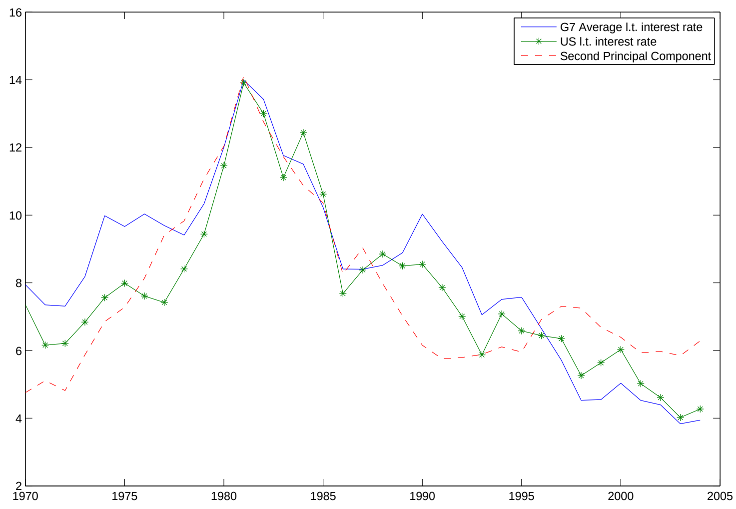


Figure 4: **Second Principal Component**



Appendix 1: Data

Data frequency is annual and the sample ranges from 1970 to 2004.

The source of the data for saving, investment and GDP is OECD, National Accounts, Annual Accounts, Disposable income and net lending - net borrowing.

Investment is Gross Capital Formation. Saving is the sum of Consumption of Fixed Capital and Net Saving. Saving and Investment rates are calculated by the authors as the ratio of Saving and Investment to GDP.

Long term Interest Rates of G7 countries are in OECD Economic Outlook Statistics and Projections/Financial Data.

Data refer to the following 23 countries: Australia, Austria, Belgium, Canada, Germany, Denmark, Spain, Finland, France, United Kingdom, Greece, Ireland, Iceland, Italy, Japan, Korea, Mexico, Netherlands, Norway, New Zealand, Portugal, Sweden and United States.

Appendix 2: Tests of heterogeneity in the coefficients in equation (10b)

Table 3: **Coefficients on the factors in equation (11b). Sample 70-99**

Country	**1st Factor**	**2nd Factor**
Australia	0.20**	0.23
Austria	0.30**	0.08
Belgium	0.38**	0.10
Canada	0.25**	0.21
Denmark	0.42**	−0.03
Finland	0.73**	0.53**
France	0.46**	0.12
Germany	0.36**	−0.03
Greece	0.56**	−0.35**
Iceland	0.66**	0.25*
Ireland	0.50**	0.82**
Italy	0.32**	0.28**
Japan	0.50**	−0.02
Korea	−0.18**	−0.00
Mexico	0.10**	0.32**
Netherlands	0.28**	−0.17
New Zealand	0.35**	0.30**
Norway	0.91**	0.52**
Portugal	0.04	0.69**
Spain	0.18**	−0.43**
Sweden	0.35**	0.21
UK	0.21**	−0.10**
USA	0.02	0.19
F-stat.	**10.21 (0.00)**	**4.10(0.000)**
Chi Sq.-stat.	**224.70 (0.00)**	**90.28 (0.00)**

** Significant at 5% level, * Significant at 10% level.

The null hypothesis of the F and *Chi Square* tests reported in the last two rows of table 3 is

$$H_0 : \delta_{i,j} = \delta_{i,h} \text{ for each } j \text{ and } h$$

and the tests are conducted, separately,on the coefficients of both factors estimated from equation $11b$.