Feldstein-Horioka Paradox Revisited

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A central concern in the field of international finance is always capital mobility. Feldstein and Horioka (1980) propose a simple test for international capital mobility and obtain a sign of very low capital mobility. Their interesting result is often described as the Feldstein-Horioka paradox. This paper reexamines their study using panel data analysis. Following the standard model selection procedure, preferred estimators of the elasticity of domestic investment-GDP ratio on domestic saving-GDP ratio are always significantly lower than one. In the light of our results, the Feldstein-Horioka paradox turns out to be not so robust because of cross country heterogeneities.

Key Words : Panel Data; International Capital Mobility; Feldstein-Horioka Paradox.

I. Introduction

A central concern in the field of international finance is always capital mobility. Indeed, there are many approaches to quantify the extent of international capital mobility in the literature. Among them, Feldstein and Horioka (1980) propose the simplest test. Their basic model is

$$\bar{I}(i) = \alpha + \beta\bar{S}(i) + u_i\,, \tag{1}$$

where $\bar{I}(i) = \frac{1}{T}\sum_{1}^{T}\frac{I_{it}}{GDP_{it}}$, $\bar{S}(i) = \frac{1}{T}\sum_{1}^{T}\frac{S_{it}}{GDP_{it}}$, I means domestic investment, S is domestic savings, u is an error term, and subscript i and t mean country i and time t respectively. The series of studies, such as Feldstein and Horioka (1980), Feldstein (1983), Feldstein and Bacchetta (1989), obtained the estimates of β close to 1. In the case of perfect capital mobility, an exogenous marginal increase in domestic savings could be invested in the country which offers the best returns, hence we expect that there is no correlation between domestic savings and domestic investment. Since the evidence provided by Feldstein and Horioka (1980) (the value of β close to 1) was inconsistent with

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perfect capital mobility, this finding was called "the Feldstein-Horioka Paradox."[1]

Two types of studies followed Feldstein and Horioka (1980). The first line of research (for example, Bayoumi (1990) and Obstfeld (1986)) added more control variables to the right hand side of equation (1) such as the proxy of fiscal policy and the effect of non-traded goods. The second line of study uses the time series data within a country, or regional cross sectional data within a county to estimate equation (1) (see Tesar (1991), Obstfeld (1994) for time series estimates, Bayoumi and Rose (1993) for U.K. regional data, and Dekle (1995) for Japanese regional data).

Although we do not necessarily think that the analysis à la Feldstein and Horioka (1980) is the best way to quantify the degrees of international capital mobility, we follow their research strategy in this paper. This is because we believe that our reexamination of the Feldstein and Horioka (1980) study provides a nice example for emphasizing the importance of controlling country specific heterogeneity in the analysis of cross country panel data.[2]

Our estimation results suggest that (i) one way fixed effect model sometimes dominates a time series model, (ii) a pooling model is always rejected against a time series model or one way fixed effect model, and (iii) based on our model selection procedure, preferred estimates of β coefficients are always significantly lower than one. The results of Feldstein and Horioka (1980) are not robust, contrary to their assertions.

This paper amply demonstrates that it is important to control country specific heterogeneity in the case of a cross country study utilizing panel data. We conjecture that some of the stylized facts obtained from the recent cross country studies, such as endogenous growth theory and analysis of the relationship between central bank independence and economic performance, are subject to the same problem due to the failure to incorporate country heterogeneity.

The organization of this paper is as follows. Section II reviews the various estimation strategies; variations of Feldstein and Horioka (1980). Section III gives our empirical approach. Section IV reports the results of estimation, and Section V provides a brief summary.

II. Statistical Methods and Economic Interpretation

A. Statistical Methods

Let I_{it} be the ratio of domestic investment to GDP, S_{it} be the ratio of domestic savings to GDP, subscript i represents country, and subscript t implies time. Various statistical methods concerning the relationship between I_{it} and S_{it} exist in the literature.

[1]Using a different model from Feldstein and Horioka (1980), French and Poterba (1991) argued that financial investment has a domestic bias.

[2]See Obstfeld (1994) for a general survey on this topic.

The first uses the time series data within a county. The estimate obtained in this way is called a *time series estimator*, hereafter $\hat{\beta}(i)_{ts}$. $\hat{\beta}(i)_{ts}$ is the OLS estimator of equation (2),

$$I_{it} = \alpha_{ts}(i) + \beta_{ts}(i) S_{it} + e_{it}, \ i = given, \ t = 1, \ldots T. \qquad (2)$$

$$E(e_{it}) = 0, \ Var(e_{it}) = \sigma_e^2.$$

The second method uses cross sectionally pooling data. The cross sectional estimate is called a *cross sectional estimator*, hereafter $\hat{\beta}_{cs}(t)$, which is the OLS estimator of equation (3),

$$I_{it} = \alpha_{cs}(t) + \beta_{cs}(t) S_{it} + e_{it}, \ i = 1, \ldots, N, t = given. \qquad (3)$$

Feldstein and Horioka (1980) took a similar strategy as the above cross sectional estimate, however they averaged the data over time for each country before estimation. Such estimator is called a *between estimator* (hereafter $\hat{\beta}_{betw}$), which is the OLS estimator of equation (4),

$$\bar{I}(i) = \alpha_{betw} + \beta_{betw} \bar{S}(i) + e_i, i = 1, \ldots, N, t = 1, \ldots T. \qquad (4)$$

where $\bar{I}(i) = \frac{1}{T} \sum_{1}^{T} \frac{I_{it}}{GDP_{it}}$, $\bar{S}(i) = \frac{1}{T} \sum_{1}^{T} \frac{S_{it}}{GDP_{it}}$.

Note that it is possible to estimate a saving-income relationship without taking into account the differences in time and country. This strategy yields *pooling estimator* $\hat{\beta}_{pool}$, which is the OLS estimator of equation (5),

$$I_{it} = \alpha_{pool} + \beta_{pool} S_{it} + e_{it}, \ i = 1, \ \ldots, \ N, \ t = 1, \ \ldots T. \qquad (5)$$

$$E(e_{it}) = 0, \ Var(e_{it}) = \sigma_e^2.$$

The estimation we shall emphasize in this paper is the *one way fixed effect model.* This method allows for heterogeneity among countries. The *one way fixed effect estimator*, which we call $\hat{\beta}_{of}$, is the OLS estimator of equation (6),

$$I_{it} = \alpha_{of}(i) + \beta_{of} S_{it} + e_{it}, i = 1, \ldots, N, t = 1, \ldots T. \qquad (6)$$

$$E(e_{it}) = 0, \ Var(e_{it}) = \sigma_e^2.$$

Finally, we introduce the *two way fixed effect model* that adds a time dummy common to all countries, which is the generalization of equation (6). The *two way fixed effect estimator*, $\hat{\beta}_{tf}$, is the OLS estimator of equation (7),

$$I_{it} = \alpha(0) + \alpha_{tf}(i) + \gamma_{tf}(t) + \beta_{tf} S_{it} + e_{it}, i = 1, \ldots, N, t = 1, \ldots T.$$
$$E(e_{it}) = 0, \; Var(e_{it}) = \sigma_e^2. \tag{7}$$

The rest of this section explains the relationship among various estimators introduced above. In particular, it is possible to obtain easy interpretation if the explanatory variable is scalar. First, by the OLS estimator of equation (5),

$$\hat{\beta}_{pool} = T_{SS}^{-1} T_{SI}, \; \hat{\alpha}_{pool} = \bar{I} - \hat{\beta}_{pool} \bar{S}. \tag{8}$$

where $T_{SS} = \sum_{i=1}^{N} \sum_{t=1}^{T} (S_{it} - \bar{S})^2$, $T_{SI} = \sum_{i=1}^{N} \sum_{t=1}^{T} (S_{it} - \bar{S})(I_{it} - \bar{I})$, $T_{II} = \sum_{i=1}^{N} \sum_{t=1}^{T} (I_{it} - \bar{I})^2$,

$$\bar{S} = \frac{1}{NT} \sum_{i=1}^{N} \sum_{t=1}^{T} S_{it}, \; \bar{I} = \frac{1}{NT} \sum_{i=1}^{N} \sum_{t=1}^{T} I_{it}.$$

Using the standard theorem of the analysis of covariance (ANOVA),

$$T_{SS} = \sum_{i=1}^{N} \sum_{t=1}^{T} (S_{it} - \bar{S})^2 = \sum_{i=1}^{N} \sum_{t=1}^{T} \{(S_{it} - \bar{S}_i) + (\bar{S}_i - \bar{S})\}^2 = \sum_{i=1}^{N} W_{SS}(i) + N \times B_{SS}$$

where $W_{SS}(i) = \sum_{t=1}^{T} (S_{it} - \bar{S}_i)^2$, $\bar{S}_i = \frac{1}{T} \sum_{t=1}^{T} S_{it}$, $B_{SS} = \sum_{i=1}^{N} (\bar{S}_i - \bar{S})^2$.

Similarly, we obtain

$$T_{SI} = \sum_{i=1}^{N} \sum_{t=1}^{T} \{(S_{it} - \bar{S})(I_{it} - \bar{I})\} = \sum_{i=1}^{N} W_{SI}(i) + N \times B_{SI}$$

$$W_{SI}(i) = \sum_{t=1}^{T} (S_{it} - \bar{S}_i)(I_{it} - \bar{I}_i), \; \bar{I}_i = \frac{1}{T} \sum_{t=1}^{T} I_{it}, \; B_{SI} = \sum_{t=1}^{T} (\bar{S}_i - \bar{S})(\bar{I}_i - \bar{I}).$$

combining the above results together yields,

$$\hat{\beta}_{pool} = \frac{T_{SI}}{T_{SS}} = \frac{\sum_{i=1}^{N} W_{SI}(i) + (N \times B_{SI})}{\sum_{i=1}^{N} W_{SS}(i) + (N \times B_{SS})} = \theta \hat{\beta}_{of} + (1 - \theta) \hat{\beta}_{betw} \tag{9}$$

where $\theta = \dfrac{\sum_{i=1}^{N} W_{SI}(i)}{\sum_{i=1}^{N} W_{SS}(i) + (N \times B_{SS})}$, $\hat{\beta}_{of} = \dfrac{\sum_{i=1}^{N} W_{SI}(i)}{\sum_{i=1}^{N} W_{SS}(i)}$, $\hat{\beta}_{betw} = \dfrac{B_{SI}}{B_{SS}}$.

Hence, $\hat{\beta}_{pool}$ is a weighted average of $\hat{\beta}_{of}$ and $\hat{\beta}_{betw}$, whose weight is θ.

Note that equation (9) can be rewirtten as

$$\hat{\beta}_{pool} = \theta \sum_{i=1}^{N} \hat{\delta}_i \beta(i)_{ts} + (1 - \theta) \hat{\beta}_{betw} \tag{10}$$

by using the time series estimator, where $\delta_i = \frac{W_{SS}(i)}{\sum_{i=1}^{N} W_{SS}(i)}$, $\hat{\beta}(i)_{ts} = \frac{W_{SI}(i)}{W_{SS}(i)}$.

From equations (9) and (10),

$$\hat{\beta}_{of} = \sum_{i=1}^{N} \hat{\delta}_i \beta(i)_{ts} \tag{11}$$

Namely, $\hat{\beta}_{of}$, which is in fact the standard estimate of panel data analysis, is the weighted average of $\hat{\beta}_{ts}(i)$ whose weights are δ_i.

B. Economic Interpretation

The estimation methods reviewed so far should be selected according to the objectives of researchers. With the help of Obstfeld (1994), the statistical discussion in A can be interpreted on the basis of economic theory.

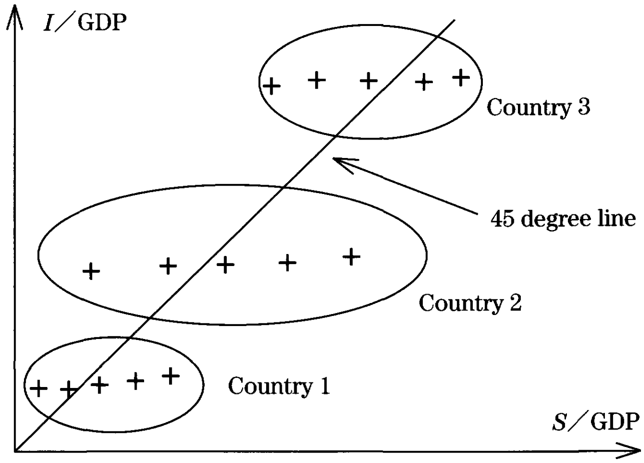
1. *Economic intuition of $\hat{\beta}_{betw}$, $\hat{\beta}_{cs}(t)$, and $\hat{\beta}_{of}$*

$\hat{\beta}_{cs}(t)$ measures the proportion of marginal increments in domestic savings invested domestically holding other things constant. To our best knowledge, Sinn (1992) is the first study to present $\hat{\beta}_{cs}(t)$. However, $\hat{\beta}_{cs}(t)$ uses cross country data without considering heterogeneity, such as differences in the exchange rate system, the phase of the business cycle, and the stage of economic development. Such heterogeneity can easily make $\hat{\beta}_{cs}(t)$ biased.

Hence, most researchers use equation (4) instead of equation (3). Obstfeld (1994) calls the analysis based on $\hat{\beta}_{betw}$ a cross sectional approach, and argued that it is suitable to investigate the long run relationship between savings and investment. As Obstfeld (1994) points out, the short run cyclical fluctuations which contaminate cross sectional data could be smoothed out by taking an average over time. In this sense, $\hat{\beta}_{betw}$ is superior to $\hat{\beta}_{cs}(t)$, however, the simple average over time cannot remove persistent heterogeneity. In this case, $\hat{\beta}_{betw}$ is subject to the same bias as $\hat{\beta}_{cs}(t)$. For example, suppose we have data for three countries over five years as in Figure 1. It is quite obvious that the investment-GDP ratio is independent of the saving-GDP ratio when the data for each country is observed. However, once the five year average of the data for each country is regressed, $\hat{\beta}_{betw}$ gives us an estimator close to 1.

As discussed in Section I, there are many researches that add the missing variables in equation (4) to take into account heterogeneity across countries. Nonetheless, such method also has a drawback since it is not clear which variable controls the heterogeneity of countries. We shall take $\hat{\beta}_{of}$ as the second best method to control heterogeneity assuming that the nature of heterogeneity among countries is stable over the period of estimation.

Figure 1
Graphical Presentaion of the Feldstein-Horiooka Paradox



2. $\hat{\beta}(i)_{ts}$ and $\hat{\beta}_{of}$

Obstfeld (1994) points out that $\hat{\beta}(i)_{ts}$ is suitable to examine the short run relationship between savings and investment within a country. We admit that this approach is free from cross sectional bias due to the heterogeneity of countries. However, a time series approach uses the data for a single country, and tends to include the longer sample period to obtain enough degrees of freedom in the process of estimation. Suppose a researcher wants to assess a change in the degree of capital mobility in the world economy during the 1980s. Time series data from a country cannot be long enough to make any sensible estimation. It is desirable to combine cross country data with shortrun time series data. However, great care must be taken when cross sectional data is combined as was pointed out in the previous section. Note that $\hat{\beta}_{of}$ is a weighted average of $\hat{\beta}(i)_{ts}$ using δ_i as weights shown in equation (11). $\hat{\beta}_{of}$ can be taken as a device to combine time series data with heterogeneous cross country data.

3. $\hat{\beta}_{pool}$ and $\hat{\beta}_{of}$

Feldstein (1983) suggests the relevance of $\hat{\beta}_{of}$ to examine the implications of equation (1). Nonetheless, he finds that $\hat{\beta}_{pool}$ and $\hat{\beta}_{betw}$ take fairly close values and argues that he can safely ignore $\hat{\beta}_{of}$, and reports the results of the estimation adding a time trend to the one way fixed effect model. We found his argument needs further examination, since equation (9) implies that the fact that $\hat{\beta}_{pool}$ and $\hat{\beta}_{betw}$ take fairly close values does mean θ being close to zero, but does not necessarily mean $\hat{\beta}_{of}$ being close to zero or negligible.[3]

[3]Note that θ being close to zero corresponds to the fact that $N\times B_{SS}$ is relatively larger than $\sum_{i=1}^{N} W_{SS}(i)$, which also does not imply that the one way fixed effect approach is not valid.

Therefore we have every reason to estimate $\hat{\beta}_{of}$ in order to examine the validity of Feldstein's (1983) argument.

III. The Model and Test Statistics

We shall examine whether $\hat{\beta}_{of}$ and $\hat{\beta}_{tf}$ yield significantly lower values than one. In addition, the model selection procedure is presented below.[4]

In our view, $\hat{\beta}_{betw}$ is not a valid estimation since it ignores cross country heterogeneity, as was shown in the estimator of Figure 1. Hence, we proceed with model selection as follows. First we examine whether cross country data can be pooled.[5] In so doing, both equations (12) and (13) are estimated:

$$I_{it} = \alpha(i)_{ts} + \beta(i)_{ts} S_{it} + u_{it}, \quad i = given, t = 1, \ldots T. \tag{12}$$

$$I_{it} = \alpha_{pool} + \beta_{pool} S_{it} + u_{it}, i = 1, \ldots, N, t = 1, \ldots T. \tag{13}$$

Note that equation (13) is a restricted model of equation (12) adding the constraint that both intercept and slope coefficients are the same across countries, therefore we can test the validity of this restriction by the standard F test. The relevant test statistic in this case is

$$F(1) = \frac{(RSSPL - RSSTS)/(N-1)(K+1)}{RSSTS/(NT - N(K+1))}$$

where $RSSPL$ is the sum of squared residuals of equation (13), $RSSTS$ is the additive of the sum of squared residuals of equation (12) of each country, K is the number of explanatory variables net of intercept term (hence 1 in this case), and $F(1)$ follows F distribution with the degrees of freedom $(N-1)(K+1)$ and $(NT\text{-}N(K+1))$. The rejection of equation (13) implies that we should use the time series model rather than the pooling model.

On condition that the pooling model is rejected, we then proceed to test whether the one way fixed effect model is superior to the time series model. Equation (14) is estimated:

$$I_{it} = \alpha_{of}(i) + \beta_{of} S_{it} + u_{it}, i = 1, \ldots, N, t=1, \ldots T. \tag{14}$$

Note that equation (14) is a restricted model of equation (12) setting $\beta(i)_{ts}$ the same for all countries, hence we can test this restriction by the F test. The relevant test statistic is

[4]In practice, savings and investment are quite likely to be determined simultaneously, hence results of Feldstein and Horioka (1980) must be understood with great care. Nevertheless, our main objective in this paper is to show that completely different results could emerge even if the Feldstein and Horioka (1980) approach is employed. Therefore we do not seek alternative model specifications in this paper.

[5]See Hisao (1986) for details about the model selection procedure.

$$F(2) = \frac{(RSSOF - RSSTS)/(N-1)}{RSSTS/(N(T-1) - K)}$$

where $RSSOF$ is the sum of the squared residual of equation (14). $F(2)$ follows F distribution with the degrees of freedom (N-1) and ($N(T$-1)-K). The one way fixed effect model must be selected if $F(2)$ does not reject the null hypothesis of homogeneous slopes and different intercepts.

On condition that equation (14) is selected over equation (12), we must examine whether equation (14) is superior to equation (13) to avoid a cyclical ordering of model preference. Since equation (13) imposes the restriction of a constancy of both slopes and intercepts over country i on equation (14), the relevant F-statistic is

$$F(3) = \frac{(RSSPL - RSSOF)/(N-1)}{RSSOF/(NT-(N+1))} .$$

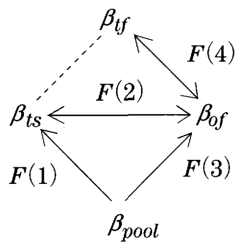
$F(3)$ follows F distribution with the degrees of freedom (N-1) and ($NT-(N+1)$).

Finally, we test whether the two way fixed effect model is superior to the one way fixed effect model, which, in turn, is selected over both time series and pooling models. The test is easy since the one way model imposes all restrictions of the time effect in the two way model to be zero.[6] The test statistics $F(4)$ is

$$F(4) = \frac{(RSSOF - RSSTF)/(T-1)}{RSSTF/(NT-(N+1)-(T-1))}$$

where $RSSTF$ is the sum of the squared residual of the two way fixed effect model. $F(4)$ follows the F distribution with the degrees of freedom ($T-1$) and ($NT-(N+1)-(T-1)$). The structure of model selection procedure is summarized in Figure 2.

Figure 2
Structure of Model Selection Procedure



[6] This test is conditional upon the preference of the one way fixed effect model over the time series model. For the sake of complete ordering of model selection, we should compare the time series model with the two way fixed effect model. However, we believe that as long as the time series model is selected over the one way fixed effect model, it is quite likely to be selected over the two way fixed effect model as well. In any case, this omission does not disturb our main conclusion at all.

IV. Data and Estimation Results

The data are taken from OECD, *National Accounts, Main Aggregates*, Vol. 1, from 1960 to 1989, covering 23 countries (excluding Luxembourg). Three variables: domestic net saving, domestic net investment, and GDP are used. Feldstein (1983) points out that net investment and net saving data can be subject to measurement errors, and could bias the estimator of saving-investment regressions. Nevertheless we employ net investment and net saving data for the sake of comparison on $\hat{\beta}$ are significantly lower than 1 even with a potential bias. The results of Feldstein and Bacchetta (1989) are reproduced first, then four types of model from 1960-89 at ten years' interval are estimated. The results are summarized in Table 1. As Feldstein and Bacchetta (1989) reports, $\hat{\beta}_{\rm betw}$ and $\hat{\beta}_{\rm pool}$ take values close to 1. Second, $\hat{\beta}_{of}$ is significantly lower than 1. However, except for the sample of 1963-72 and 1979-88, we could not accept $\hat{\beta}_{of}$ over $\hat{\beta}(i)_{ts}$ as can be seen in Table 2.

These results would reflect the fact that the ten years' interval is too long to justify a situation in which a fixed effect is constant across countries. Instead, we estimate the models with five years' intervals. Table 3 confirms the same trends as in Table 1: $\hat{\beta}_{of}$ are significantly lower than 1 and $\hat{\beta}_{betw}$ and $\hat{\beta}_{pool}$ are close to 1. $F(1)$ in Table 4 rejects $\hat{\beta}_{pool}$ against $\hat{\beta}(i)_{ts}$ for all cases. However, $F(2)$ suggests that in 12 out of 26 estimation cases, we could not reject the null of $\hat{\beta}_{of}$ against $\hat{\beta}(i)_{ts}$ at the 5% level. $F(4)$ shows that if $\hat{\beta}_{of}$ is accepted, 5 out of 12 cases suggest that $\hat{\beta}_{tf}$ is accepted against the null of $\hat{\beta}_{of}$.

Table 5 summarizes selected models and its estimators. The results indicate that in the early 1960s and the late 1970s, the degree of capital mobility varies across countries, while in the late 1960s and the early 1970s, the one way fixed effect models were selected due to the common economic shock, namely the Nixson shock over the exchange rate regime.

After the 1980s in which the restrictions on the capital mobility were completely removed among the OECD economies, the economic integration has been advanced and international economic shocks could have been easily transmitted across countries. Thus the two way fixed effect models become likely to be selected.

In retrospect, the degree of international capital mobility has been steadily increased among countries over time.

V. Summary and Conclusion

The main estimation results are: (i) $\hat{\beta}_{of}$ sometimes dominates $\hat{\beta}(i)_{ts}$, particularly in the shorter sample periods; (ii) $\hat{\beta}_{pool}$ is always rejected against both $\hat{\beta}(i)_{ts}$ and $\hat{\beta}_{of}$; (iii) based on the model selection procedure, preferred estimators of the elasticity of domestic investment-GDP ratio on domestic saving-GDP ratio are always significantly lower than 1 if $\hat{\beta}(i)_{ts}$ is not selected. In the light of our results, the Feldstein-Horioka paradox turns out to be not so robust.

Table 1
Estimatiion Results of coefficient β Using Ten Year Sample

Sample	*Pool*	s.e	*Betw*	*s.e.*	*OF*	s.e	*TF*	s.e
1960-69	0.762	0.037	0.838	0.079	0.509	0.063	0.484	0.066
1961-70	0.765	0.036	0.846	0.078	0.506	0.061	0.476	0.065
1962-71	0.752	0.035	0.806	0.080	0.534	0.063	0.497	0.068
1963-72	0.721	0.034	0.773	0.081	0.528	0.057	0.547	0.062
1964-73	0.715	0.033	0.748	0.086	0.597	0.053	0.625	0.059
1965-74	0.689	0.039	0.732	0.092	0.540	0.066	0.591	0.068
1966-75	0.665	0.041	0.738	0.097	0.493	0.061	0.550	0.071
1967-76	0.658	0.042	0.758	0.102	0.463	0.059	0.513	0.073
1968-77	0.659	0.044	0.785	0.112	0.459	0.057	0.501	0.074
1969-78	0.694	0.045	0.820	0.116	0.505	0.057	0.513	0.075
1970-79	0.707	0.045	0.849	0.122	0.494	0.055	0.449	0.073
1971-80	0.717	0.046	0.895	0.124	0.454	0.053	0.366	0.071
1972-81	0.733	0.047	0.937	0.134	0.460	0.052	0.320	0.070
1973-82	0.782	0.050	0.951	0.156	0.567	0.052	0.358	0.070
1974-83	0.841	0.054	0.940	0.173	0.686	0.058	0.409	0.067
1975-84	0.818	0.054	0.928	0.171	0.623	0.058	0.428	0.063
1976-85	0.793	0.051	0.883	0.158	0.609	0.059	0.375	0.063
1977-86	0.774	0.049	0.851	0.144	0.587	0.061	0.374	0.064
1978-87	0.763	0.045	0.823	0.129	0.589	0.061	0.413	0.066
1979-88	0.747	0.044	0.803	0.119	0.548	0.067	0.374	0.069
1980-89	0.722	0.043	0.782	0.113	0.461	0.070	0.336	0.070

s.e. = standard error of estimated parameters,
Pool = pooling estimator,
Betw = between estimator,
OF = one way fixed effect estimator,
TF = two way fixed effect estimator.

Table 2
Test Statistics

Sample	*F* (1)	*p-val*	*F* (2)	*p-val*	*F* (3)	*p-val*	*F* (4)	*p-val*
1960-69	5.90	0	3.97	0	5.94	0	1.28	24.71
1961-70	5.20	0	3.01	0	6.08	0	1.32	22.62
1962-71	4.58	0	1.78	2.11	6.81	0	1.47	15.99
1963-72	4.87	0	1.52	7.06	7.78	0	2.11	2.99
1964-73	5.79	0	1.67	3.55	9.25	0	2.35	1.54
1965-74	4.73	0	1.96	0.86	6.79	0	5.39	0
1966-75	4.56	0	2.04	0.58	6.37	0	4.21	0.01
1967-76	5.37	0	3.08	0	6.26	0	3.55	0.04
1968-77	6.36	0	3.98	0	6.63	0	3.10	0.16
1969-78	6.45	0	3.89	0	6.88	0	3.78	0.02
1970-79	7.65	0	4.22	0	8.23	0	3.90	0.01
1971-80	7.47	0	3.23	0	9.46	0	4.35	0
1972-81	8.68	0	3.71	0	10.59	0	4.88	0
1973-82	9.00	0	3.01	0	12.34	0	5.00	0
1974-83	9.38	0	2.54	0.04	13.93	0	7.04	0
1975-84	11.26	0	3.34	0	15.34	0	6.40	0
1976-85	11.09	0	3.50	0	14.75	0	8.12	0
1977-86	9.66	0	2.97	0	13.52	0	7.82	0
1978-87	7.61	0	1.61	4.86	12.79	0	6.44	0
1979-88	6.55	0	1.42	10.86	11.18	0	6.50	0
1980-89	8.99	0	3.36	0	11.69	0	5.72	0

p-val = probability that rejects the null.

Table 3
Estimation Results of coefficient β Using Five Year Sample

Sample	*Pool*	s.e	*Betw*	*s.e.*	*OF*	s.e	*TF*	s.e
1960-64	0.855	0.049	0.906	0.091	0.532	0.091	0.460	0.095
1961-65	0.871	0.052	0.924	0.092	0.623	0.096	0.550	0.103
1962-66	0.840	0.053	0.877	0.088	0.628	0.111	0.509	0.122
1963-67	0.761	0.053	0.824	0.091	0.435	0.103	0.326	0.110
1964-68	0.682	0.054	0.726	0.102	0.423	0.103	0.363	0.102
1965-69	0.655	0.054	0.674	0.099	0.527	0.114	0.529	0.117
1966-70	0.677	0.049	0.688	0.084	0.587	0.116	0.578	0.129
1967-71	0.701	0.047	0.704	0.082	0.672	0.119	0.645	0.139
1968-72	0.714	0.044	0.725	0.079	0.639	0.095	0.662	0.105
1969-73	0.757	0.043	0.756	0.083	0.762	0.084	0.778	0.092
1970-74	0.704	0.056	0.771	0.094	0.319	0.113	0.493	0.115
1971-75	0.654	0.063	0.809	0.122	0.346	0.079	0.353	0.099
1972-76	0.635	0.068	0.844	0.141	0.339	0.075	0.275	0.100
1973-77	0.672	0.076	0.843	0.183	0.450	0.075	0.290	0.106
1974-78	0.765	0.091	0.787	0.206	0.707	0.109	0.468	0.117
1975-79	0.760	0.088	0.860	0.193	0.431	0.109	0.444	0.105
1976-80	0.813	0.077	0.919	0.159	0.339	0.104	0.351	0.102
1977-81	0.830	0.073	0.943	0.151	0.336	0.096	0.294	0.103
1978-82	0.840	0.070	0.929	0.156	0.519	0.079	0.411	0.100
1979-83	0.859	0.070	0.900	0.161	0.708	0.079	0.450	0.098
1980-84	0.825	0.073	0.837	0.165	0.762	0.094	0.534	0.099
1981-85	0.713	0.075	0.734	0.161	0.518	0.128	0.423	0.127
1982-86	0.651	0.067	0.700	0.135	0.112	0.134	0.155	0.143
1983-87	0.640	0.055	0.687	0.112	0.191	0.100	0.165	0.107
1984-88	0.634	0.050	0.671	0.097	0.303	0.098	0.254	0.103
1985-89	0.650	0.046	0.667	0.087	0.422	0.118	0.265	0.126

s.e. = standard error of estimated parameters,
Pool = pooling estimator,
Betw = between estimator,
OF = one way fixed effect estimator,
TF = two way fixed effect estimator.

Table 4
Test Statistics

Sample	*F* (1)	*p-val*	*F* (2)	*p-val*	*F* (3)	*p-val*	*F* (4)	*p-val*
1960-64	4.54	0	1.59	7.61	6.57	0	1.81	13.32
1961-65	4.14	0	2.36	0.37	4.46	0	1.21	31.09
1962-66	3.36	0	2.13	0.93	3.61	0	1.63	17.45
1963-67	3.70	0	2.01	1.51	4.34	0	1.94	11.07
1964-68	4.49	0	1.87	2.58	5.87	0	2.65	3.85
1965-69	3.17	0	1.23	25.15	4.83	0	2.05	9.43
1966-70	2.67	0.01	1.17	30.02	4.00	0	1.55	19.33
1967-71	2.60	0.02	0.83	67.55	4.55	0	0.73	57.17
1968-72	2.70	0.01	0.78	73.85	4.89	0	1.83	13.04
1969-73	4.87	0	1.82	3.17	6.61	0	2.48	4.98
1970-74	2.67	0.01	0.93	55.86	4.48	0	7.59	0
1971-75	4.27	0	1.88	2.53	5.50	0	6.15	0.02
1972-76	5.84	0	2.93	0.04	5.96	0	5.63	0.04
1973-77	7.69	0	3.11	0.02	8.11	0	4.38	0.28
1974-78	6.12	0	1.85	2.83	8.63	0	6.57	0.01
1975-79	7.16	0	1.76	3.94	10.61	0	2.95	2.44
1976-80	6.46	0	1.23	25.71	11.09	0	2.91	2.59
1977-81	8.87	0	2.25	0.58	11.91	0	2.45	5.21
1978-82	12.11	0	3.01	0.03	14.28	0	2.65	3.80
1979-83	9.07	0	1.48	11.29	14.95	0	6.39	0.01
1980-84	8.71	0	1.33	18.62	14.91	0	8.62	0
1981-85	7.53	0	1.02	45.05	13.96	0	5.81	0.03
1982-86	7.97	0	1.98	1.71	11.30	0	1.44	22.68
1983-87	7.81	0	1.52	9.67	12.53	0	0.24	91.25
1984-88	5.84	0	1.55	8.77	8.95	0	0.82	51.32
1985-89	5.50	0	1.96	1.81	7.33	0	2.56	4.40

p-val = probability that rejects the null.

Table 5
Selected Estimator
(5% significance level)

Sample	Selected	Coefficients	s.e.
1960-64	*OF*	0.532	0.091
1961-65	*TS*		
1962-66	*TS*		
1963-67	*TS*		
1964-68	*TS*		
1965-69	*OF*	0.527	0.114
1966-70	*OF*	0.587	0.116
1967-71	*OF*	0.672	0.119
1968-72	*OF*	0.639	0.095
1969-73	*TS*		
1970-74	*TF*	0.493	0.115
1971-75	*TS*		
1972-76	*TS*		
1973-77	*TS*		
1974-78	*TS*		
1975-79	*TS*		
1976-80	*TF*	0.351	0.102
1977-81	*TS*		
1978-82	*TS*		
1979-83	*TF*	0.450	0.098
1980-84	*TF*	0.534	0.099
1981-85	*TF*	0.423	0.127
1982-86	*TS*		
1983-87	*OF*	0.191	0.100
1984-88	*OF*	0.303	0.098
1985-89	*TS*		

s.e. = standard error of estimated parameters,
TS = time series estimator,
OF = one way fixed effect estimator,
TF = two way fixed effect estimator.

In general, our results suggest that it is important to control cross country heterogeneity in the case of cross country study using panel data. Some of the stylized facts obtained from the recent literature using cross country data, such as the endogenous growth theory and analysis of the relationship between central bank independence and economic performance, might well be subject to the same problem which we demonstrate here. Careful reexaminations of such cross country studies, especially in terms of cross country heterogeneities, is now urgently called for.

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