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Essays in Capital Mobility, Growth, and Macroeconomic Volatility

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ESSAYS IN CAPITAL MOBILITY, GROWTH, AND, MACROECONOMIC VOLATILITY

by

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ABSTRACT

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This dissertation comprises three chapters in international macroeconomics. Specifically, we focus on international financial integration and its linkage to economic growth and volatility. In Chapter 1, we revisit the Feldstein-Horioka (1980) puzzle that saving-investment correlation exhibits a pattern contrary to expectation, being higher among the OECD countries that are more financially integrated and lower among emerging markets economies with less financial integration and greater capital controls. We find that the evolution of FH coefficient is highly consistent with increased financial integration over time, thus resolving the puzzle dynamically. We also explain the cross-country component of the puzzle by showing that financial market imperfections influence how well FH coefficient measures capital mobility.

In chapter 2, we study the linkage between financial integration and economic growth. We develop a dynamic stochastic model that generalizes Obstfeld's (1994) model by incorporating the costs from systemic risk besides the well-known benefit from risk-

sharing by Obstfeld (1994). We show that potential cost from the systemic risk could lower the benefit from risk diversification in an integrated financial market. By using the stock market data from Taiwan and US to calibrate the model, we find that the predictions of the model are consistent with actual data on growth.

In chapter 3, we study the relationship between financial integration and economic volatility. Prior research that has studied this relationship has not explored the potentially distinct effects of capital inflows and capital out flows on volatility. Our contribution is to make this crucial distinction conducting our analysis. We find that non-OECD countries with higher levels of external debt assets are associated with lower consumption volatility, and external debt liabilities are associated with higher consumption volatility. This finding is insignificant for OECD countries.

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Chapter 1

International Capital Mobility Revisited: A Dynamic View of Feldstein-Horioka Puzzle

1.1 Introduction

Understanding global financial integration is the key to understand the functioning of the global economy. Yet, the most basic ingredient for this understanding, i.e., how to *measure* financial integration has eluded economists. In their seminal paper, Feldstein and Horioka (1980) focused on the *correlation* between savings and investments (the so called FH coefficient), based on the idea that such a correlation is *inversely* related to international capital mobility: a high correlation should imply a lower capital mobility as savings must equal investments in autarky, while a low correlation should imply a higher international capital mobility as capital inflows and outflows fill any gaps. Yet from its early days the Feldstein-Horioka hypothesis faced the puzzling observation that saving-investment correlation exhibited a reverse pattern: It was *higher* among the OECD countries that were more financially integrated and *lower* among emerging markets economies which experienced less financial integration and greater capital controls (e.g., Frankel, 1992). This observation paved the way for what came to be the "Feldstein-Horioka (FH) puzzle".

There have been numerous attempts to address or explain the FH puzzle over the past three decades[1]. Of these early contributions, a statement by Frankel (1992) stands out. Frankel observed that, "if the saving-investment regressions were a good test for barriers to financial-market integration, one would expect to see the coefficient falling over time. Until recently, this prediction has not been supported by the evidence…" (Frankel, 1992, pp. 198). It is *this* observation that this paper tries to address among its several other contributions.

Specifically, we show that this dynamic trend in falling FH coefficient (a) *does* in fact exist and (b) *is* related to measures of international capital mobility over time. This paper is thus a fresh new attempt at addressing this old puzzle. It finds that in its *dynamic* form, the original Feldstein-Horioka hypothesis may be in fact vindicated. Further, the paper explains part of the reason for the persistence of the puzzle across countries and provides evidence of this explanation. It is remarkable that despite the existence of many factors militating against the validity of the FH coefficient as a measure of capital mobility, we do in fact find strong evidence in its favor in a dynamic sense. Our findings point to the robustness and longevity of the original hypothesis at least dynamically.

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[1] For example, Sinn (1992) suggested the possibility of an upward bias in the FH coefficient, due to the averaging of values over time in FH's original paper; Frankel (1992) suggested that the high value of the coefficient may be due to the procyclicality of savings and investments; Feldstein (1994) and Obstfeld and Rogoff (2000) attributed the high value of the coefficient to the "home bias" in investor preferences; Devereux (1996) argued that the high value may be due to the simultaneous effect from the taxation policies; Chu (2012) suggested the possibility of an upward bias due to the use of a common price deflator. Frankel (1992) has observed that currency and interest rate differentials and a lack of substitutability between different kinds of capital all make the FH coefficient an unreliable measure of capital mobility. For a detailed survey up to 2008, see Apergis and Tsoumas (2009).

The paper makes three distinct contributions to this literature: First, we address the FH puzzle by departing from both the customary cross country averaging or single-parameter time series estimation and introduce a *time-varying-parameter* (TVP) model in order to uncover the potential dynamic evolution of the FH coefficient.[2] Utilizing data for 67 countries from 1970 to 2009, and applying the TVP model to each one, we find that the FH coefficients has in fact *fallen* over time in most economies of the sample, whether developing or developed.

Our second contribution is to re-examine the age old question of whether the FH coefficient is an appropriate measure of international capital mobility. To do this, we need a measure of international capital mobility that is unrelated to, and is thus independent of, the FH coefficient itself. For this purpose, we utilize two indices of international mobility constructed by Lane and Milesi-Ferretti (2007). These indices have been widely applied as measures of international financial integration, yet surprisingly not in the context of examining the FH hypothesis[3]. We then show that in this dynamic view, both the FH coefficient *and* the Lane and Milesi-Ferretti indices are in fact *consistent*: The decline in the FH correlation over time is associated with rise in the Lane-Milesi-Ferretti measures of international financial or international equity integration over time. These results tend to vindicate the classic role of the FH coefficient and move away from the FH puzzle. They suggest that dynamically, the correlation between saving and

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[2] Other recent efforts at dynamically estimating the FH coefficients do exist, yet they are either sporadic--for example, carried out for only one or a few countries--or employ methods that suffer from various shortcomings. This literature is discussed extensively in a later section.

[3] See section 1.2.2 for details of these measures.

investment (FH coefficient) is in fact a valid measure of international capital mobility after all. Thus, when FH hypothesis is interpreted dynamically, our results depart from prevailing view. We further apply this method to check for the *size* effect as per Frankel (1992) and Baxter and Crucini (1993), which states that the FH coefficients are generally higher for large economies, on the presumption of greater endogeneity of the co-movements between saving and investment for these countries.

Our third contribution is explaining part of the cross country persistence of the puzzle. Verifying the cross-sectional persistence with our data we offer *capital market imperfections* as an explanation and use a unique dataset known as the KAOPEN index by Chinn and Ito (2008) to measure the level of capital market deregulation in relation to the FH hypothesis. We find that when the capital markets are highly deregulated, the correlation between the FH coefficient and international integration indices is "more negative". Thus, the more deregulated an economy is, the more accurately the FH coefficient reveals the degree of its capital mobility.

Navigating the complex web of the FH hypothesis and the FH puzzle and decoupling it into dynamic and cross-sectional dimensions we are thus able to address the puzzle dynamically and find salient explanation for its cross-county persistence. Given the critical importance of saving and investment to financial and goods markets and to fiscal, monetary and capital market policies, the significance of revisiting the original hypothesis--both reaffirming it dynamically, and explaining *where* it may not hold statically-- cannot be overstated.

Section 1.2 provides the conceptual framework and a brief review of the literature on the puzzle and the Lane and Milesi-Ferretti (2007) measures of international financial integration. Section 1.3 describes the data and introduces the TVP model. Section 1.4 shows the results of the TVP model and the relationship between the FH coefficients and the Lane-Milesi-Ferretti measures. Section 1.5 describes the KAOPEN index by Chinn and Ito (2008) and examines the hypothesis that capital market openness affects the validity of FH coefficients in terms of capital mobility. Section 1.6 concludes.

1.2 Conceptual framework and literature review

1.2.1 Feldstein and Horioka Puzzle

Using a simple cross-sectional regression of investments on savings as fraction of GDP for 16 OECD countries for the 1960-1974, Feldstein and Horioka (1980) found a highly significant and positive coefficient of the savings term. This finding's surprising implication that international capital mobility among the OECD countries was limited (hence the "puzzle"), received considerable attention and inspired much subsequent research. Some researchers re-estimated the FH coefficient using the same cross-sectional approach with later dates and reaffirmed the puzzle (Feldstein, 1983; Penati and Dooley, 1984; Obstfeld, 1986; Feldstein and Bachetta, 1991); others expanded the sample, focusing on the FH coefficients among different *types* of economies. For example, Dooley, Frankel and Mathieson (1987) applying the cross-sectional test to 62 countries, found that the *least* developed countries were more likely to experience smaller FH coefficients and high income countries were more likely to experience higher level of FH coefficients, thus accentuating the puzzle. Similar puzzling findings were echoed in Kasuga’s (2004) study of 79 developing and 23 OECD countries.

In this paper we ask; can introducing a time dimension help solve the puzzle? A number of studies have tried to estimate the FH coefficient by time-series or panel data. For example, using US data from 1946 to 1987, Miller (1988) found that national saving and domestic investment appear cointegrated prior to 1971 during the fixed exchange rate regime, but not so after 1971 where Bretton Woods was abandoned. Gulley (1992), however, showed that a cointegrated relationship between savings and investments exists in *both* fixed and flexible exchange rate regimes. Sinha and Sinha (2004) utilized an error-correction (EC) model that yielded results consistent with Gulley's (1992).[4]

As for panel data approaches, Krol (1996) estimated the FH coefficient in a fixed effects model, finding it to be *lower* than in previous studies, thus leading to the claim the FH puzzle vanishes under his approach. However, this claim would be based on *a priori* thinking that capital mobility should be high among most countries. Yet, as we have seen, Sinha and Sinha's (2004) finding of high savings-investment cointegration suggests the opposite. Jansen (2000) argues that Krol's (1996) results include an outlier, i.e., Luxemburg, and that the FH coefficient is considerably larger if Luxemburg is dropped from the sample. Vamviskidis and Wacziarg (1998) apply a fixed effects panel model to a sample of countries from 1970 to 93, finding the FH coefficient to be 0.671 for the OECD countries but only 0.246 for the remaining 83 developing countries. In short, time-series and panel data approaches seem unable to provide consistent and robust results due

[4] However, a complicating factor is the surprising exception in their finding that low income countries exhibit lower FH coefficient (indicating higher capital mobility), a finding also shared with ours (see later), and one that leaves the FH puzzle unresolved, at least for this group.

to the sensitivity from both the sample selection and model selection and therefore cannot either explain or resolve the FH puzzle.

As the saga continues, several researchers have argued that the FH coefficient is not a proper measure of capital mobility from a theoretical point of view, arguing that saving and investment are highly correlated no matter what the level of capital mobility or financial integration is (Obstfeld, 1986; Engel and Kletzer, 1989; Finn, 1990; Cardia, 1991; Mendoza, 1991; Tesar, 1993; Stockman and Tesar, 1995). Cardia (1992) further shows, based on an open-economy model, that both the failure of real interest parity and productivity changes are each sufficient to generate a high positive correlation between national saving and investment. Barro, Mankiw and Sala-i-Martin (1995) introduce the role of human capital. Under the assumption that perfect capital mobility leads to steady-state convergence for per capita output, physical and human capital, they find that the assumption of perfect capital mobility is irrelevant in explaining the behavior of the steady-state variables of physical and human capital. Thus, a strong relationship between saving and investment is obtained, regardless of the degree of physical and human capital mobility. Xie (1998) provides an endogenous growth model in which the range of differentiated consumption goods and specialized producer durables are both endogenously determined, showing that this feature yields a high degree of saving-investment correlation even when international financial markets are integrated.

Although such theoretical attempts are important, the role of evidence remains crucial. Returning to empirics, a fundamental limitation in time-series or panel data estimation methods is that they produce a *single* estimator of FH coefficient, thus forgoing information otherwise available from the dynamic properties of capital mobility. As a precursor to the key importance of dynamics in addressing the FH puzzle, for example, the application of a Markov-switching technique by Ho (2000) and Telatar, Telatar and Bolatoglu (2007), which allows the samples to be drawn from two different time regimes (regime-switching model), showed that the coefficient was significantly different in these two regimes. In the same spirit, by applying the endogenous structural break model for UK, Ozmen and Parmaksiz (2003) found that major policy changes in different periods affected the correlation between savings and investments. This sensitivity of the correlation to different time regimes suggests a pathway of research towards a possible resolution of the puzzle by focusing on *dynamics*.

One essential limitation of the Markov-switching technique, however, is their *exogenous* choice of the number of time regimes, rending the method somewhat rigid. An alternative and more flexible approach is the time-varying-parameter (TVP) estimation technique which estimates the evolution of the entire pattern of the FH coefficient over time. However, both the TVP and the Markov Switching models have so far been applied to either a single country or a small set of countries.[5] In so doing they cannot address the cross country variations in FH, especially those between developed and less developed countries, which is a central part of the FH puzzle. By applying the TVP model to a larger sample (including developed and developing economies), this paper is able to address the puzzle both dynamically and across countries.

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[5] In terms of the TVP method, Hatemi-J and Hacker (2007) apply a TVP model only to Sweden and Ibrahim and Harun (2010) apply it only to G7. In terms of Markov Switching model, Ho (2000) studies Taiwan and Telatar, et.al. (2007) study several European economies.

1.2.2 Measurement of Capital Mobility: Lane and Milesi-Ferretti Indices

The second objective of this paper is to examine whether or not the FH coefficient *actually* measures capital mobility. Due to the complexity of the current account structure, the relationship between domestic saving and investment (FH coefficient) may in turn be quite complex. For example, the interpretation of the FH coefficients contains not only the degree of capital mobility, but also implicitly the differences in policies and capital market regulations across countries. In fact numerous papers have questioned the feasibility of FH coefficient as a measure of capital mobility[6]. Here, we would like to re-examine this question with respect to a *dynamic* view of the FH coefficient per country, thus avoiding complicating cross country variations. For this purpose, we must use a measure of capital mobility that is both *independent* of FH coefficient itself as well as dynamic. We introduce two indices of international financial integration, originally constructed by Lane and Milesi-Ferretti (2003) and later updated (Lane and Milesi-Ferretti, 2007), that measure countries' *stock* of external assets and liabilities from the flow data computed by the International Monetary Fund (IMF) also known as International investment Position, IIP. The two measures are IFIGDP and GEQY; the first includes all five categories of the IMF's IIP: portfolio investments, foreign direct investments (FDI), other investments, financial derivatives and reserve assets, all as a share of GDP; and the second contains only the equity components of IIP, the portfolio investment in equity[7] as well as FDI. Figure 1.1 shows the pattern of IFIGDP and GEQY

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[6] For a detailed survey, see Apergis and Tsoumas (2009).

[7] The methodology is described in the IMF Balance of Payments Manual, fifth edition, 1993 (BPM5). The portfolio investment category includes both a debt and an equity component. Only the latter is used for constructing GEQY while both are used for constructing IFIGDP.

for four income groups (taking the group median). As can be seen, with one exception[8], both the IFIGDP and GEQY show a secular upward trend over the last four decades. This is consistent with the common expectation of an overall increase in international financial integration over this period. In what follows we will examine this question rigorously.

[Insert Figure 1.1 here]

1.3 Data and TVP model

1.3.1 Data

To estimate the Feldstein-Horioka coefficient, we collect the annual saving and investment data (relative to GDP) from 1970 to 2009 for 67 countries, classified as: (1) high-income OECD; (2) upper-middle income; (3) lower-middle income; (4) low income[9]. Table 1.1 shows an average investment rate of about 22% for the whole sample, 15% for low-income countries, and 24-25% for OECD and high-middle income countries, i.e. more than 10 percentage points higher than for lower-middle and low income group. Saving rates on the other hand indicate greater volatility, especially among middle income countries, as can be seen from figure 1.2. Table 1.2 shows the correlation of savings and investments for each country in the sample, reaffirming the Feldstein and Horioka (1980) puzzle when viewed *across* country groups: While for most countries the correlation is positive, it is *higher* on average for the OECD group than for upper-middle group, whose average coefficient is in turn higher than that for the lower-middle income group. This is the opposite of what one would expect from the relative mobility of capital

[8] The IFIGDP measure for the low income countries shows a decline since mid 1990.

[9] Data are from the World Development Indicators (WDI). The 67 countries include Saudi Arabia (SAU), the only high-income non-OECD country in the sample. But due to data limitations, we cannot include other high-income non-OECDs.

among the three country groups, hence reaffirming the puzzle cross-sectionally. The one exception to the puzzle is the low income group which exhibits the highest correlation *and* for which we would expect lowest capital mobility. But aside from the fact that there are only 6 countries in this group and thus a generalization is questionable, later we will learn that this group does in fact exhibit surprisingly high capital mobility and thus, in this sense, it does also contribute to the reaffirmation of the puzzle. We now turn to our dynamic analysis.

[Insert Table 1.1 here]

[Insert Figure 1.2 here]

[Insert Table 1.2 here]

1.3.2 Dynamic Estimation of FH: A Preliminary Test

As was discussed in section 1.2, the most common methods in previous research have been cross-sectional, time-series or panel. These methods all produce a *single* estimator of FH coefficient which may be too restrictive. For example, in the previous section, we observed the fluctuation of the saving and investment rates in Table 1.1 and Figure 1.1 and saw that they move together in some periods, but deviate in others. To examine whether or not the relationship between savings and investments is constant, we construct, as a *precursor* to our fully dynamic estimation (see Section 1.4), a panel regression fixed effects model, which can potentially detect some preliminary dynamics of the savings-investments correlations. To do this we introduce some simple decade-dummies as follows:

$$\left(\frac{I}{Y}\right)_{it} = \beta_0 + \beta_1 \left(\frac{S}{Y}\right)_{it} + \sum_{k=2}^{4} \beta_k \left[D_k \times \left(\frac{S}{Y}\right)_{it}\right] + BZ_{it} + \delta_i + \varepsilon_{it} \qquad (1\text{-}1)$$

$\forall i = 1 \ldots 67, t = 1970 \ldots 2009$

where $(I/Y)_{it}$ is the investment rate; $(S/Y)_{it}$ is the saving rate; D_k (k=1…4) is a dummy variable equaling 1 in the sample period k and zero otherwise. The four periods are, (1) 1970-1979 (base period); (2) 1980-1989; (3) 1990-1999; (4) 2000-2009. Finally, Z_{it} denotes the set of controls, including natural log of GDP per capita, and population to control for country size effect (see Section 1.4.2). Results are reported in Table 1.3, for the full sample as well as 4 subsamples (OECD, upper-middle, lower-middle, and low income countries). Having tested for panel unit-roots and ruled out the possibility of a spurious regression,[10] the coefficient of the saving rate for the base period 1970-79 (i.e., β_1, the FH coefficient) is positive and significant across all groups, echoing the previous findings of a positive correlation between saving and investment. But the key variables are the interaction terms ($D_k \times (S/Y)_{it}$). The coefficients show two features (a) they are all negative and significant and (b) for each decade they are progressively more negative and significantly different from the previous decade. All this is consistent with the idea the coefficient declines over time among all different groups and is thus potentially consistent with the idea of increasing international capital mobility.[11] In sum, even at a basic level of gross partitioning of time into 10-year periods we find that the

[10] Of the several available panel unit-root tests, the two most prominent ones are the IPS (Im, Pesaran and Shin, 2003), and the LLC (Levin-Lin-Chu, 2002) tests. The IPS test is more appropriate in our case since it is more general and can apply to unbalanced panels and missing observations. Using this test, the investment rate and saving rate on full sample and each sub-sample are stationary, and thus there is no spurious regression in the estimation in Table 1.3. The IPS panel unit-root test results are shown in Appendix B.

[11] Across groups, the higher base-decade coefficient for OECD (0.332) compared to same coefficient for upper middle income and lower middle income groups (0.273 and 0.096) hints at the persistence of the cross-sectional form of the FH puzzle. But the much higher coefficient for low income group (0.62) is unusual. The small number of countries in this subsample might be one explanation. We shall return to the cross-sectional evidence in Section 1.5.

correlation between saving and investment may well not be constant, but rather, time variant. These results are suggestive of deeper underlying dynamics of the FH coefficients and call for a more rigorous investigation. To do this, we will now apply the time-varying-parameter method, estimating the FH coefficient in *each* country over time.

[Insert Table 1.3 here]

1.3.3 Time-varying-parameter (TVP) Method

Following Harvey (1987) and Kim and Nelson (1999), the regression that form the basis of the TVP model can be written as state-space form whose coefficients vary in time and possess certain specific dynamic properties. We estimate FH coefficient (β) for each country i in the following so called measurement equation:[12]

$$\left(\frac{I}{Y}\right)_t = \alpha_t + \beta_t \left(\frac{S}{Y}\right)_t + \varepsilon_t \quad (1\text{-}2)$$

The corresponding transition equation is:

$$\beta_t = \mu + F\beta_{t-1} + v_t \quad (1\text{-}3)$$

$$\varepsilon_t \sim i.i.d.\, N(0, R)$$

$$v_t \sim i.i.d.\, N(0, Q)$$

With the recursive procedure of Kalman filter, we compute the optimal estimate of unobserved-state vector β_t (the FH coefficient) in a dynamic domain and estimate the parameters in Kalman filter using MLE.

[12] The TVP model applied in our paper is a standard approach, which presumes the FH coefficient follows the Markov process with AR(1) setting. Other TVP approaches, such as TVP in GARCH, are not appropriate for the present purpose due to the nature of the data. In this case, for example, TVP in GARCH is suitable for high frequency data while our data is of course annual.

1.4 TVP Estimation Results and the Lane-Milesi-Ferretti indices

1.4.1 TVP Estimation Results

Results, presented in Appendix A (Figures A-1 to A-4), show that for most countries the FH coefficients exhibits a noticeable *decline* over time. Few noteworthy observations are as follows: In US, the coefficient drops from 0.97 in 1973 to 0.66 in 2009; in UK it drops from 0.91 to 0.65; in China it drops from 0.83 to 0.59; while in India it drops from 0.87 to 0.38. One interesting case is Luxemburg for which the coefficient is at 0.41 in 1973. This is much lower than other countries in the OECD group, and it drops even further to a low value of 0.16 in 2009. To show the general pattern of the estimated results, the mean value of the time varying FH coefficient for the full sample and each subsample are plotted against time (Figure 1.3)[13]. It is clearly evident that the FH coefficients exhibit a *declining* trend. From 1973 to 2009, the average value of the coefficient drops from 0.88 to 0.33 across all countries, from 0.94 to 0.51 for OECD countries, from 0.93 to 0.25 for the upper-middle income group, from 0.88 to 0.21 for lower-middle income group, and from 0.69 to 0.39 for the low income countries. This is a strong confirmation of the finding of the previous section in which the coefficient declined from decade to decade (Table 1.3). Further, note that the coefficient is higher among the OECD than other groups, a finding that is consistent with the findings by Dooley, Frankel and Mathieson (1987), Vamviskidis and Wacziarg (1998) and Kasuga (2004).

[Insert Figure 1.3 here]

[13] While the time period is 1973-2009, the first 3 years are dropped due to the estimation of TVP model.

1.4.2. Relation to International Capital Mobility over Time

Using the estimated FH coefficients, we now come to the second main contribution of this paper: to examine the relationship of the FH coefficient to the actual and ***independently*** measured index of international capital mobility, as developed by Lane and Milesi-Ferretti presented earlier. The original proposition, put forth by Feldstein and Horioka, is that higher (lower) levels of capital mobility imply lower (higher) FH coefficient.

For each country, we apply Autoregressive Distributed Lag (ARDL) approach (Pesaran et. al., 2001) to find the long-run relationship between FH coefficient and the financial integration indices by Lane and Milesi-Ferretti (2007). The models are specified as follow,

$$\Delta\beta_{FH,t} = \alpha_0 + \sum_{k=1}^{m_1} \alpha_1 \, \Delta\beta_{FH,t-k} + \sum_{k=0}^{m_2} \alpha_2 \, \Delta\text{IFIGDP}_{t-k} + \theta_1 \beta_{FH,t-1} + \theta_2 \text{IFIGDP}_{t-1} + \varepsilon_t \quad (1\text{-}4)$$

$$\Delta\beta_{FH,t} = \gamma_0 + \sum_{k=1}^{n_1} \gamma_1 \, \Delta\beta_{FH,t-k} + \sum_{k=0}^{n_2} \gamma_2 \, \Delta\text{GEQY}_{t-k} + \lambda_1 \beta_{FH,t-1} + \lambda_2 \text{GEQY}_{t-1} + u_t \quad (1\text{-}5)$$

In Equations (1-4) and (1-5) we can obtain short-run and long-run estimates in a single step. By Pesaran et. al. (2001), the advantage of applying the ARDL model is that the variables could be I(1) or I(0) or a combination of the two. Cointegration can be tested by joint significance of θ_1 and θ_2 in equation (1-4) and λ_1 and λ_2 in equation (1-5) (F test). Alternatively, we could also re-estimate the model with lagged error-correction term (EC_{t-1}) based on the fitted values (m_1, m_2, n_1 and n_2) in equations (1-4) and (1-5). The fitted values are determined by Akaike's Information Criterion (AIC) used to select the optimum lags (Bahmani-Oskooee and Gelan, 2006). The variables are cointegrated if the coefficient of EC_{t-1} is significantly negative.

The long-run effect can be estimated by normalizing the lagged-linear combination in equations (1-4) and (1-5). In other words, the long-run coefficients are $-\hat{\theta}_2/\hat{\theta}_1$ in equation (1-4) and $-\hat{\lambda}_2/\hat{\lambda}_1$ in equation (1-5). Results, reported in Table 1.4, show that, in general, the FH coefficients and IFIGDP have negative long-run relationship for most of the countries. The long-run coefficients between the FH coefficients and GEQY are somewhat similar. Some of the long-run coefficients are insignificantly negative, but we find the FH coefficients and Lane and Milesi-Ferretti indices are still significantly cointegrated. This is one of our key findings: Greater capital mobility over time is now associated with a *reduction* in the correlation between saving and investment. This is precisely in accordance with Feldstein and Horioka's original intuition.

[Insert Table 1.4 here]

To examine the significance of the relationship between FH coefficients and the Lane and Milesi-Ferretti indices, not only over time, but also across countries, we estimate a panel regression with fixed effects for each country group.

$$\beta_{it}^{FH} = \beta_0 + \beta_1 \mathrm{IFIGDP}_{it} + \beta_2 \ln(\mathrm{GDPPC})_{it} + \delta_i + \varepsilon_{it} \tag{1-6}$$

$$\beta_{it}^{FH} = \beta_0{}' + \beta_1{}' \mathrm{GEQY}_{it} + \beta_2{}' \ln(\mathrm{GDPPC})_{it} + \delta_i + \varepsilon_{it} \tag{1-7}$$

where, for country i at time t, β_{it}^{FH} is the FH coefficient, IFIGDP_{it} and GEQY_{it} are the Lane and Milesi-Ferretti indices, and $\ln(\mathrm{GDPPC})$ is the natural log of GDP per capita.

Results are reported in Table 1.5[14]. The point of this investigation is of course the same as in the time series approach of Table 1.4, but in a panel regression framework. If the FH coefficients are to be an inverse measure of international capital mobility, then β_1 and $\beta_1{}'$ are expected to be *negative*. From Table 1.5, in the "All Countries" sample, the estimated coefficients of IFIGDP and GEQY are negative and significant even with the control of GDP per capita. This is consistent with findings from the correlation coefficients in Table 1.4. In the four subsamples, we still find strong evidence that the FH coefficient is inversely related to the Lane and Milesi-Ferretti indices but the results are more robust for the upper-middle and the lower-middle income groups than for the other two groups [15,16], and interestingly, much larger (in absolute value) for the scale of the coefficients of the Lane-Milesi-Ferretti indices for upper-middle income countries than

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[14] By using the Im, Pesaran and Shin (IPS) panel unit-root test (Im, Pesaran and Shin, 2003), we examine the stationarity of the FH coefficients, IFIGDP and GEQY on whole sample and each sub-sample group (refer to Appendix B). The result shows that the dependent variable (FH coefficient) and independent variables (IFIGDP and GEQY) do not have the same degree of integration. Therefore, there is no spurious regression issue in the estimations of Table 1.5.

[15] For example, the OECD countries exhibit the same pattern (of the negative relationship) but only when the control variable is not included. When the control variable is added, the estimators for OECD become insignificant. In the low income group, the effectiveness of FH coefficient is supported by the negative and significant estimators on IFIGDP, but not for the GEQY. One reason for the latter may be the limited sample size (only six countries) and the greater heterogeneity among the low income countries (For example this group exhibit exceptionally high variance in its current accounts across the group members).

[16] An alternative measure, developed by Chinn and Ito, known as the Chinn-Ito index (Chinn and Ito, 2008), also exists which has been viewed as a *de jure* measure and includes an important (and novel) set of regulatory measure. We will later use this index as an indicator of financial market imperfection. To see whether this index can also be used as a measure of international capital mobility we conducted several experiments. We found that while the Chinn-Ito index had explanatory power in some instances (e.g., OECD) the results were not robust in the presence of the Lane-Milesi-Ferretti indices which did exhibit robustness. It therefore appears that the Chinn-Ito index may be a more suitable measure of financial market imperfection than of capital mobility. As mentioned, we will in fact use this measure in this latter sense to explain the FH puzzle in cross-sectional domain (see section 1.5).

for the other subgroups. The reason can be seen from the Figure 1.1 and especially Figure 1.3. While Figure 1.1 simply establishes that both IFIGDP and GEQY variables have risen for the sample period for all groups (including our group of interest), Figure 1.3 indicates that the FH coefficient for the upper-middle income groups has fallen more consistently and to a much larger extent, dropping from a high of 0.93 in 1973 to a low 0.25 in 2009. By contrast, the trend of FH coefficient for OECDs is flatter. As for lower-middle income countries, FH coefficient seems steady from 1988 to 2009, while for the low income countries, it actually increased slightly from about 0.2 to 0.35 during 1980 and 2009.

In sum, results from the panel regressions reaffirm the time series results and point to the viability of the FH coefficient as a measure of capital mobility *when dynamics are considered*. These results are consistent with Feldstein-Horioka's original hypothesis.[17]

Considering the cross-sectional comparison, we must still explain *why* the FH coefficients for OECD (high income) economies are larger than those for lower income economies. One explanation that has been put forward is the size effect (Frankel, 1992; Baxter and Crucini, 1993). This is discussed in the following section.

[Insert Table 1.5 here]

1.4.3 Size Effect

Frankel (1992) and Baxter and Crucini (1993) proposed introducing country size as a way to explain the cross-country persistence of the FH puzzle. In this subsection, we re-

[17] We also considered a natural experiment case, the adoption of euro. However, there is no evidence to support a significant structure break before and after the adoption. As most of Euro countries have decreasing FH coefficients, the finding does not support the case that the adoption of euro could lower the FH coefficients.

examine this effect, and show how it influences the viability of the FH coefficients as a measure of capital mobility across countries. This will provide the basis for our alternative explanation (Section 1.5).

Frankel (1992) suggested that if the domestic economy is "large" in the world financial markets, then the world interest rate becomes endogenous. As such, a shortfall in domestic saving will drive up world interest rates, crowding out investment domestically as well as abroad. Baxter and Crucini (1993) construct a two-country, one-good version of the standard neoclassical model, and find that the country size (measured by a fraction of world population) is an important determinant of saving-investment correlations. Their explanation is that large countries have larger effects on the world interest rate, and their model shows that for an arbitrarily large country, the correlation between true saving and investment is approximately 1.

If size implies that saving and investment rates are highly correlated due to interest rate endogeneity, then FH coefficient is no longer suitable indicator of international capital market integration. To examine this issue and see how the size effect influences the FH coefficients, we adopt a cross-section regression with FH coefficient as the dependent variable and natural log of real GDP (lnRGDP), population (lnPOP) and real GDP per capita (lnGDPPC)--entered separately--as independent variables measuring country size effects. We also include as controls the Lane and Milesi-Ferretti indices (IFIGDP and GEQY), indicating international capital mobility. If the arguments of Frankel (1992) and Baxter and Crucini (1993) are true, the estimators of the "size effect" measures should be positive, implying that larger countries experience higher saving-investment correlations.

To construct our cross-sectional framework, we divide the full sample period (1973-2009) into four time regimes (1973-1979, 1980-1989, 1990-1999 and 2000-2009) compute the mean value of the dependent and independent variables over time, and estimate a cross-sectional regression model within each time regime. The results show that, for all time regimes, the estimators for the size effect variables are positive and significant (Table 1.6). This finding is consistent with the argument by of Frankel (1992) and Baxter and Crucini (1993). Moreover, in most of the cases, we can observe that the estimators for the Lane and Milesi-Ferretti indices are *insignificant* and now only weakly related to the FH coefficient. This result implies that the size effect dominates the FH coefficients under the cross-sectional framework. It also implies that the FH puzzle in the domain of cross-sectional comparison still remains, making the interpretation of the FH coefficient more complex. In the next section, we provide a deeper discussion and a plausible explanation for this phenomenon.

[Insert Table 1.6 here]

1.5 Cross-sectional Explanation of the puzzle: Financial Market Imperfection

To sum up to this point, while in the dynamic time-series approach the FH coefficients and Lane-Milesi-Ferretti financial integration indices are highly negatively correlated for each country (and thus FH coefficient appears a suitable indicator of international capital mobility over time), across countries the story is different. Here, the FH coefficients are significantly affected by country size, and this is a more robust variable dominating the Lane-Milesi-Ferretti financial integration variables.

This brings us to the third and last contribution of the paper. In seeking to explain why FH coefficient fails to explain the capital mobility across countries, we look to the role of *financial market imperfections,* as a potential explanation. We hypothesize that departures from a deregulated capital market are why the FH coefficient may not reflect the true international mobility of capital and set out to examine this hypothesis. Several studies attempt to explain this "size effect" in terms of the behavior of investors and the environment of financial markets. For instance, the high correlation between saving and investment is attributed to "home bias" where capital is mobile but investors prefer to keep it at home (Feldstein, 1994; Obstfeld and Rogoff, 2000)[18]. Devereux (1996) argues that the higher correlation between saving and investment can be traced to tax policies that affect both simultaneously. Gunji (2003) introduces a proxy for the legal protection of investors, and finds that the countries with lower investor protection have a lower FH coefficient. This suggests that an increase of domestic saving may flow out to countries with stronger investor protection, rather than into domestic investment.

In light of this background we introduce an index of capital market imperfection. Two such indices are available in the literature; the Sachs-Warner index (Sachs and Warner, 1995) which is a binary variable (0 is closed, 1 is opened) and thus somewhat limited in its usefulness, and a quantitative and more precise index, developed by Chinn and Ito (2008), which captures the "level" of openness, known by the authors as the KAOPEN index (described below). With one exception, we are not aware of any studies that use financial deregulation index in the FH context, and certainly none that use the more

[18] Other empirical and theoretical studies about the home bias can be found in Tesar and Werner (1995), Lewis (1999), and Gordon and Gaspar (2001).

precise KAOPEN index in this context.[19] In this paper, we incorporate the KAOPEN index. KAOPEN is based on variables that codify the tabulation of restrictions on cross-border financial transactions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). The index is the first standardized principal component of four categories of restrictions on external accounts.

Our sample is the same as used earlier except that Luxemburg is dropped due to the missing value in the Chinn-Ito index. To focus on the cross-sectional variation in an effort to explain the FH puzzle in its cross-sectional dimension, we compute the average values of the KAOPEN index *over time* for each country for the four subgroups in our sample. These are normalized from 0 to 100 and increasing in the degree of capital market openness. Figure 1.4 presents the results averaged over each of four different decades. As expected, the index for the OECD economies is much higher than the rest of the sample, and also increasing over the past three decades. Generally, however, capital market openness has increased for all four groups.

[Insert Figure 1.4 here]

We now set up a logistic regression in which the dependent variable is the probability (p) for significance of *long-run estimates*[20] between the FH coefficient and the Lane and

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[19] The exception is the Bahmani-Oskooee and Chakrabarti (2005) who use the Sachs-Warner index in a panel cointegration framework for a sample of 20 OECD and 106 non-OECD countries from 1960-2000 to examine whether the correlation between saving and investment is sensitive to the countries' openness. They find that the relationship is significantly stronger in closed economies than in countries that are open after initial closure. However, as stated above a binary domain does not capture the "degree" of openness. Also, as the FH coefficients are estimated by a panel cointegration model, only a single estimator for the FH coefficient is produced, overlooking the dynamic property of international capital mobility.

[20] Refer to Table 1.4 for the long-run estimates.

Milesi-Ferretti indices (IFIGDP and GEQY) and the KAOPEN index is the independent variable, as follows:

$$ln\left(\frac{p_i}{1-p_i}\right) = \alpha_0 + \alpha_1 \text{KAOPEN}_i + \alpha_2 \text{OECD}_i + \varepsilon_i \qquad \forall i = 1 \ldots 65 \qquad (1\text{-}8)$$

where for each country i, p_i is the probability that the long-run coefficient between FH coefficient and the Lane and Milesi-Ferretti indices is significantly negative, i.e., $p_i(\beta_{FH}, \text{IFIGDP})$ or $p_i(\beta_{FH}, \text{GEQY})$; KAOPEN_i is the capital market openness index averaged for time; OECD_i is the dummy index for OECD membership the dummy variable for OECD countries, to examine the robustness of results to the inclusion of this OECD. This logistic regression is preferable to the linear regression because it limits the probability between 0 and 1.

What are the expected signs? We observe that since a lower FH coefficient implies higher capital mobility (the FH hypothesis) and a large value of IFIGDP and GEQY also indicate the same thing, it follows that when the long-run estimates are significantly negative, the FH coefficient is a more accurate measure of international capital mobility. Following this observation combined with the hypothesis that financial market imperfections are why FH puzzle arises, we would expect to observe the coefficient of KAOPEN, i.e., α_1, to be significant and positive; that is, more deregulated economies are more likely to experience a better fit between the FH coefficient and capital mobility.

Results are shown in Table 1.7. The coefficients of KAOPEN are positive and highly significant: less regulation (higher KAOPEN) accounts for a higher possibility of significantly negative long-run relationship between the FH coefficients and financial integration.

[Insert Table 1.7 here]

1.6 Conclusions

This paper investigates the relationship between two methods that have been used to measure the level of international capital mobility, Feldstein-Horioka method (Feldstein and Horioka, 1980) and Lane and Milesi-Ferretti (2007) indices and examines the unusual finding, the Feldstein-Horioka puzzle.

Feldstein and Horioka (1980) offered a measure of international capital mobility based on the correlation between domestic saving and investment (FH coefficient), expecting a higher correlation to imply lower capital mobility and a lower correlation to imply higher mobility. Given the evidence of high correlation in OECD countries and low correlation in emerging countries, a so called “Feldstein-Horioka puzzle” was born.

In this paper, we have addressed this puzzle by moving away from cross country averages to capture the fluctuating properties of capital flow. By introducing the time-varying-parameter (TVP) model, and stressing a dynamic view of the correlation of domestic saving and investment, we have found the FH coefficients are decreasing for most of the countries, no matter developing or developed. Does this mean that capital markets have become more integrated over time?

To answer this we then compared the FH indicator of capital mobility to the widely used measure of international financial integration, Lane and Milesi-Ferretti (2007) indices, based on the IMF balance of payments statistics. The Lane and Milesi-Ferretti (2007) index indicated that indeed increased international financial integration has occurred over time. We found strong support for the relationship between the FH coefficient and the Lane and Milesi-Ferretti in ways that vindicates the original FH hypothesis and removes the FH puzzle in a dynamic perspective. However, we also find the existence of a size effect where the FH coefficients are generally higher for the larger countries, which are defined as higher population, real GDP or GDP per capita. In other words, although we find increasing international capital mobility per country over time, the cross-sectional comparison between countries still supports the Feldstein-Horioka puzzle.

We offer a potential explanation for the persistence of FH puzzle between the countries: financial market imperfection. To examine this notion, we incorporate the KAOPEN index (Chinn and Ito, 2008) containing information on the level of deregulation. Results show that financial market imperfection affects the viability of FH coefficient as a measure of international capital mobility: in a well deregulated financial market, the FH coefficient is more likely to reveal the level of international capital mobility.

By thus navigating the complex web of the FH hypothesis and FH puzzle and decoupling that into a dynamic and a cross sectional dimension we are able to address the puzzle dynamically, and find a salient and robust explanation for the puzzle across counties.

Given the critical importance of saving and investment to both financial and goods markets and to fiscal, monetary and capital market policies, the significance of reviving the original and classic Feldstein Horioka hypothesis--both reaffirming it dynamically, and explaining where it may not hold statically-- cannot be overstated.

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Figures and Tables

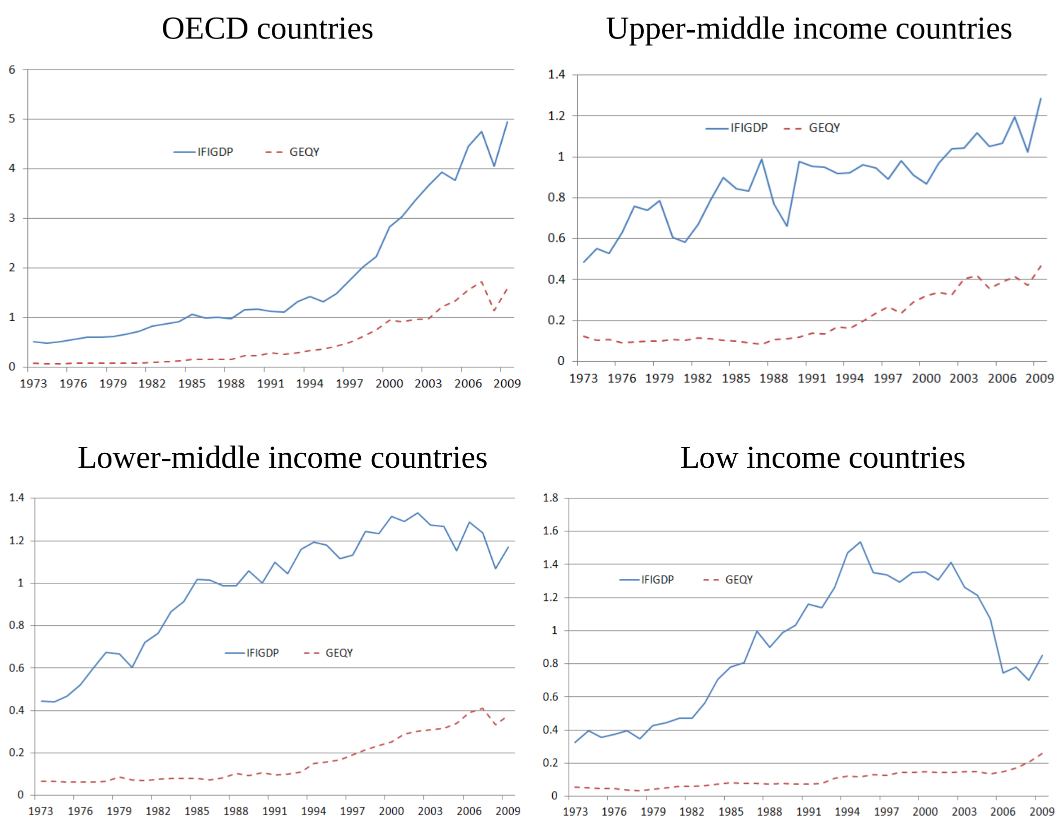

Figure 1.1 Median Lane and Milesi-Ferretti Indices in Sample Groups

Figure 1.2 Average Saving and Investment Rate in the Sample Groups

Table 1.1 Average Saving and Investment Rate

	Periods	OECD	Upper-mid	Lower-mid	Low	Total
Saving rate	1970-79	24.42 (7.10)	24.15 (11.75)	14.76 (17.14)	9.69 (11.11)	20.39 (14.20)
	1980-89	22.52 (6.22)	24.93 (9.95)	11.22 (19.68)	9.33 (6.47)	18.23 (14.51)
	1990-99	23.62 (6.89)	24.43 (9.97)	14.20 (15.47)	6.44 (9.91)	19.23 (12.74)
	2000-09	24.58 (8.41)	27.23 (13.16)	15.56 (14.54)	8.54 (6.58)	21.06 (13.45)
	1970-2009	23.79 (7.23)	25.19 (11.33)	13.94 (16.87)	9.69 (9.19)	19.83 (13.78)
Investment rate	1970-79	25.37 (4.01)	24.13 (9.15)	19.95 (6.32)	15.34 (7.67)	22.31 (7.31)
	1980-89	22.69 (3.79)	22.78 (6.73)	22.20 (7.36)	12.62 (4.54)	21.64 (6.56)
	1990-99	21.50 (4.42)	21.82 (6.20)	23.35 (11.07)	14.12 (5.30)	21.49 (8.00)
	2000-09	21.18 (3.37)	20.36 (3.66)	22.16 (6.94)	20.12 (5.73)	21.19 (5.13)
	1970-2009	22.68 (4.25)	22.27 (6.85)	21.92 (8.22)	15.56 (6.55)	21.66 (6.84)

Notes: 1. Countries are classified into four groups by the World Bank based on per capita income.
2. Standard deviations are in parentheses.

Table 1.2 Correlation Coefficients of Investment Rate and Saving Rate

OECD		Upper-Middle Income		Lower-Middle Income		Low Income	
Country code	ρ	Country code	ρ	Country code	ρ	Country code	ρ
AUT	0.3811	BRA	0.6819	BOL	0.0829	GHA	0.0390
BEL	0.7071	BWA	-0.3704	CHN	0.8910	KEN	0.4765
CAN	0.5077	CHL	0.6742	CIV	0.6463	MDG	0.6552
CHE	0.6557	COL	-0.0047	ECU	0.1846	RWA	0.2124
DEU	0.4527	CRI	0.3617	EGY	0.6446	ZAR	0.6030
DNK	0.0629	DOM	0.5076	GTM	-0.1247	ZMB	0.6924
ESP	0.6496	DZA	-0.1524	HND	0.0385		
FIN	0.4575	GAB	0.2792	IND	0.9600		
FRA	0.7741	MEX	0.1449	LKA	0.2100		
GBR	0.6790	MYS	0.0718	LSO	0.0406		
GRC	0.7472	PER	0.5941	MAR	0.3276		
IRL	-0.0366	TUR	0.8468	NIC	-0.4213		
ISL	0.5130	URY	0.1703	PAK	0.2913		
ISR	-0.4578	VEN	0.2744	PHL	0.5591		
ITA	0.6740	ZAF	0.7818	PNG	-0.6001		
JPN	0.9672			PRY	0.5076		
KOR	0.7207			SEN	0.0396		
LUX	0.0296			SLV	0.3653		
NLD	0.2437			SWZ	-0.0650		
NOR	-0.2664			SYR	0.0543		
PRT	0.5504			THA	0.5777		
SWE	0.2669			TUN	0.3232		
USA	0.5585						
OECD	0.4277	Upper-mid	0.3241	Lower-mid	0.2515	Low	0.4464

Note: Countries are classified into four groups by the World Bank based on per capita income.

Table 1.3 Panel Regression of Investment Rate on Saving Rate

Independent variables	All countries	OECD	Upper-middle income	Lower-middle income	Low income
Saving rate ($\left(\frac{S}{Y}\right)_{it}$)	0.2049 (0.0598)***	0.3317 (0.0566)***	0.2727 (0.0680)***	0.0957 (0.0441)**	0.6171 (0.0829)***
$D_2 \times \left(\frac{S}{Y}\right)_{it}$	-0.1372 (0.0598)***	-0.1019 (0.0233)***	-0.1057 (0.0496)*	-0.1325 (0.0643)*	-0.3265 (0.0911)**
$D_3 \times \left(\frac{S}{Y}\right)_{it}$	-0.2499 (0.0554)***	-0.1791 (0.0409)***	-0.1649 (0.1065)	-0.2855 (0.1538)*	-0.4611 (0.0897)***
$D_4 \times \left(\frac{S}{Y}\right)_{it}$	-0.3030 (0.0406)***	-0.2250 (0.0517)***	-0.2688 (0.0874)***	-0.2643 (0.0666)***	-0.2644 (0.1294)*
lnGDPPC	4.7627 (1.4172)***	4.3576 (1.5445)**	4.7996 (3.5803)	8.1886 (1.9401)***	5.9802 (2.7109)*
lnPOP	5.9526 (1.9315)***	-8.3313 (5.6013)	-0.4817 (4.3023)	3.7830 (3.0700)	13.8837 (4.1612)**
Constant	-115.0197 (33.7576)***	111.4043 (84.9972)	-11.7896 (70.5088)	-94.7321 (50.1706)*	-250.1815 (81.8544)**
R^2 (within)	0.1648	0.3751	0.2922	0.1682	0.5336
Obs.	2680	920	600	880	240

Notes: 1. Countries are classified into four groups by the World Bank based on per capita income.
2. The panel regressions are country fixed effect models.
3. Robust standard errors are in parentheses.
4. *, **, *** indicates coefficient different from null at 10%, 5%, 1% significance level respectively.

Table 1.4 Long-run Coefficient Estimates

Group	Country	Equation (1-4)			Equation (1-5)		
		$IFIGDP_{t-1}$	F statistic	EC_{t-1}	$GEQY_{t-1}$	F statistic	EC_{t-1}
OECD	AUT	-0.0410 (-5.9085)***	4.1743**	-0.2499 (2.8808)***	-0.1024 (3.6523)***	2.4480	-0.1663 (2.1774)**
	BEL	-0.0067 (7.1363)***	9.1967***	-0.8013 (4.3810)***	-0.0093 (3.5373)***	75.2052***	-0.9255 (12.4727)***
	CAN	-0.2350 (18.5249)***	7.3312***	-0.5112 (3.8728)***	-0.2950 (15.0420)***	4.0528**	-0.3261 (2.8930)***
	CHE	-0.0337 (5.2011)***	3.3429**	-0.2511 (2.6283)**	-0.0678 (5.6069)***	4.0395**	-0.3103 (2.8889)***
	DEU	-0.1129 (2.8030)***	1.8265	-0.1316 (1.9317)*	-0.3160 (1.6316)	1.0613	-0.0905 (1.4616)
	DNK	-0.0732 (4.5910)***	3.6876**	-0.2755 (2.7097)**	-0.1675 (4.8707)***	3.0442*	-0.2310 (2.5002)**
	ESP	0.0519 (1.6941)	2.9380*	-0.1875 (2.4631)**	0.1509 (1.6401)	3.0278*	-0.1833 (2.5005)**
	FIN	-0.0470 (4.7151)***	1.6391	-0.1636 (1.8426)*	-0.0582 (1.2986)	1.8312	-0.1074 (1.9406)*
	FRA	0.0167 (0.3728)	3.3305**	-0.0671 (2.5043)**	0.0142 (0.1437)	3.2922**	-0.0715 (2.4605)**
	GBR	0.0193 (1.8517)*	9.7388***	-0.2627 (4.4627)***	0.0452 (1.6462)	8.0122***	-0.2602 (4.0686)***
	GRC	-0.1310 (0.3862)	0.8381	-0.0871 (1.2841)	-0.2843 (0.1289)	0.7930	-0.0770 (1.2768)
	IRL	0.0030 (0.3600)	6.0966***	-0.1551 (3.5127)***	0.0072 (0.2975)	6.7767***	-0.1577 (3.7122)***
	ISL	-1.3674 (1.8076)*	2.2978	-0.1459 (2.0356)*	226.6350 (0.0331)	2.1397	0.0030 (2.1174)**
	ISR	0.0193 (2.0486)*	9.7488***	-0.3057 (4.4914)***	0.0169 (1.1130)	9.6899***	-0.2919 (4.4609)***
	ITA	0.0518 (0.1939)	1.4169	-0.0628 (1.7084)*	0.8998 (0.22389)	1.3608	-0.0280 (1.6528)
	JPN	-0.0709 (3.9953)***	4.5412**	-0.4198 (3.0630)***	-0.1892 (2.2193)**	3.7806**	-0.2624 (2.7492)***
	KOR	-0.3665 (2.2478)**	9.2506***	-0.4067 (4.3154)***	-0.1566 (0.6286)	2.7894*	-0.2731 (2.3974)**
	NLD	-0.0275 (1.7594)*	2.8386*	-0.1806 (2.4111)**	-0.0596 (1.4814)	2.6256*	-0.1679 (2.3146)**
	NOR	0.4722 (0.8575)	3.8553**	-0.0770 (2.7822)**	1.1100 (1.1529)	7.5165***	-0.1389 (3.9300)***
	PRT	0.0037 (1.6857)	16.3933***	-0.3246 (5.7852)***	0.0130 (1.7404)*	16.5882***	-0.3247 (5.8380)***
	SWE	-0.0062 (1.1863)	8.9837***	-0.2310 (4.3136)***	-0.0117 (1.2890)	9.0314***	-0.2309 (4.3252)***
	USA	-0.0202 (0.3457)	1.0292	-0.0618 (1.4430)	-0.0672 (0.4294)	0.9474	-0.0595 (1.3985)

Table 1.4 Long-run Coefficient Estimates (continued)

Group	Country	Equation (1-4)			Equation (1-5)		
		$IFIGDP_{t-1}$	F statistic	EC_{t-1}	$GEQY_{t-1}$	F statistic	EC_{t-1}
Upper-Middle Income	BRA	-0.6200 (2.4508)**	7.4110***	-0.2312 (3.8768)***	-0.3681 (1.5215)	2.3003	-0.1781 (2.1600)**
	BWA	-0.3804 (1.3567)	2.4799	-0.1264 (2.1603)**	0.2461 (0.4259)	5.6443***	-0.1851 (3.1837)***
	CHL	-0.1619 (1.2386)	1.3994	-0.1359 (1.7106)	-0.3283 (1.4359)	6.3104***	-0.1633 (3.6403)***
	COL	-0.1385 (0.9172)	3.2021*	-0.1311 (2.5689)**	0.2117 (0.5016)	3.2630**	-0.1179 (2.5811)**
	CRI	-0.3453 (0.7367)	5.6311**	-0.2276 (3.3332)***	8.8213 (0.6437)	12.9691***	-0.1029 (4.6230)***
	DOM	-1.5530 (0.9384)	6.1173***	-0.0864 (1.6049)	-3.0337 (1.0242)	7.6269***	-0.1286 (2.7602)***
	DZA	2.3645 (0.3654)	2.2494	-0.0300 (2.1709)**	47.5341 (0.4035)	4.5414**	-0.0234 (3.0759)***
	GAB	-0.0319 (0.0288)	0.6722	-0.0496 (1.1755)	1.6675 (1.1944)	0.8794	-0.0741 (1.3458)
	MEX	-1.8085 (4.9193)***	4.8396	-0.2055 (3.1780)***	0.2536 (0.2046)	5.5696***	-0.1740 (3.3988)***
	MYS	-0.5433 (5.2319)***	7.7789***	-0.3631 (3.8611)***	-1.0663 (5.0795)***	4.5171**	-0.2913 (3.0677)***
	PER	0.2923 (0.6409)	2.3864	-0.2946 (2.2361)**	0.2149 (0.5968)	2.7610*	-0.2322 (2.3365)**
	TUR	-0.8166 (4.6765)***	6.1890***	-0.4691 (3.5717)***	-1.3584 (1.1367)	5.0735**	-0.5795 (3.2604)***
	URY	-0.1890 (4.0778)***	20.2213***	-0.6210 (6.3757)***	-1.7599 (2.9674)***	8.1212***	-0.4839 (4.1250)***
	VEN	-1.0760 (12.3404)***	8.0530***	-0.6877 (4.1123)***	-0.2038 (0.1279)	1.1330	-0.1014 (1.4853)
	ZAF	0.0735 (0.6490)	2.0408	-0.0972 (2.0108)*	0.0959 (0.6886)	2.1154	-0.0982 (2.0090)*
Lower-Middle Income	BOL	-0.2265 (0.8753)	3.8807**	-0.1966 (2.7950)***	-0.3134 (1.8091)*	10.9078***	-0.2925 (4.7274)***
	CHN	-0.0005 (0.0481)	8.9040***	-1.0766 (4.3087)***	0.0113 (0.5195)	7.6075***	-1.1022 (3.9756)***
	CIV	-0.7415 (4.6333)***	5.3937***	-0.2687 (2.9700)***	-1.0694 (0.6321)	1.4602	-0.1428 (1.7362)*
	ECU	-0.2284 (6.6924)***	5.9248***	-0.3112 (3.5197)***	0.9967 (0.9114)	13.6032***	-0.1687 (3.4523)***
	EGY	-0.0396 (0.6588)	32.3516***	-0.3641 (8.2097)***	-0.0501 (0.3947)	9.9964***	-0.3722 (4.5766)***
	GTM	-1.6733 (3.1585)***	3.0065*	-0.2089 (2.2238)**	-3.6252 (0.6905)	1.2443	-0.0969 (1.5964)
	HND	-0.0969 (1.6069)	11.3483***	-0.2258 (4.8207)***	-0.1818 (2.1910)*	15.2805***	-0.4488 (5.6247)***

Table 1.4 Long-run Coefficient Estimates (continued)

Group	Country	Equation (1-4)			Equation (1-5)		
		$IFIGDP_{t-1}$	F statistic	EC_{t-1}	$GEQY_{t-1}$	F statistic	EC_{t-1}
Lower-Middle Income	IND	0.2821 (0.9075)	2.2554	-0.0960 (2.1016)**	0.2756 (0.6757)	2.1397	-0.1011 (2.0586)**
	LKA	-0.4394 (1.0967)	7.2565***	-0.2208 (3.7310)***	1.8303 (1.5325)	8.1076***	-0.1810 (4.0674)***
	LSO	0.1208 (3.0899)***	4.1957**	-0.3379 (2.8252)***	0.1768 (2.7663)**	4.1330**	-0.3604 (2.9143)***
	MAR	-0.0371 (1.3192)	17.8970***	-0.6912 (6.0571)***	-0.0260 (1.4037)	18.2905***	-0.6163 (6.1658)***
	NIC	-0.0764 (3.6090)***	4.9194**	-0.3219 (3.1375)***	0.1826 (0.2599)	1.7466	-0.1537 (1.8061)*
	PAK	-1.2350 (2.1649)**	2.3819	-0.2580 (2.1979)**	7.5373 (0.0913)	0.9326	-0.0115 (0.6534)
	PHL	-4.2749 (0.8326)	5.4224***	-0.0402 (3.3478)***	-3.5315 (4.4201)***	6.7683***	-0.2703 (3.7658)***
	PNG	0.1766 (0.2734)	35.0269***	-0.7660 (7.0571)***	0.4039 (0.5196)	33.0443***	-0.8432 (7.5948)***
	PRY	-0.4692 (1.0182)	1.2218	-0.0848 (1.5702)	1.1004 (0.3475)	1.0136	-0.0520 (1.4024)
	SEN	-0.1514 (4.1463)***	42.8261***	-0.4731 (9.3964)***	-0.4893 (1.6396)	30.8955***	-0.3380 (7.9032)***
	SLV	-0.5867 (4.2873)***	5.1582**	-0.2660 (2.9258)***	-0.9206 (1.1918)	1.9933	-0.1414 (1.9917)*
	SWZ	-0.3389 (1.1164)	2.3738	-0.3090 (2.2111)**	-1.5281 (1.8922)*	3.3745**	-0.3752 (2.6263)**
	SYR	-0.0571 (1.0470)	2.1250	-0.1804 (2.1041)**	-0.8349 (2.6921)**	1.3521	-0.2242 (1.4640)
	THA	-0.4596 (2.1639)**	1.5507	-0.1787 (1.7722)*	-1.1225 (3.0588)***	4.7486**	-0.3283 (3.1510)***
	TUN	-0.3400 (5.4660)***	36.5138***	-0.6375 (8.5880)***	-0.5690 (4.4635)***	31.0069***	-0.5581 (7.9182)***
Low Income	GHA	-0.2170 (1.1494)	2.4701	-0.1876 (2.2705)**	-2.0143 (2.2725)**	3.8930**	-0.2354 (2.7676)***
	KEN	0.1143 (0.5262)	2.6046	-0.3211 (2.3387)**	1.5971 (2.4027)**	18.4970***	-0.5678 (6.1977)***
	MDG	-0.1395 (1.5639)	10.5730***	-0.5472 (4.6779)***	0.2595 (0.6746)	9.7311***	-0.4215 (4.4221)***
	RWA	0.2181 (2.1259)**	2.7140*	-0.2053 (2.3779)**	3.6106 (0.4353)	0.2206	-0.0357 (0.6779)
	ZAR	0.0754 (0.7800)	3.5117**	-0.2913 (2.6016)**	2.2155 (1.3177)	3.7650**	-0.2810 (2.7859)***
	ZMB	0.2054 (6.4656)	15.3814***	-0.3652 (5.6608)***	0.3984 (2.8633)***	2.6386*	-0.2607 (2.3513)**

Notes: 1. T statistics are in parentheses.

2. *, **, *** indicates coefficient different from null at 10%, 5%, 1% significance level respectively.

Table 1.5 Panel Regression of FH Coefficient on Lane-Milesi-Ferretti Indices

	All Countries				OECD			
IFIGDP	-0.0359 (0.0027)***	-0.0228 (0.0028)***			-0.0255 (0.0020)***	0.0002 (0.0023)		
GEQY			-0.0833 (0.0079)***	-0.0323 (0.0086)***			-0.0706 (0.0055)***	0.0012 (0.0062)
lnGDPPC		-0.2227 (0.0174)***		-0.2403 (0.0185)***		-0.3839 (0.0215)***		-0.3851 (0.0218)***
Constant	0.5224 (0.0059)***	2.2866 (0.1378)***	0.5031 (0.0054)***	2.4100 (0.1470)***	0.7212 (0.0070)***	4.4260 (0.2078)***	0.7109 (0.0064)***	4.4380 (0.2115)***
R^2(within)	0.0688	0.1302	0.0454	0.1103	0.1646	0.4044	0.1701	0.4044
Obs.	2394	2394	2376	2376	814	814	814	814

	Upper-middle Income				Lower-middle Income			
IFIGDP	-0.3860 (0.0282)***	-0.3234 (0.0314)***			-0.0696 (0.0082)***	-0.0659 (0.0080)***		
GEQY			-0.4001 (0.0558)***	-0.1894 (0.0641)***			-0.2086 (0.0461)***	-0.1122 (0.0504)**
lnGDPPC		-0.1827 (0.0424)***		-0.3003 (0.0493)***		-0.1709 (0.0309)***		-0.1592 (0.0358)***
Constant	0.7883 (0.0284)***	2.2040 (0.3302)***	0.5282 (0.0181)***	2.8978 (0.3892)***	0.4201 (0.0121)***	1.5779 (0.2095)***	0.3918 (0.0133)***	1.4544 (0.2390)***
R^2(within)	0.2578	0.2826	0.0874	0.1465	0.0853	0.1199	0.0261	0.0507
Obs.	554	554	553	553	804	804	787	787

	Low Income			
IFIGDP	-0.0548 (0.0214)**	-0.0516 (0.0284)*		
GEQY			0.1502 (0.0920)	0.2156 (0.0951)**
lnGDPPC		0.0124 (0.0705)		0.1324 (0.0555)**
Constant	0.3913 (0.0284)***	0.3178 (0.4190)	0.2912 (0.0256)***	-0.4688 (0.3195)
R^2(within)	0.0295	0.0297	0.0122	0.0378
Obs.	222	222	222	222

Notes: 1. The panel regressions are fixed effect models over countries.
2. Robust standard errors are in parentheses.
3. *, **, *** indicates coefficient different from null at 10%, 5%, 1% significance level respectively.

Table 1.6 Cross-section Regression of FH Coefficient on Size Effect

1973 - 1979	IFIGDP	-0.0845	-0.0362	-0.1643			
		(0.0795)	(0.0916)	(0.0840)*			
	GEQY				-0.3608	-0.3160	-0.4946
					(0.1973)*	(0.2552)	(0.1996)**
	lnRGDP	0.0554			0.0538		
		(0.0153)***			(0.0147)***		
	lnPOP		0.0401			0.0363	
			(0.0201)*			(0.0191)*	
	lnGDPPC			0.0834			0.0763
				(0.0223)***			(0.0222)***
	Constant	-0.5390	0.1139	0.1913	-0.5065	0.1941	0.2059
		(0.3837)	(0.3613)	(0.1846)	(0.3678)	(0.3336)	(0.1795)
	R^2	0.2108	0.0620	0.2088	0.2371	0.0918	0.2287
	Obs.	62	62	62	62	62	62
1980 - 1989	IFIGDP	-0.0439	-0.0203	-0.1237			
		(0.0479)	(0.0693)	(0.0454)***			
	GEQY				-0.0526	0.1003	-0.2891
					(0.1786)	(0.2496)	(0.1651)*
	lnRGDP	0.0846			0.0853		
		(0.0128)***			(0.0130)***		
	lnPOP		0.0486			0.0537	
			(0.0255)*			(0.0254)**	
	lnGDPPC			0.1253			0.1217
				(0.0177)***			(0.0201)***
	Constant	-1.5243	-0.2911	-0.3749	-1.5796	-0.4131	-0.4261
		(0.3336)***	(0.4584)	(0.1586)**	(0.3247)***	(0.4430)	(0.1615)**
	R^2	0.4058	0.0788	0.4313	0.3961	0.0807	0.3820
	Obs.	65	65	65	65	65	65
1990 - 1999	IFIGDP	0.0116	0.0344	-0.0183			
		(0.0273)	(0.0416)	(0.0293)			
	GEQY				0.0583	0.2111	-0.0079
					(0.0617)	(0.0689)***	(0.0744)
	lnRGDP	0.0851			0.0827		
		(0.0112)***			(0.0114)***		
	lnPOP		0.0743			0.0757	
			(0.0241)***			(0.0246)***	
	lnGDPPC			0.0930			0.0909
				(0.0215)***			(0.0230)***
	Constant	-1.7088	-0.8804	-0.3167	-1.6543	-0.9281	-0.3242
		(0.2785)***	(0.4215)**	(0.1729)*	(0.2833)***	(0.4207)**	(0.1830)*
	R^2	0.3707	0.1387	0.2335	0.3738	0.1905	0.2289
	Obs.	65	65	65	65	65	65
2000 - 2009	IFIGDP	0.0185	0.0358	0.0121			
		(0.0095)*	(0.0144)**	(0.0109)			
	GEQY				0.0473	0.0954	0.0311
					(0.0226)**	(0.0332)***	(0.0272)
	lnRGDP	0.0610			0.0608		
		(0.0099)***			(0.0099)***		
	lnPOP		0.0689			0.0668	
			(0.0149)***			(0.0159)***	
	lnGDPPC			0.0575			0.0580
				(0.0217)**			(0.0215)***
	Constant	-1.2264	-0.8998	-0.1598	-1.2139	-0.8555	-0.1598
		(0.2392)***	(0.2543)***	(0.1607)	(0.2425)***	(0.2680)***	(0.1617)
	R^2	0.3509	0.2646	0.2052	0.3438	0.2546	0.2028
	Obs.	65	65	65	65	65	65

Notes: 1. Robust standard errors are in parentheses.

2. *, **, *** indicates coefficient different from null at 10%, 5%, 1% significance level respectively.

Table 1.7 Logistic Regression Results for Financial Market Imperfection

Dependent variable	$p_i(\beta_{FH}, IFIGDP)$		$p_i(\beta_{FH}, GEQY)$	
Model	I	II	III	IV
KAOPEN	0.6307 (0.2404)***	0.9306 (0.3549)**	0.4091 (0.2476)*	0.7650 (0.3844)**
OECD		-0.9877 (0.8335)		-1.1722 (0.9423)
Constant	-0.5510 (0.2771)**	-0.2824 (0.3561)	-1.2440 (0.3135)***	-0.9474 (0.3821)**
Pseudo R^2	0.0884	0.1054	0.0386	0.0614
Obs.	65	65	65	65

Notes: 1. Standard errors are in parentheses.
2. *, **, *** indicates coefficient different from null at 10%, 5%, 1% significance level respectively.

Appendix A:

Graphical Representation of FH Coefficient Estimates

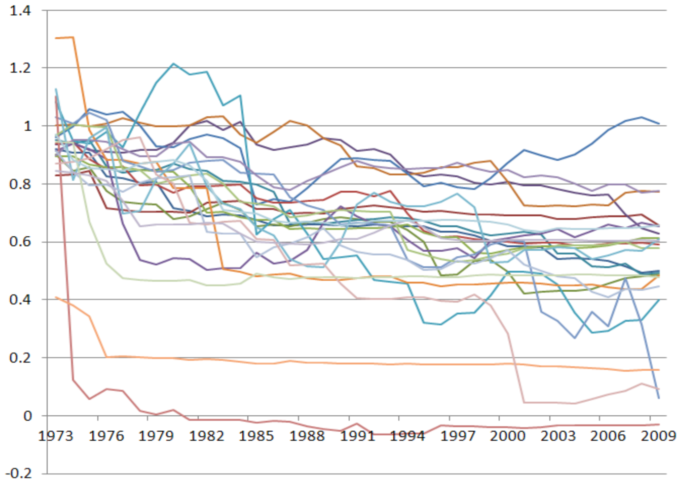

Figure A-1 FH Coefficients for OECD Countries

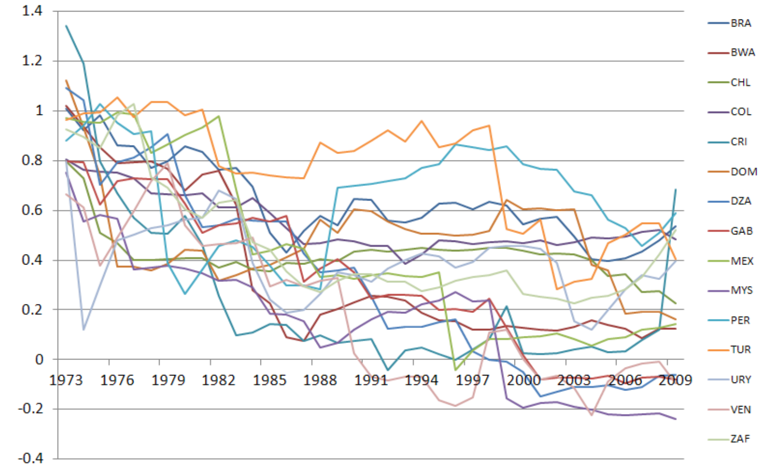

Figure A-2 FH Coefficients for Upper-middle Income Countries

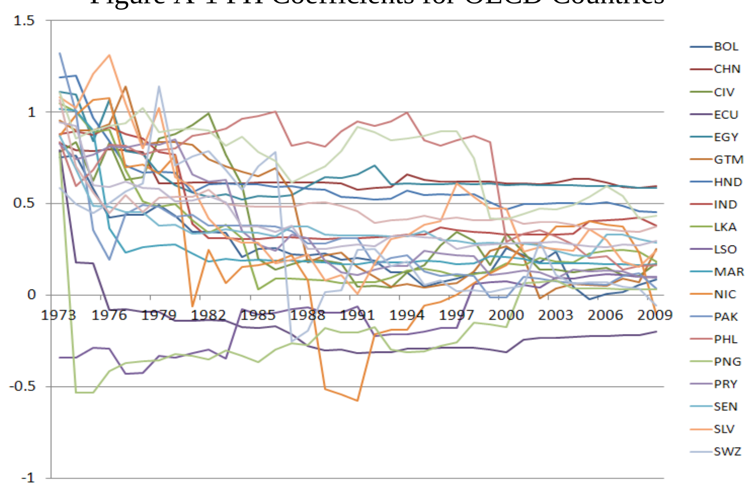

Figure A-3 FH Coefficients for Lower-middle Income Countries

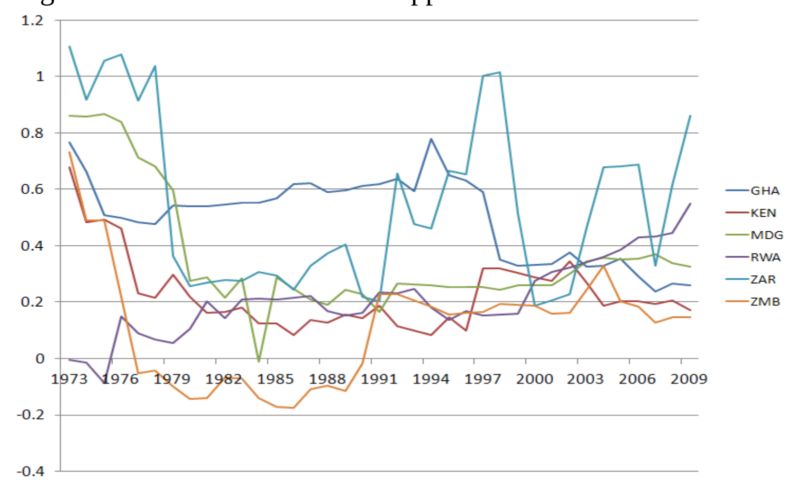

Figure A-4 FH Coefficients for Low Income Countries

Appendix B:

Table B-1 Im, Pesaran and Shin (IPS) Panel Unit-root Test

Samples	Variables	Levels	First differences
Whole countries	I/Y	-3.8506 (0.0001)***	
	S/Y	-5.6292 (0.0000)***	
	β_{FH}	-8.5842 (0.0000)***	
	IFIGDP	8.9090 (1.0000)	-27.7682 (0.0000)***
	GEQY	15.8811 (1.0000)	-28.6742 (0.0000)***
OECD	I/Y	-1.6320 (0.0513)*	
	S/Y	-2.2636 (0.0118)**	
	β_{FH}	-3.1035 (0.0010)***	
	IFIGDP	15.3725 (1.0000)	-15.9048 (0.0000)***
	GEQY	10.4262 (1.0000)	-17.4164 (0.0000)***
Upper-middle income	I/Y	-3.2715 (0.0005)***	
	S/Y	-3.3306 (0.0004)***	
	β_{FH}	-3.3622 (0.0004)***	
	IFIGDP	0.7120 (0.7618)	-13.6495 (0.0000)***
	GEQY	8.4106 (1.0000)	-14.3156 (0.0000)***
Lower-middle income	I/Y	-2.0282 (0.0213)**	
	S/Y	-2.3355 (0.0098)***	
	β_{FH}	-7.6364 (0.0000)***	
	IFIGDP	-0.8572 (0.1957)	-16.4265 (0.0000)***
	GEQY	7.4420 (1.0000)	-15.8235 (0.0000)***
Low-income	I/Y	-0.4923 (0.3112)	-9.2247 (0.0000)***
	S/Y	-4.4551 (0.0000)***	
	β_{FH}	-2.3727 (0.0088)***	
	IFIGDP	-0.2826 (0.3887)	-7.9619 (0.0000)***
	GEQY	4.5890 (1.0000)	-8.0525 (0.0000)***

Note: 1. t-statistics are in the table. P-values are in parentheses.
2. *, **, *** indicates coefficient different from null at 10%, 5%, 1% significance level respectively.

Chapter 2

Financial Integration, Risk Diversification, and Growth

2.1 Introduction

The degree of financial integration has improved over the past several decades. There is a substantial literature discussing the effect of financial integration on economic growth or welfare. One of the key channels through which financial integration is considered to benefit economic growth is the channel of risk-sharing (Prasad et. al., 2003). Intuitively, while savers are risk averse, higher-return projects entail higher risk than lower-return projects. As such, financial market integration, by facilitating diversification of risk, induces a portfolio shift toward projects that earn higher expected returns (Obstfeld, 1994).

This paper is closely related to Obstfeld (1994) which supposes that each country can invest in two projects, riskless and risky. By developing a continuous-time stochastic model, Obstfeld (1994) shows the international risk diversification can yield welfare gains through its effect on expected consumption growth by allowing the world portfolio to shift from safe lower return capital to riskier higher return capital. Other papers have also evaluated the welfare gains from international risk-sharing. Cole and Obstfeld (1991), Gourinchas and Jeanne (2006) and Martin and Viktoria (2007) find the existence of gains from international risk-sharing, but the effect is not significant. van Wincoop (1999) and

Kim et al. (2003) suggest that the welfare gains vary with the degree of relative risk aversion, the stochastic process of endowment and the persistence of economic shock.

Although it is generally assumed that financial integration stabilizes financial market, and creates the opportunity for risk diversification, the contagion effect of the financial crises in the recent decades draws the attention to the "cost" of financial integration. With a higher level of financial integration, financial crisis is no longer confined to a country or a region. Financial integration not only creates valuable opportunities for portfolio diversification, risk sharing, and intertemporal trade, it also causes a potential drawback by fostering systemic risk (through the "contagion" of the failure of one part of the integrated financial system) (Eichengreen et al., 1998; Williamson, 1998; Stiglitz, 2010). Some previous papers provide theoretical frameworks to address this issue. Fecht and Grüner (2005) consider a two-regional case, and derive the interbank market structure to illustrate the trade-off between the benefit from diversification and the cost from the contagion effect (increase in systemic risk). Daniel et al. (2007) develop a dynamic, small-open economy, general-equilibrium model that shows that financial liberalization contributes to banking crises. Fecht et al. (2012) study the relationship between financial integration and financial stability. They construct a model which incorporates the integrated interbank market, and allows the bank's loan portfolios to adjust endogenously. In their model, banks can diversify the idiosyncratic risk from the integrated interbank market. They find the need for risk sharing increases the risk of cross-border contagion and the likelihood of widespread banking crises. Demirgüç-Kunt and Detragiache (2001) and Boyd, et al. (2010) provide some empirical evidence that financial liberalization increase the likelihood of bank crises.

In contrast, some of the empirical findings claim that financial liberalization does not elevate the probability of bank crises. Bonfiglioli and Mendicino (2004) find the correlation between the occurrence of banking crises and the capital flow restrictions is unclear in 90 countries from 1975 to 1999. Moreover, capital account liberalization mitigates the harmful effects of the banking crises. In 69 developing countries from 1975 to 1997, Glick et al. (2006) find that countries with fewer restrictions on capital flows experience a smaller probability of currency crises than the countries with more restrictions. The empirical analysis by De Nicolò and Luciana (2010) indicates that higher levels of financial integration predict lower levels of systemic real risk, and the prediction is stronger in the emerging markets. Angkinand et al. (2010) show the inverted U-shape relationship between the financial liberalization and the probability of banking risk in 48 countries from 1973 to 2005. By separating the sample, they find that the probability of banking crises is reduced with the higher level of financial liberalization, except the countries with weaker regulation and supervision. Enowbi Batuo and Mlambo (2012) study the effect of financial liberalization on banking crises within African countries from 1985 to 2010. The result shows that the financial liberalization tends to reduce the likelihood of banking crises.

One reason for the contrast results between theoretical and empirical findings is the complexity of data. As discussed before, the effects of financial integration on growth have two directions, positive effect through the channel of risk-sharing and negative effect through the channel of contagion effect. The empirical data for bank crisis is influenced by these two effects simultaneously which are difficult to identify individually.

Rather than focus on the bank crisis, we are more interested in economic growth in the content of financial integration. Instead of focusing the benefit of risk-sharing and the effect on bank crisis in the previous empirical and theoretical studies, this paper provides the linkage between systemic risk and economic growth which contains fruitful intuitions, and sheds the light on the missing gap in the previous studies on systemic risk.

To illustrate the benefit of risk diversification and the cost of systemic risk under the integrated financial market, this paper focuses on the volatilities of the risky investments, and provides a framework to show the effect of volatilities on portfolio decision and expected consumption growth. To address the issue of systemic risk, we consider the extent of correlation of risk between domestic and foreign investment (Stiglitz, 2010). To motivate the construction of our model, we look at the stylized fact on the relationship between systemic risk and growth. Based on the WDI data from the World Bank, we compute the correlation coefficient of risk premium (lending rate minus treasury bill rate) between each individual country and the world average for 69 countries from 1995 to 2011, and show the relationship between correlation coefficient and the average consumption growth in Figure 2.1. Since the correlation coefficient of risk premium is considered to be the measure of systemic risk (Stiglitz, 2010), Figure 2.1 shows a negative relationship between the levels of systemic risk and consumption growth[1], and shed the light on the potential cost of contagion effect from financial integration .

[Insert Figure 2.1 here]

[1] The negative effect of correlation on consumption growth is statistically significant in Figure 2.1. Similar result could be shown by using the growth of GDP per capita.

The theoretical model in this paper is closely related to Obstfeld (1994). However, Obstfeld (1994) only considered one risky investment, and unable to addresses the issue of systemic risk which is caused by international financial integration. For the purpose of investigating the effects of systemic risk, we identify risky investments into two sectors, domestic and foreign. In other words, we suppose that each individual can invest in three projects, risk-free investment, domestic risky investment and foreign risky investment, and determine the share for each project. The risk-free investment provides a constant return. The risky projects which may correlate with each other provide different expected returns and volatilities, and the relationship between domestic and foreign risky investments is the key to address the contagion effect in our model. The goal of this paper is to find out how the international portfolio is affected by the rate of returns, the volatilities of these risky assets, and the correlation between domestic and foreign investments. Moreover, this paper sheds the light on the growth of expected consumptions which is also affected by the returns and risks.

Section 2.2 describes the model and evaluates the optimal portfolio and expected consumption growth. In section 2.3, we discuss the effects of volatilities and correlation on investment portfolio and growth. Section 2.4 shows a numerical example. The last section provides the concluding remarks.

2.2 The Model

Suppose that the representative agent has an infinite-horizon expected utility function given by

$$U_t = E_t\{\sum_{s=t}^{\infty} \beta^{s-t} u(C_s)\} \qquad (2\text{-}1)$$

where the population is normalized to 1. We assume a linear technology with constant returns to scale in capital at the firm level, the AK model. There are three types of capital can be invested from domestic savings and offer different levels of return:

1) Constant riskless gross return, r

2) Domestic risky return at time t, $r_{D,t+1}$

3) World risky return at time t, $r_{W,t+1}$

where $r_{D,t+1}$ and $r_{W,t+1}$ are i.i.d., and $E_t(r_{D,t+1}) > r$ and $E_t(r_{W,t+1}) > r$. Capital can be moved from riskless and risky production, and vice versa, instantaneously and with no frictional costs.

For the capital inflow, B_t denotes the international debt which is restricted by a constant fraction (m) of total capital stock K_t. In each period t, the economy needs to repay the interest according to the world interest rate which is equal to the domestic risky return, $r_{D,t}$. Let K_t denotes to total amount of capital accumulated by the end of period t-1. The representative agent's budget constraint is,

$$K_{t+1} = \{x_{F,t}(1 + r) + x_{D,t}(1 + r_{D,t}) + x_{W,t}[1 + (1 - \tau)r_{W,t}]\}K_t - C_t - (1 - \tau)r_{D,t}B_t$$

$$\Rightarrow K_{t+1} = \{x_{F,t}(1 + r) + x_{D,t}(1 + r_{D,t}) + x_{W,t}[1 + (1 - \tau)r_{W,t}] - (1 - \tau)mr_{D,t}\}K_t - C_t \qquad (2\text{-}2)$$

where τ represents the transaction cost. $\tau = 0$ implies there is no transaction cost.

m represents the fraction of total capital stock which is used for international borrowing

$x_{F,t}$ is the share of capital invested in riskless asset on the end of date t-1

$x_{D,t}$ is the share of capital invested in domestic risky asset on the end of date t-1

$x_{W,t}$ is the share of capital invested in world risky asset on the end of date t-1

$x_{F,t} + x_{D,t} + x_{W,t} = 1 + m \quad \forall t$

The stochastic intertemporal maximization problem[2] becomes,

$$\max \quad U_t = E_t\{\sum_{s=t}^{\infty} \beta^{s-t} u(C_s)\}$$

$$\text{s.t.} \quad K_{t+1} = \{x_{F,t}(1+r) + x_{D,t}(1+r_{D,t}) + x_{W,t}[1+(1-\tau)r_{W,t}] - (1-\tau)mr_{D,t}\}K_t - C_t$$

$$x_{F,t} + x_{D,t} + x_{W,t} = 1 + m$$

$W_t \equiv \{x_{F,t}(1+r) + x_{D,t}(1+r_{D,t}) + x_{W,t}[1+(1-\tau)r_{W,t}] - (1-\tau)mr_{D,t}\}K_t$ is the value of total resources at the start of time t, and

$$W_{t+1} = \{x_{F,t+1}(1+r) + x_{D,t+1}(1+r_{D,t+1}) + x_{W,t+1}[1+(1-\tau)r_{W,t+1}] - (1-\tau)mr_{D,t+1}\}(W_t - C_t)$$

Since $\sum_{n=F}^{W} x_{n,t} = \sum_{n=F}^{W} x_{n,t+1} = 1 + m \quad \text{for} \quad n = F, D, W$ then,

$$\Rightarrow W_{t+1} = \{1 + m + r + x_{D,t+1}(r_{D,t+1} - r) + x_{W,t+1}[(1-\tau)r_{W,t+1} - r] - m[(1-\tau)r_{D,t+1} - r]\}(W_t - C_t) \tag{2-3}$$

Let $J_t(W_t)$ denotes the value function at the start of time t. This value function depends on the value of total resources at time t, W_t, and time t information if current and

[2] This formulation, though generalized presently, is based on the framework that Obstfeld (1994) and Obstfeld (1996) provide.

past asset returns contain useful information for predicting future returns. The Bellman equation for time t is,

$$J_t(W_t) = \max_{C_t, x_{n,t+1}} \left(u(C_t) + \beta E_t J_{t+1} \left(\{1 + m + r + x_{D,t+1}(r_{D,t+1} - r) + x_{W,t+1}[(1-\tau) r_{W,t+1} - r] - m[(1-\tau) r_{D,t+1} - r]\}(W_t - C_t) \right) \right)$$

The first-order conditions,

1) $\frac{\partial J_t(W_t)}{\partial C_t} = 0$

$$\Rightarrow u'(C_t) = \beta E_t \left(u'(C_{t+1}) \{1 + m + r + x_{D,t+1}(r_{D,t+1} - r) + x_{W,t+1}[(1-\tau) r_{W,t+1} - r] - m[(1-\tau) r_{D,t+1} - r]\} \right) \quad (2\text{-}4)$$

2) $\frac{\partial J_t(W_t)}{\partial x_{D,t+1}} = 0$

$$\Rightarrow E_t\left[u'(C_{t+1})(r_{D,t+1} - r)\right] = 0 \quad (2\text{-}5)$$

3) $\frac{\partial J_t(W_t)}{\partial x_{W,t+1}} = 0$

$$\Rightarrow E_t\left[u'(C_{t+1})[(1-\tau) r_{W,t+1} - r]\right] = 0 \quad (2\text{-}6)$$

We specifying the utility function, that $u(C_t) = \ln C_t$. This utility function exhibits the coefficient of relative risk-aversion ($\rho = -Cu''/u'$) equal to 1. While more complex forms can also be used to model risk aversion, this functional form is adequately consistent with the existence of risky investments. Obsfeld (1996, pp. 479) uses this same form as well. We presume the optimal consumption function has the proportional form,

$$C_s = \mu W_s \qquad \forall s = t, t+1, \dots \quad (2\text{-}7)$$

where μ is a constant.

From the first-order conditions (equation (2-4) to (2-6)), we can solve for μ, and the utility function can be written as,

$$C_s = (1-\beta)W_s \qquad \forall s = t, t+1, \dots \tag{2-8}$$

The stochastic Euler conditions are as follow,

$$1 = \beta E_t\left(\frac{C_t}{C_{t+1}}\left[(1+m)(1+r) - m(1-\tau)r_{D,t+1}\right]\right)$$

$$\Rightarrow \beta E_t\left(\frac{C_t}{C_{t+1}}\right) = \frac{1+\beta(1-\tau)mCov_t\left(\frac{C_t}{C_{t+1}},\ r_{D,t+1}\right)}{(1+m)(1+r)-m(1-\tau)E_t\left(r_{D,t+1}\right)} \tag{2-9}$$

$$1 = \beta E_t\left(\frac{C_t}{C_{t+1}}\left[1+m+(1+m\tau)r_{D,t+1}\right]\right)$$

$$\Rightarrow \beta E_t\left(\frac{C_t}{C_{t+1}}\right) = \frac{1-\beta(1+m\tau)mCov_t\left(\frac{C_t}{C_{t+1}},\ r_{D,t+1}\right)}{1+m+(1+m\tau)E_t\left(r_{D,t+1}\right)} \tag{2-10}$$

$$1 = \beta E_t\left(\frac{C_t}{C_{t+1}}\left[1+m+(1+m)(1-\tau)r_{W,t+1} - m(1-\tau)r_{D,t+1}\right]\right)$$

$$\Rightarrow \beta E_t\left(\frac{C_t}{C_{t+1}}\right) = \frac{1+\beta m(1-\tau)Cov_t\left(\frac{C_t}{C_{t+1}},\ r_{D,t+1}\right)-\beta(1+m)(1-\tau)Cov_t\left(\frac{C_t}{C_{t+1}},\ r_{W,t+1}\right)}{1+m-m(1-\tau)E_t\left(r_{D,t+1}\right)+(1+m)(1-\tau)(1+m\tau)E_t\left(r_{W,t+1}\right)} \tag{2-11}$$

We apply the result of Taylor approximation[3] on equation (2-9),

$$\Rightarrow \beta E_t\left(\frac{C_t}{C_{t+1}}\right) = \frac{1-\beta(1-\tau)mCov_t\left(\frac{C_{t+1}}{C_t},\ r_{D,t+1}\right)}{(1+m)(1+r)-m(1-\tau)E_t\left(r_{D,t+1}\right)} \tag{2-12}$$

Substituting equation (2-12) and the result of Taylor approximation, the covariance between consumption growth and risky returns can be written as a function of expected returns, parameters of capital inflow, transaction cost and time preferences.

$$Cov_t\left(\frac{C_{t+1}}{C_t},\ r_{D,t+1}\right) = \frac{E_t\left(r_{D,t+1}\right)-r}{\beta(1+m+r+m\tau r)} \tag{2-13}$$

$$Cov_t\left(\frac{C_{t+1}}{C_t},\ r_{W,t+1}\right) = \frac{E_t\left(r_{W,t+1}\right)-\frac{r}{(1-\tau)}}{\beta(1+m+r+m\tau r)} \tag{2-14}$$

[3] The detailed specification of Taylor approximation is in appendix A.

Note that, from equation (2-3) and (2-8), we have,

$$\frac{C_{t+1}}{C_t} = \frac{W_{t+1}}{W_t}$$

$$\Rightarrow \frac{C_{t+1}}{C_t} = \{1 + m + r + x_{D,t+1}(r_{D,t+1} - r) + x_{W,t+1}[(1-\tau)r_{W,t+1} - r] - m[(1-\tau)r_{D,t+1} - r]\} \quad (2\text{-}15)$$

Suppose the optimal share variables are x_D^* and x_W^* which are constant with i.i.d. risky returns. According to (2-15), we can derive $\mathrm{Cov}_t(C_{t+1}/C_t, r_{D,t+1})$ and $\mathrm{Cov}_t(C_{t+1}/C_t, r_{W,t+1})$ in terms of x_D^* and x_W^*, where

$$\mathrm{Cov}_t\left(\frac{C_{t+1}}{C_t}, \ r_{D,t+1}\right) = \beta \mathrm{Var}_t(r_{D,t+1})x_D^* + \beta(1-\tau)\mathrm{Cov}_t(r_{D,t+1}, r_{W,t+1})x_W^* - \beta m(1-\tau)\mathrm{Var}_t(r_{D,t+1}) \quad (2\text{-}16)$$

$$\mathrm{Cov}_t\left(\frac{C_{t+1}}{C_t}, \ r_{W,t+1}\right) = \beta \mathrm{Cov}_t(r_{D,t+1}, r_{W,t+1})x_D^* + \beta(1-\tau)\mathrm{Var}_t(r_{W,t+1})x_W^* - \beta m(1-\tau)\mathrm{Cov}_t(r_{D,t+1}, r_{W,t+1}) \quad (2\text{-}17)$$

From equations (2-13), (2-14), (2-16) and (2-17), we can solve for the fraction of domestic and foreign risky investments (x_D^* and x_W^*).

$$\Rightarrow x_D^* = \frac{AV_W - B\mathrm{Cov}}{\beta C[V_D V_W - \mathrm{Cov}^2]} + m(1-\tau) \quad (2\text{-}18)$$

$$\Rightarrow x_W^* = \frac{BV_D - A\mathrm{Cov}}{\beta C(1-\tau)[V_D V_W - \mathrm{Cov}^2]} \quad (2\text{-}19)$$

where $A \equiv [E_t(r_{D,t+1}) - r]$

$B \equiv \left[E_t(r_{W,t+1}) - \frac{r}{1-\tau}\right]$

$C \equiv \beta[1 + m + r + m\tau r]$

$V_D \equiv \mathrm{Var}_t(r_{D,t+1})$

$V_W \equiv \mathrm{Var}_t(r_{W,t+1})$

$\mathrm{Cov} \equiv \mathrm{Cov}_t(r_{D,t+1}, r_{W,t+1})$

By taking the expectation on both side of equation (2-15), we can obtain the expected consumption growth which contains x_D^* and x_W^*.

$$E_t\left(\frac{C_{t+1}}{C_t}\right)^* = \{1 + m + r + x_D^*[E_t(r_{D,t+1}) - r] + x_W^*[(1-\tau)E_t(r_{W,t+1}) - r] - m[(1-\tau)E_t(r_{D,t+1}) - r]\}\beta$$

or,

$$E_t\left(\frac{C_{t+1}}{C_t}\right)^* \equiv g^* = C - \beta m(1-\tau)A + \frac{A^2V_W + B^2V_D - 2AB\mathrm{Cov}}{C[V_DV_W - \mathrm{Cov}^2]} \quad (2\text{-}20)$$

Equation (2-18), (2-19) and (2-20) represent the share of domestic risky investments, foreign risky investment, and expected consumption growth under the individual optimization (maximizing investor’s life time utility subject to budget constraints) respectively, and are depended on the returns and variances of domestic and foreign risky assets, and the covariance between domestic and foreign returns.

2.3 Risk, Portfolio and Consumption Growth

In this section, we will discuss the impact from variance and covariance between the share of capital flows on the global investment portfolio (investment shares in domestic and foreign risky investment) and the expected growth of consumption. From the previous section, we determined the optimal level of the investment shares on domestic (x_D^*) and foreign risky asset (x_W^*) and the expected consumption growth (g^*). We explore the first order conditions with respect of V_D, V_W, Cov, and provide interpretations on the portion of risky investments and growth[4].

2.3.1 The Effects of $\mathbf{Var}(\mathbf{r_D})$ and $\mathbf{Var}(\mathbf{r_W})$

We first look at the fraction of domestic risky investments (x_D^*). By differentiating equation (2-18) in V_D, we have,

$$\frac{\partial x_D^*}{\partial V_D} = \frac{-A{V_W}^2 + BV_W Cov}{\beta C(V_D V_W - Cov^2)^2}$$

Since $0 < m < 1$, $0 < \tau < 1$, and riskless return (r) is greater than zero, the denominator is positive. Considering the risk-adjusted non-arbitrage condition (the risk-adjusted excess returns of domestic and foreign risky assets, ($\left[E_t\left(r_{D,t+1}\right) - r\right]/\sigma_D$) and ($\left[E_t\left(r_{W,t+1}\right) - r\right]/\sigma_W$), are equal, where σ_D and σ_W are the standard error of $r_{D,t+1}$ and $r_{W,t+1}$ respectively), the sign of ($\partial x_D^*/\partial V_D$) is negative (see proof in the Appendix B). Thus,

$$\frac{\partial x_D^*}{\partial V_D} < 0 \qquad (2\text{-}21)$$

i.e. The higher the volatility of domestic risky returns, the lower will be the share of risky investment in domestic assets.

Second, by differentiating equation (2-19) over V_D, we have,

$$\frac{\partial x_W^*}{\partial V_D} = \frac{-B\,Cov^2 + AV_W\,Cov}{\beta(1-\tau)C(V_D V_W - Cov^2)^2}$$

---

[4] The investment shares of risk-free assets (x_F^*) is determined when we obtain the optimal level of the investment shares on domestic (x_D^*) and foreign risky asset (x_W^*). However, we can still consider the effects of V_D, V_D, Cov on x_F^*, and the discussion is in Appendix C.

Since $0 < m < 1$, $0 < \tau < 1$ and $r > 0$, the denominator is positive. Considering the risk-adjusted non-arbitrage condition, the sign of $(\partial x_W^* / \partial V_D)$ is positive (see proof in the Appendix B). Thus,

$$\frac{\partial x_W^*}{\partial V_D} > 0 \qquad (2\text{-}22)$$

i.e. the higher the volatility of domestic risky returns, the higher will be the proportion of risky investment in foreign assets.

Third, by differentiating equation (2-20) in V_D, we have,

$$\frac{\partial g^*}{\partial V_D} = \frac{-A^2 V_W{}^2 - B^2 Cov^2 + 2AB V_W Cov}{C(V_D V_W - Cov^2)^2}$$

Since $0 < m < 1$, $0 < \tau < 1$ and $r > 0$, the denominator is positive. Considering the risk-adjusted non-arbitrage condition, the sign of $(\partial g^* / \partial V_D)$ is negative (see proof in the Appendix B). Thus,

$$\frac{\partial g^*}{\partial V_D} < 0 \qquad (2\text{-}23)$$

i.e. the higher the volatility of domestic risky returns, the lower will be the expected consumption growth.

We can summarize the findings from equation (2-21) to (2-23) in the following proposition:

Proposition 1: *For $0 < m < 1$, $0 < \tau < 1$ and, $r > 0$, an increase in domestic volatility leads to (a) a decline in the share of domestic assets, (b) a rise in the share of foreign assets, and (c) a decline in expected consumption growth.*

Following the same process, we could examine the effects of the volatility of foreign risky return (V_W). By differentiating equation (2-18) over V_W, we have,

$$\frac{\partial x_D^*}{\partial V_W} = \frac{-A Cov^2 + B V_D Cov}{\beta C(V_D V_W - Cov^2)^2}$$

Since $0 < m < 1$, $0 < \tau < 1$ and $\mathrm{r} > 0$, the denominator is positive. Considering the risk-adjusted non-arbitrage condition, the sign of $(\partial \mathrm{x}_{\mathrm{D}}^{*}/\partial \mathrm{V}_{W})$ is positive (proof is in Appendix B). Thus,

$$\frac{\partial \mathrm{x}_{\mathrm{D}}^{*}}{\partial \mathrm{V}_{\mathrm{W}}} > 0 \qquad \text{(2-24)}$$

i.e. the higher the volatility of foreign risky returns, the higher will be the proportion of risky investment in domestic assets.

Similarly, by differentiating equation (2-19), we have

$$\frac{\partial \mathrm{x}_{\mathrm{W}}^{*}}{\partial \mathrm{V}_{\mathrm{W}}} = \frac{-\mathrm{B}{\mathrm{V}_{\mathrm{D}}}^{2} + \mathrm{A}\mathrm{V}_{\mathrm{D}}\mathrm{Cov}}{\beta(1-\tau)\mathrm{C}(\mathrm{V}_{\mathrm{D}}\mathrm{V}_{\mathrm{W}} - \mathrm{Cov}^{2})^{2}}$$

Since $0 < m < 1$, $0 < \tau < 1$ and $\mathrm{r} > 0$, the denominator is positive. Considering the risk-adjusted non-arbitrage condition, the sign of $(\partial \mathrm{x}_{\mathrm{W}}^{*}/\partial \mathrm{V}_{W})$ is negative (proof is in Appendix B).

$$\frac{\partial \mathrm{x}_{\mathrm{W}}^{*}}{\partial \mathrm{V}_{\mathrm{W}}} < 0 \qquad \text{(2-25)}$$

i.e. the higher the volatility of foreign risky returns, the lower will be the share of risky investment in foreign assets.

By differentiating the expected consumption growth (g^{*}) in V_{W}, we have

$$\frac{\partial \mathrm{g}^{*}}{\partial \mathrm{V}_{\mathrm{W}}} = \frac{-(\mathrm{A}\mathrm{Cov} - \mathrm{B}\mathrm{V}_{\mathrm{D}})^{2}}{\mathrm{C}(\mathrm{V}_{\mathrm{D}}\mathrm{V}_{\mathrm{W}} - \mathrm{Cov}^{2})^{2}} < 0 \qquad \text{(2-26)}$$

i.e. the higher the volatility of foreign risky returns, the lower will be the expected consumption growth.

In sum, we address the following proposition from equation (2-24) to (2-26),

Proposition 2: *For $0 < m < 1$, $0 < \tau < 1$ and, $r > 0$, an increase in foreign volatility leads to (a) a rise in the share of domestic assets, (b) a decline in the share of foreign assets, and (c) a decline in expected consumption growth.*

2.3.2 The Effects of $\mathbf{Cov(r_D, r_W)}$

The main contribution of this paper is to provide a theoretical framework to illustrate how the systemic risk affects the portfolio and growth. Similar with the previous section, we first differentiate equation (2-18) and (2-19) in the covariance term (Cov).

For the share of domestic risky investment (x_D^*),

$$\frac{\partial x_D^*}{\partial Cov} = \frac{-B(V_D V_W + Cov^2) + 2AV_W Cov}{\beta C(V_D V_W - Cov^2)^2}$$

For the share of foreign risky investment (x_W^*),

$$\frac{\partial x_W^*}{\partial Cov} = \frac{-A(V_D V_W + Cov^2) + 2BV_D Cov}{\beta(1-\tau)C(V_D V_W - Cov^2)^2}$$

Since $0 < m < 1$, $0 < \tau < 1$ and $r > 0$, the denominators are positive. Under the risk-adjusted non-arbitrage condition, $(\partial x_D^* / \partial Cov)$ and $(\partial x_W^* / \partial Cov)$ are both negative (see proof in the Appendix B). Thus,

$$\frac{\partial x_D^*}{\partial Cov} < 0 \qquad (2\text{-}27)$$

$$\frac{\partial x_W^*}{\partial Cov} < 0 \qquad (2\text{-}28)$$

The intuition is straightforward. Higher covariance between domestic and foreign risky returns implies more difficult to diversify the risk of portfolio by investing in both domestic and foreign assets, and investors are exposed to higher systemic risk. In this case, individuals prefer to lower the investment share in risky assets (both domestic and foreign), and raise the holding of risk-free assets.

Second, by differentiating the expected growth (g^*) of consumption in covariance (Cov), we have

$$\frac{\partial g^*}{\partial Cov} = \frac{-2[AB(V_D V_W + Cov^2) - Cov(A^2 V_W + B^2 V_D)]}{C(V_D V_W - Cov^2)^2}$$

Since $0 < m < 1$, $0 < \tau < 1$ and $r > 0$, the denominator is positive. Under the risk-adjusted non-arbitrage condition, ($\partial g^*/\partial \mathrm{Cov}$) is negative (see proof in the Appendix B). Thus,

$$\frac{\partial g^*}{\partial \mathrm{Cov}} < 0 \qquad \text{(2-29)}$$

The explanation is straightforward. According to the findings from equation (2-27) and (2-28), higher level of covariance lowers the share of risky investment, and raises the investment in risk-free assets. Since the return of risk-free investment is lower than risky investment, the consumption growth would be lower due to the lower return from the investment portfolio. This finding indicates that higher covariance which implies higher level of systemic risk reduces the benefit from the risk diversification.

We can summarize the findings from equation (2-27) to (2-29) in the following proposition:

Proposition 3: *For* $0 < m < 1$, $0 < \tau < 1$ *and,* $r > 0$*, an increase in the covariance of domestic and foreign risky returns leads to (a) a decline in the share of domestic assets, (b) a decline in the share of foreign assets, and (c) a decline in expected consumption growth.*

2.4 Numerical Analysis: An example of Taiwan

In the section 2.2, we show that the fraction of wealth invests in domestic and foreign risky assets (x_D^*, x_W^*), and the expected consumption growth (g^*) as functions of risk-free return, expected risky returns, volatilities of risky returns, covariance of domestic and foreign risky returns, and other parameters of transaction cost, capital inflow and time preference. In section 2.3, we show the relationship between the “risk” and “growth”. It is feasible for us to see how the portfolio and growth is affected by manipulating these parameters, especially the parameters we are interested (volatilities and correlation). In this section, we are going to demonstrate how the volatilities and correlation between risky assets affect the portfolio and growth by applying the numerical analysis.

The numerical example is based on the stock market returns. The home country is Taiwan, and the foreign country is United States. The annual stock market returns are calculated from Taiwan stock exchange index and NASDAQ stock market index, 1984-2012, to estimate the expected domestic and foreign risky returns, variance and covariance. The presumption for the usage of data is that we assume the NASDAQ stock index is an approximation of the price of foreign risky assets. Table 2.1 shows the list of parameters we assign to the numerical example, and the equilibrium results from the model. We assume the risk-free return (r) is 0.05, $\tau = 0.1$, $m = 0.3$, $\beta = 1$.

[Insert Table 2.1 here]

Considering the effects of volatilities, Figure 2.2 and 2.3 show the patterns of shares in risky investments (x_D^* and x_W^*) and expected consumption growth (g^*). When the variance of domestic (foreign) risky assets increases, individuals will decrease (increase) the fraction of domestic risky investment, and increase (decrease) the holding of foreign risky assets. In other words, the variances of risky returns affect the shares of domestic and foreign risky investments inversely. As we discussed in the previous section, the effect on the expected consumption growth is negative. In Figure 2.1 and 2.2, we can observe that, when other conditions unchanged, higher volatility of risky return will induce lower consumption growth.

[Insert Figure 2.2 here]

[Insert Figure 2.3 here]

Considering the effects of covariance, Figure 2.4 shows that when the covariance increases, other conditions unchanged, the shares in domestic and foreign risky investment and the expected consumption growth will decrease. Intuitively, larger covariance between risky returns implies the effectiveness of risk diversification is lower. Moreover, larger covariance also implies a higher level of potential systemic risk[5]. With higher covariance, individuals will choose to hold less risky assets no matter domestic or foreign (x_D^* and x_W^* both decrease), and the expected consumption growth is lower due to the lower portfolio return. This result is consistent with the stylized fact which is a negative relationship between the levels of systemic risk and consumption growth (Figure 2.1).

[Insert Figure 2.4 here]

In addition, we are able to examine the effect of transaction costs (τ) imposed on the international transaction, and might be affected by financial market (institution)

[5] Figure 2.4 and 2.6 shows the positive regime of covariance to demonstrate the effects of systemic risk which means the positive relationship between the risky returns. However, the pattern is the same in the negative regime of covariance.

perfection, search and information cost, and the degree of international capital mobility. According to our numerical example (Table 2.1), we evaluate the effect of transaction cost on shares in risky investments (x_D^* and x_W^*) and expected consumption growth (g^*) in Figure 2.5. The proportion on domestic investments (x_D^*) has small change when transaction costs increases from 0 to 50% (slightly drops from 61% to 56%). However, the proportion on foreign investments (x_W^*) decreases dramatically from 61% to 7% when transaction cost increases. The expected consumption growth (g^*) also decreases due to the decreases of the shares in both domestic and foreign risky investments which have higher returns. This finding indicates the benefit from lower transaction cost. However, lower cost on international transactions implies more open financial markets. But this might also elevate the systemic risk (higher correlation between domestic and foreign returns), which might affect the economy adversely. To investigate the role of transaction cost (τ) in the context of the relationship between systemic risk an economic growth, we consider the effects of covariance on expected consumption growth under different level of transaction cost. In Figure 2.6, we can observe that higher covariance is associated with lower growth ($\partial g^*/\partial Cov$ are negative), and the marginal effect of covariance decreases with higher levels covariance. More importantly, Figure 2.6 shows that higher transaction cost (τ) is associated with a less negative effect of covariance on growth ($\partial g^*/\partial Cov$). In other words, the country with larger transaction cost (less open to international financial markets) would have smaller drawback from the increase of systemic risk.

In sum, we have two observations about the effect of transaction cost: (a) lower transaction cost implies more open financial markets, and benefits the economic growth; (b) higher transaction cost could mitigate the drawback from increasing systemic risk. Since we have two opposite directions from the effects of transaction cost on growth, for the further research, it will be interesting to revisit the theoretical model by considering the central planner, and find the “optimal” value of transaction cost.

[Insert Figure 2.5 here]

[Insert Figure 2.6 here]

One step further, to examine the effectiveness of our model, we compute the expected consumption growth from the model, and see if the theoretical results could capture the variation of the actual data. In order to illustrate dynamic patterns in theoretical results, we use 10 years as a window period, and calculate the rolling average returns, variances and covariance from Taiwan stock exchange index and NASDAQ stock market index (sample period shrinks to 1994-2012). Note that the rolling average returns, variances and covariance represent the expectation for the next period. For instance, the average return calculated in the end of 2000 (the window period is from 1991 to 2000) represents the expected return in 2001. Figure 2.7 shows the trends of expected consumption growth (theoretical value) and the growths of consumption per capita and GDP per capita (GDPPC) from 1994 to 2012. Since the growths of consumption per capita and GDP per capita are the actual statistical data from DGBAS (The Directorate General of Budget, Accounting and Statistics) in Taiwan, the similarity of patterns between theoretical and actual values indicates the effectiveness of our model which is useful to capture the variation of actual values[6]. Note that, to focus on the variation of data, we neglect the influence of starting value, and apply the values of expected consumption growth, consumption per capita growth and of GDP per capita growth are transformed into indices which set the value in 1994 as 100.

[Insert Figure 2.7 here]

2.5 Concluding Remarks

Financial integration is supposed to stabilize the financial market, and creates the opportunity for risk diversification, and the channel of risk-sharing is considered to benefit the economic. However, in an opposite direction, the contagion effect of the financial crises in the recent decades draws the attention to the “cost” of financial integration. Financial integration is not only creates valuable opportunities for portfolio diversification, risk sharing, and intertemporal trade, but also create the potential for systemic risk.

This paper focuses on the issue of risk, and constructs a stochastic dynamic model to demonstrate the effects of risk on growth. The main feature of the model is that each individual can invest in three projects, risk-free investment, domestic risky investment and foreign risky investment, and determine the share for each project. The model shows how the growth of expected consumptions affected volatilities of both risky returns, and the covariance between two risky returns. Incorporating the risk-adjusted non-arbitrage

[6] Before 2001, the theoretical value follows the actual values of growth with one year lag. However, after 2001, the correlation coefficient between the theoretical value (expected consumption growth) and the actual growth of consumption per capita is 75.98%, and the correlation coefficient between the theoretical value and the actual growth of GDP per capita is 78.62%!

condition, higher volatility of domestic (foreign) risky returns lowers the investment share on domestic (foreign) risky asset, but raises the investment share on foreign (domestic) risky assets. Also, higher volatilities on both domestic and foreign returns lower the growth of expected consumption. We address the systemic effect to the extent of correlation of risk between domestic and foreign investment (Stiglitz, 2010). We are able to show that higher correlation between domestic and foreign risky returns lowers the share of investment in both risky assets, and growth. In other words, the potential cost from the systemic risk could lower the benefit from risk diversification in an integrated financial market.

The stochastic dynamic model provides a theoretical framework to illustrate the effect of volatilities and systemic risk on growth. It is also feasible to apply the theoretical results into practice. We use the stock market data from Taiwan and US. The numerical example shows the consistent results with our model. Moreover, the model is able to capture the variation of actual data, and has the potential for the prediction of economic growth. In addition, we evaluate the impact of transaction cost, and find the benefit from lower transaction cost. However, there is a tradeoff in reducing transaction costs. While lower transaction costs (associated with more open financial markets) enhance economic growth, they also exacerbate the drawback from the increasing systemic risk which would have adverse economic growth.. Searching for an optimal value of transaction cost would be a critical topic for the further research, and it is also worth to investigate as an important policy issue.

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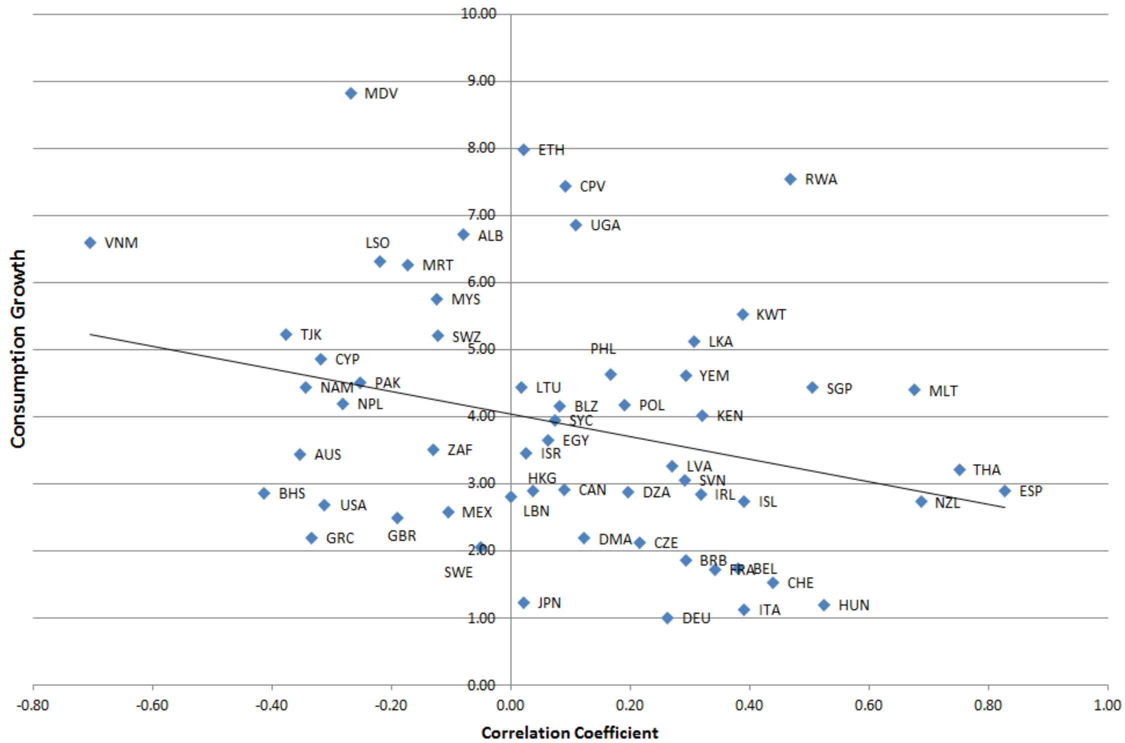
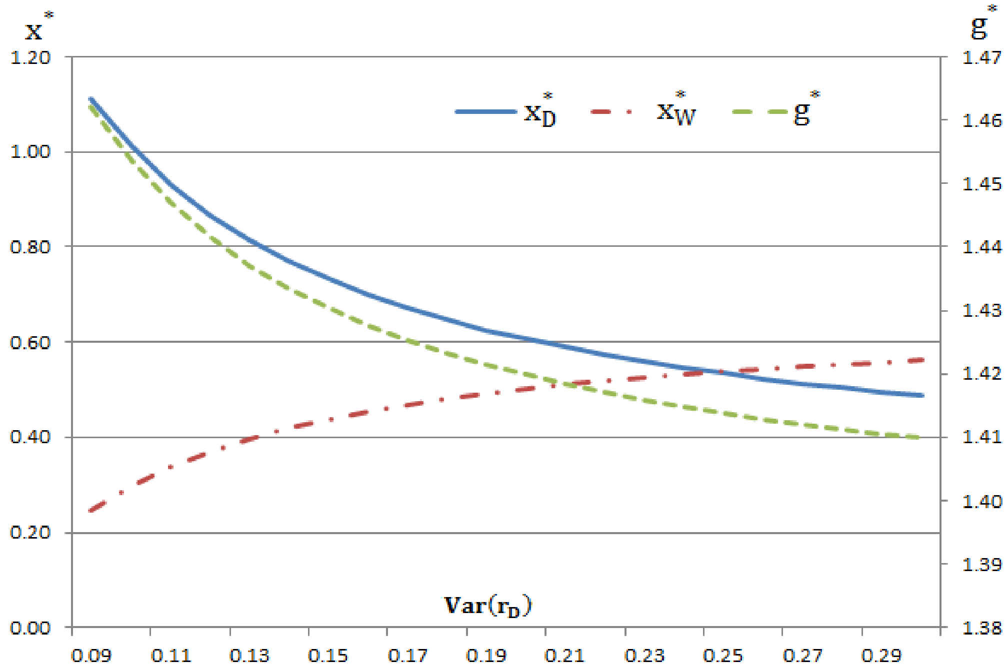
Figures and Table



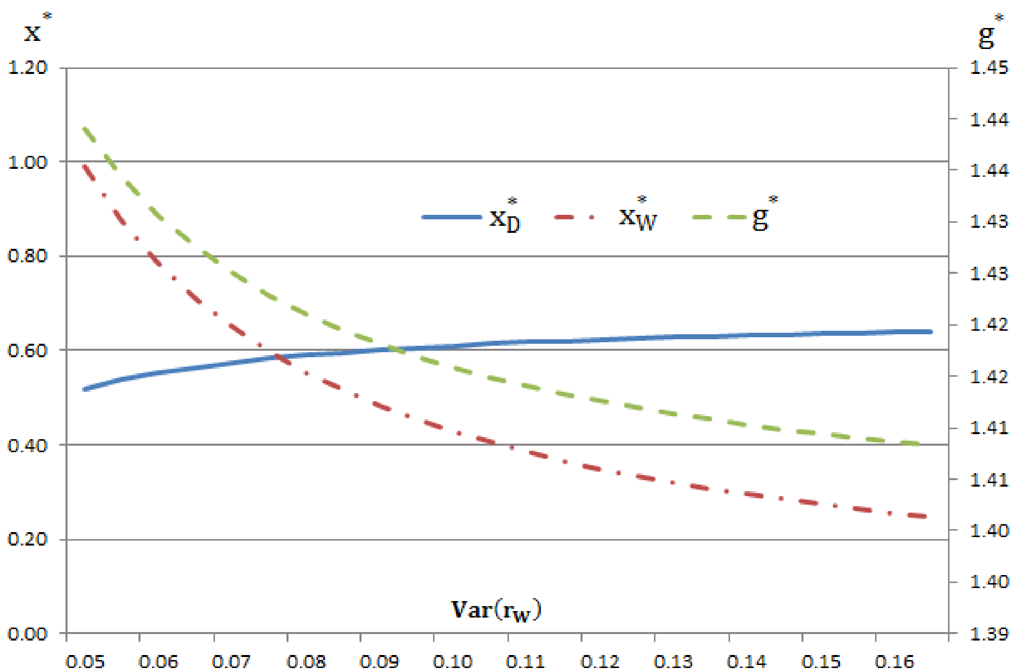
Note: The correlation coefficients are computed by the risk premium (lending rate minus treasury bill rate) for each country against the world average. The solid line is estimated by the linear regression.

Figure 2.1 Relationship Between Correlation Coefficient and Consumption Growth



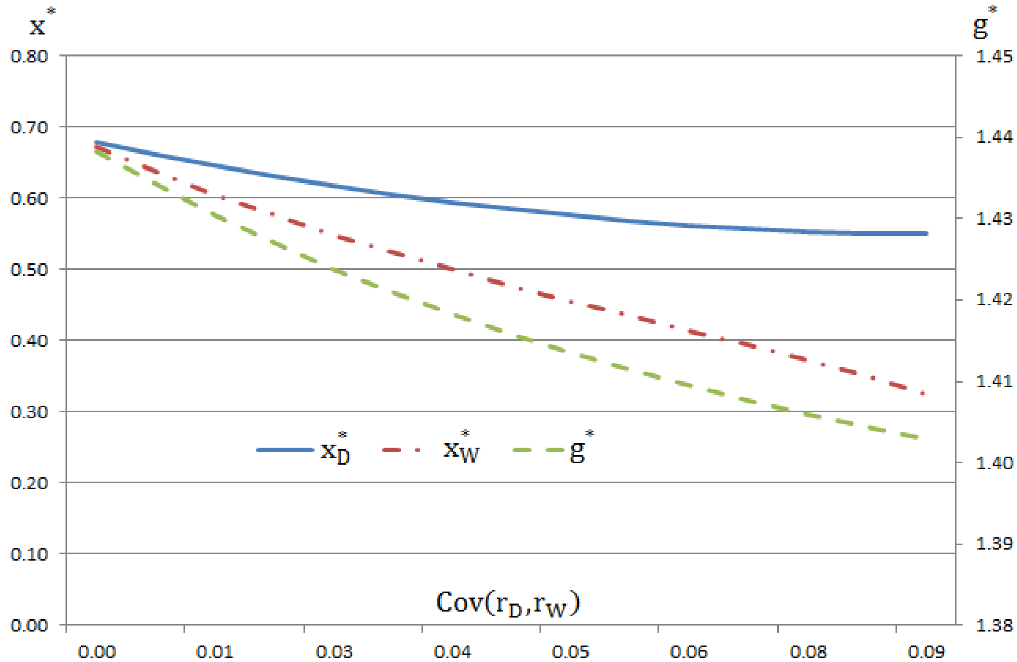
Note: The left axis indicates the share of risky investment investments (x_D^* and x_W^*).The right axis indicates the expected consumption growth (g^*).

Figure 2.2 The Effects of $\mathrm{Var}(r_D)$ on Portfolio and Growth



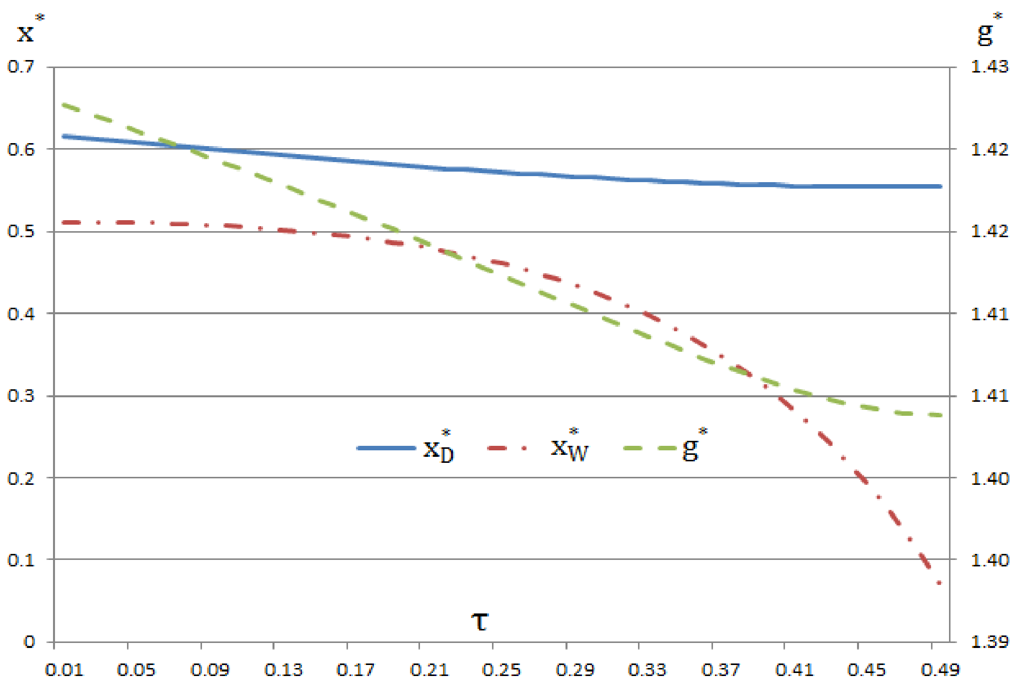
Note: The left axis indicates the share of risky investment investments (x_D^* and x_W^*).The right axis indicates the expected consumption growth (g^*).

Figure 2.3 The Effects of $\mathrm{Var}(r_W)$ on Portfolio and Growth



Note: The left axis indicates the share of risky investment investments (x_D^* and x_W^*).The right axis indicates the expected consumption growth (g^*).

Figure 2.4 The Effects of the Covariance on Portfolio and Growth



Note: The left axis indicates the share of risky investment investments (x_D^* and x_W^*).The right axis indicates the expected consumption growth (g^*).

Figure 2.5 The Effects of Transaction Cost (τ) on Portfolio and Growth

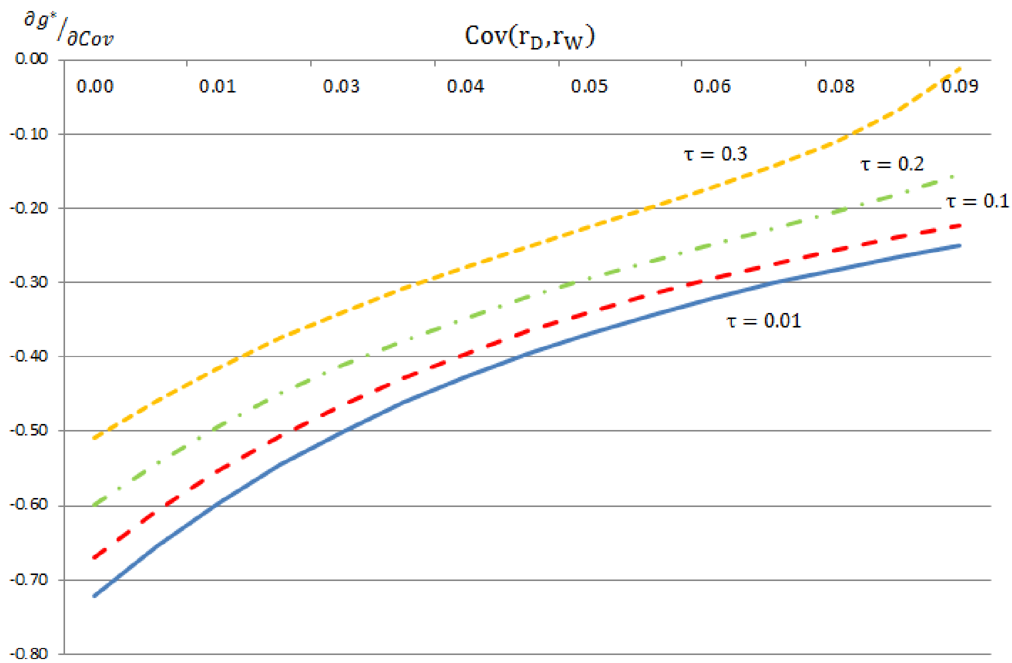
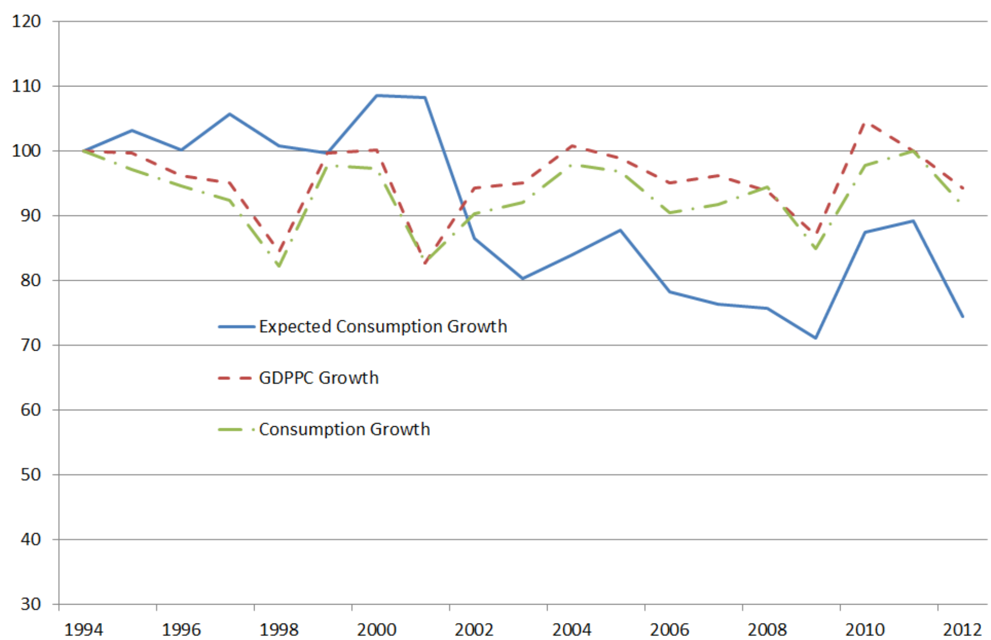


Figure 2.6 The Effects of Transaction Cost (τ) on Growth Effect by Covariance



Note: The values of expected consumption growth, consumption per capita growth and of GDP per capita growth are transformed into indices which set the value in 1994 as 100.

Figure 2.7 Theoretical and Actual Value of Growth

Table 2.1 Stock Market Returns and Equilibrium Results

	Expected return (%)	Variance (%)	Correlation coefficient (%)	Shares in risky investments	Expected consumption growth
Taiwan	16.36	20.50	28.61	0.5977	1.42
United States	12.22	8.15		0.5065	

Note: The result is based on the assumptions that $r = 0.05, \tau = 0.1, m = 0.3, \beta = 1$.

Appendix A

We begin by defining a function $f\left(\frac{C_{t+1}}{C_t}, r_{D,t+1}\right)$ for eventual use in a Taylor expansion, such that,

$$f\left(\frac{C_{t+1}}{C_t}, r_{D,t+1}\right) \equiv \beta\left(\frac{C_{t+1}}{C_t}\right)^{-1}\left[r_{D,t+1} - E_t\left(r_{D,t+1}\right)\right] \qquad (1\text{-A})$$

The conditional expectation of $f\left(\frac{C_{t+1}}{C_t}, r_{D,t+1}\right)$ will be,

$$\Rightarrow E_t\left[f\left(\frac{C_{t+1}}{C_t}, r_{D,t+1}\right)\right] = \beta Cov_t\left\{\left(\frac{C_{t+1}}{C_t}\right)^{-1}, r_{D,t+1}\right\}$$

$$= \beta Cov_t\left\{\left(\frac{C_{t+1}}{C_t}\right)^{-1}, \left[r_{D,t+1} - r\right]\right\} \qquad (2\text{-A})$$

From equation (1-A), we can apply the Taylor approximation around $\frac{C_{t+1}}{C_t} = 1$ and $r_{D,t+1} = E_t\left(r_{D,t+1}\right)$, then

$$f\left(\frac{C_{t+1}}{C_t}, r_{D,t+1}\right) \approx \beta\left[r_{D,t+1} - E_t\left(r_{D,t+1}\right)\right] - \beta\left(\frac{C_{t+1}}{C_t} - 1\right)\left[r_{D,t+1} - E_t\left(r_{D,t+1}\right)\right] \qquad (3\text{-A})$$

Taking conditional expectations on both sides of equation (3-A),

$$\Rightarrow E_t\left[f\left(\frac{C_{t+1}}{C_t}, r_{D,t+1}\right)\right] \approx -\beta Cov_t\left\{\left(\frac{C_{t+1}}{C_t} - 1\right), r_{D,t+1}\right\}$$

$$= -\beta Cov_t\left\{\left(\frac{C_{t+1}}{C_t} - 1\right), \left[r_{D,t+1} - r\right]\right\} \qquad (4\text{-A})$$

Combining (2-A) and (4-A), we have,

$$\beta Cov_t\left\{\left(\frac{C_{t+1}}{C_t}\right)^{-1}, \left[r_{D,t+1} - r\right]\right\} \approx -\beta Cov_t\left\{\left(\frac{C_{t+1}}{C_t} - 1\right), \left[r_{D,t+1} - r\right]\right\} \qquad (5\text{-A})$$

Appendix B

To identify the directions of how the changes of volatilities and covariance affect the share of domestic and foreign risky investment (x_D^* and x_W^*) and expected consumption growth (g^*), we need to incorporate the risk-adjusted non-arbitrage condition (the risk-adjusted excess returns of domestic and foreign risky assets, ($[E_t(r_{D,t+1}) - r]/\sigma_D$) and ($[E_t(r_{W,t+1}) - r]/\sigma_W$), are equal, where σ_D and σ_W are the standard error of $r_{D,t+1}$ and $r_{W,t+1}$ respectively). For instance, to determine the sign of ($\partial x_D^*/\partial V_D$), we have the following conditions,

$$\begin{cases} \frac{\partial x_D^*}{\partial V_D} > 0 \;\; if \; AV_W < BCov \\ \frac{\partial x_D^*}{\partial V_D} < 0 \;\; if \; AV_W > BCov \end{cases}$$

Dividing both side by (AV_W) and applying the risk-adjusted non-arbitrage condition, we have

$$\begin{cases} \frac{\partial x_D^*}{\partial V_D} > 0 \;\; if \; \rho_{D,W} > 1 \qquad\qquad (1-B) \\ \frac{\partial x_D^*}{\partial V_D} < 0 \;\; if \; \rho_{D,W} < 1 \qquad\qquad (2-B) \end{cases}$$

where $\rho_{D,W} = \frac{Cov}{\sigma_D \sigma_W}$, $V_D = \sigma_D^2$ and $V_W = \sigma_W^2$

Since $0 < \rho_{D,W} < 1$, condition (1-B) is ruled out, QED.

Considering the effects of covariance on the shares of risky investments, we take ($\partial x_D^*/\partial Cov$) as example.

$$\begin{cases} \frac{\partial x_D^*}{\partial Cov} > 0 \;\; if \;\; 2AV_W Cov > B(V_D V_W + Cov^2) \\ \frac{\partial x_D^*}{\partial Cov} < 0 \;\; if \;\; 2AV_W Cov < B(V_D V_W + Cov^2) \end{cases}$$

Applying the risk-adjusted non-arbitrage condition and solve for $\rho_{D,W}$, we have,

$$\begin{cases} \frac{\partial x_D^*}{\partial Cov} > 0 \quad if \ (\rho_{D,W} - 1)^2 < 0 & (3-B) \\ \frac{\partial x_D^*}{\partial Cov} < 0 \quad if \ (\rho_{D,W} - 1)^2 > 0 & (4-B) \end{cases}$$

Condition (3-B) is impossible and ruled out, QED. Similar analysis can be carried for x_W^* and g^*.

Appendix C

According to the constrain of the stochastic intertemporal maximization (equation 2-2) problem and the optimal level of the share of domestic and foreign risky investments (x_D^* and x_W^*) (equation 2-18 and 2-19), we can obtain the share of risk-free investment (x_F^*) as follow,

$$x_F^* = 1 + m - x_D^* - x_W^*$$

$$\Rightarrow x_F^* = 1 + m - \frac{AV_W - BCov}{\beta C[V_D V_W - Cov^2]} - m(1-\tau) - \frac{BV_D - ACov}{\beta C(1-\tau)[V_D V_W - Cov^2]} \qquad (1-C)$$

By differentiating equation (1-C) in V_D, we have,

$$\frac{\partial x_F^*}{\partial V_D} = \frac{AV_W{}^2 - BV_W Cov}{\beta C(V_D V_W - Cov^2)^2} + \frac{BCov^2 - AV_W Cov}{\beta(1-\tau)C(V_D V_W - Cov^2)^2} \qquad (2-C)$$

Since $0 < m < 1$, $0 < \tau < 1$ and $r > 0$, the denominator is positive. Considering the risk-adjusted non-arbitrage condition, equation (2-C) can be simplified as,

$$\frac{\partial x_F^*}{\partial V_D} = \frac{B\sigma_D \sigma_W (1-\rho_{D,W})[(1-\tau)V_W - Cov]}{\beta(1-\tau)C(V_D V_W - Cov^2)^2} \qquad (3-C)$$

The sign of equation (3-C) is determined by V_W and Cov, where

$$\begin{cases} \frac{\partial x_F^*}{\partial V_D} > 0 \quad if \ V_W > \frac{Cov}{1-\tau} & (4-C) \\ \frac{\partial x_F^*}{\partial V_D} < 0 \quad if \ V_W < \frac{Cov}{1-\tau} & (5-C) \end{cases}$$

From proposition 1, we know that an increase in domestic volatility leads to a decline in the share of domestic assets (x_D^*) and a rise in the share of foreign assets (x_W^*). However, it is not necessary a perfect substitution from one risky asset to another (except $V_W = Cov/(1-\tau)$). From equation (4-C) and (5-C), if the foreign risky investment is high enough, the individual will increase the investment in risk-free assets when domestic volatility rises.

Similarly, by differentiating equation (1-C) in V_W, we have,

$$\frac{\partial x_F^*}{\partial V_W} = \frac{ACov^2 - BV_D Cov}{\beta C(V_D V_W - Cov^2)^2} + \frac{BV_D{}^2 - AV_D Cov}{\beta(1-\tau)C(V_D V_W - Cov^2)^2} \qquad (6-C)$$

Since $0 < m < 1$, $0 < \tau < 1$ and $r > 0$, the denominator is positive. Considering the risk-adjusted non-arbitrage condition, equation (6-C) can be simplified as,

$$\frac{\partial x_F^*}{\partial V_W} = \frac{A\sigma_D \sigma_W (1-\rho_{D,W})[V_D - (1-\tau)Cov]}{\beta(1-\tau)C(V_D V_W - Cov^2)^2} \qquad (7-C)$$

The sign of equation (7-C) is determined by V_D and Cov, where

$$\begin{cases} \frac{\partial x_F^*}{\partial V_W} > 0 \quad if \;\; V_D > (1-\tau)Cov & (8-C) \\ \frac{\partial x_F^*}{\partial V_W} < 0 \quad if \;\; V_D < (1-\tau)Cov & (9-C) \end{cases}$$

Again, it is not necessary a perfect substitution from domestic assets to foreign assets when foreign volatility is higher (except $V_D = (1-\tau)Cov$). If the domestic risky investment is high enough, the individual will increase the investment in risk-free assets when foreign volatility rises.

Finally, the effect of $Cov(r_D, r_W)$ on x_F^* is obvious. From proposition 3, we know an increase in the covariance of domestic and foreign risky returns leads to a decline in the share of risky assets. In other words, the share of risk-free assets (x_F^*) will rise.

Chapter 3
Financial Integration and Economic Volatility

3.1 Introduction

Since the mid-1980s, the level of international capital mobility has increased significantly, and a large literature has concentrated on investigating the economic consequences of financial integration. However, the main stream of the literature focuses on the impact of financial integration on economic growth, and the studies of economic volatility are relatively few.

Considering the relationship between international financial integration and economic volatility, one of the key channels is risk diversification (Prasad et. al., 2003). Intuitively, more financially integrated economies should experience less macroeconomic volatility because of the lower overall risk that arises from risk diversification. However, from the existing literatures, it is difficult to reaching any definitive conclusion on an inverse relationship between financial integration and macroeconomic volatility.

Razin and Rose (1994) use cross-sectional analysis to examine the effect of current and capital account openness on the volatility of output, consumption, and investment for a sample of 138 countries over 1950-1988. They conclude that there is no significant correlation between openness and volatility. Buch, Dopke and Pierdzioch (2002) discuss the impact of international financial integration on business cycle volatility by using 25 OECD countries over the period 1969-1999. Based on the panel analysis, they find no consistent link between openness and output volatility for the sample period.

On the other hand, several other studies show that higher degree of openness is associated with higher degree of volatility. Easterly, Islam and Stiglitz (2001) study the determinants of growth volatility based on 74 countries over 1960-1997. They find the countries with well-developed domestic financial sector are associated with lower volatility, and also that openness exposes a country to greater volatility of growth. Gavin and Hausmann (1996) study the sources of macroeconomic volatility in developing countries, and find a significant positive association between the volatility of capital flows and output volatility. O'Donnell (2001) examines the effect of financial integration on the volatility of output growth using data for 93 countries over 1971-1994, finding that higher financial integration is associated with higher output volatility in non-OECD countries[1]. Kose, Prasad and Terrones (2003) study the linkage between openness and volatility based on 76 countries over the period 1960-1999. They find that financial openness is associated with higher volatilities of consumption and income. They also find that this relationship is nonlinear. Once the level of financial openness crosses a particular threshold, openness leads to lower volatility.

Several researches indicate that greater financial openness is associated to lower volatility of either output or consumption. Bekaert, Harvey and Lundblad (2006) examine the impacts of equity market liberalization and capital account openness on the volatility of consumption growth for 95 countries during 1980-2000. They find that financial liberalization is mostly associated with lower consumption growth volatility. Prasad et. al. (2007) investigates the impact of financial integration on growth volatility for 76

[1] O'Donnell (2001) examines 93 countries from 1971 to 1994 and finds that a higher degree of financial integration is associated to lower (higher) output volatility in OECD (non-OECD) countries.

developing countries. They find that developing countries can rely on financial integration to stabilize fluctuation of consumption growth. However, the critical part of the benefit from financial integration is determined by the development of financial institution and the quality of governance. IMF (2002) provides evidence to indicate financial integration to be associated with lower output volatility in the developing countries.

Given this mixed evidence the effect of international financial integration on economic volatility remains unclear and may well be influenced by the economic environment (economic development, financial institution and governance)[2]. One study by Kose, Prasad and Terrones (2009), investigates the possibility that directions of capital flows (capital flows in assets or liabilities) and different types of capital flows (i.e., equity versus debt) may be conductive to *risk sharing*. Measuring risk sharing as the gap between domestic and world economic growth, and studying the effect of capital flows on risk sharing, they find only a modest degree of capital flows on international risk sharing. In this paper we utilize a similar breakdown of capital flows into different directions and different types, to ask a different question; namely the effect of capital flows on *economic volatility*. This question has not been previously asked in the literature. Yet its importance can be surmised by the raging debate on the role of international finance on propagation of systemic risk.

We focus on the channels by which financial integration impacts economic volatility, in terms of both the *directions* and the *types* of capital flows. To elaborate we argue that

[2] See also Wang and Wen (2013). Based on data from 106 countries (1986-2006), they find a negative relationship between financial development and aggregate volatility.

the risk-sharing benefit from financial integration is more likely associated with capital outflow than inflow. Capital outflows are driven by domestic capital holders who invest in foreign assets, and diversify the idiosyncratic risk from their home country. In other words, capital outflow (accumulation of external assets) might be associated with lower economic volatility. By contrast, capital inflow (accumulation of external liabilities) would be expected to affect economic volatility differently. The recipient (home) country experiencing capital inflow *augments* its own specific risk (idiosyncratic risk), with the added exposure the risk from host countries who are holders (owners) of home country's assets. If so, then capital inflow is likely to be associated with higher economic volatility. In this paper we examine this (dual) hypothesis.

In previous studies, the quantitative measure of international financial integration is based on *combining* capital outflow and inflow (either by summation or net value). This approach is unable to explain the potential distinct impact on economic volatility, coming from *different* directions of capital flows. In this paper, we address this shortcoming. We re-examine the effect of financial integration on economic volatility based on 116 countries over the period 1975-2010, and break down the de facto indicator of financial integration into capital outflow and inflow to explore the notion that different directions of capital flow have potentially different effects on volatility. We also examine the effects of different types of capital flows (equity and debt) on economic volatility. Results from the analysis of panel data suggest that external assets (capital outflow) have significantly negative effect on consumption growth volatility, while external liabilities (capital inflow) have significantly positive effect. However, these effects are insignificant for the output growth volatility. A closer look of different types of capital flows reveals that the effects arise mainly from the external *debt* assets and liabilities, rather than equity assets and liabilities. Furthermore, considering the different *levels* of economic and financial development (Easterly, Islam and Stiglitz, 2001; O'Donnell, 2001; Kose, Prasad and Terrones, 2003; Bekaert, Harvey and Lundblad, 2006; Prasad et. al., 2007; Wang and Wen, 2013), we separate the sample into OECD and Non-OECD countries, and find the effects of external assets and liabilities are insignificant for OECD countries, and significant for non-OECD countries.

In this paper, we answer the linkage between financial integration and economic volatility, and provide a potential interpretation for the differed conclusions from previous studies. Moreover, instead of investigating the story of financial integration as a whole, the study of the impacts from the directions of capital flow on economic volatility offers insights and contains important implications for policy.

Section 3.2 describes the empirical model and data. Section 3.3 shows the results of the panel data analysis. Section 3.4 provides concluding remarks.

3.2 Empirical Model

Following the empirical model by Kose, Prasad and Terrones (2003) on the relationship between international financial integration and economic volatility, we consider the fixed effect panel regression model for 116 countries from 1975 to 2010.

$$y_{it} = \alpha + \beta FI_{it} + \gamma Z_{it} + u_i + \nu_t + \varepsilon_{it} \qquad (3\text{-}1)$$

$$\forall\ i = 1 \dots 116;\ t = 1975, 1980, 1985, \dots, 2010$$

where i and t identify the country and time period respectively, u_i denotes the unobserved country effect, and ν_t denotes the time effect.

The model contains three different sets of variables: (1) the set of dependent variables (y_{it}); (2) the set of financial integration variables (FI_{it}); (3) the set of control variables (Z_{it})[3]. The dependent variables (y_{it}) are the 5-year standard deviation of real GDP per capita growth (σ_{GDPG}), and 5-year standard deviation real consumption per capita growth (σ_{CONG})[4]. The empirical regressions are estimated separately based on different dependent variables. The dependent variables are measured by 5-year windows for each country. For instance, the standard deviation of real GDP per capita growth in 2000 is calculated by the standard deviation of real GDP per capita growth from 1996 to 2000. The 5-year window is used to filter out year-to-year cyclical fluctuations. In our case, the sample periods are counted as every 5 years from 1975 to 2010, and each country has 8 periods.

FI_{it}'s are the dependent variables associated with financial integration. Here, we considered both de jure and de facto indices. For the de jure index, we incorporate the KAOPEN index constructed by Chinn and Ito (2008). KAOPEN is based on variables that codify the tabulation of restrictions on cross-border financial transactions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). The index is the first standardized principal component of four categories of restrictions on external accounts.

For de facto indices, we introduce two measures of international financial integration, originally constructed by Lane and Milesi-Ferretti (2007). These measures estimate the

[3] The data source is listed in appendix.

[4] To deal with the outlier issue in economic volatility, we eliminate the observations which are larger than the twice of standard deviation.

stock of external assets and liabilities of countries derived from the flow data on external assets and liabilities (also known as international investment Position, IIP) that are computed by the International Monetary Fund (IMF). Lane and Milesi-Ferretti (2007) construct two measures of financial integration, IFIGDP and GEQY. The IFIGDP measure includes all five categories available in the IMF's IIP: portfolio investments, foreign direct investments (FDI), other investments, financial derivatives and reserve assets, all as a share of GDP; GEQY contains only the equity components of IIP, the portfolio investment in equity, and FDI. Moreover, as we discussed in the introduction, to examine the different impacts on economic volatility from capital inflow and outflow, we break down the IIP into two sectors, total external assets and total external liabilities. These variables are addressed as shares of GDP (TA/GDP and TL/GDP). For different types of capital flows, we consider the capital flows in equity (the portfolio investment in equity and FDI) and debt. External assets in equity (TEqA) indicate the accumulation of capital outflow into foreign equity, and external liabilities in equity (TEqL) are the accumulation of capital inflow to domestic equity. These variables are also addressed as shares of GDP (TEqA/GDP and TEqL/GDP). External assets in debt (TDeA) are the accumulation of capital outflow into foreign debt, and external liabilities in debt (TDeL) are the accumulation of capital inflow to domestic debt. These variables are also addressed as shares of GDP (TDeA/GDP and TDeL/GDP). For each 5-year window, both de jure and de facto indices are computed in average. For instance, the IFIGDP in 2000 is calculated as the average IFIGDP from 1996 to 2000.

Z_{it}'s are the control variables which include years of schooling (YoS, a proxy for human capital), natural log of population (lnPOP) and real GDP per capita (lnRGDP), trade openness (sum of exports and imports divided by GDP), and terms of trade (ToT, price of exportable goods divided by price of importable goods). All these control variables are computed in 5-year average, and match the variables of financial integration (FI_{it}).

Considering the dynamic property of economic volatility, we also examine the dynamic panel regression.

$$y_{it} = \alpha + \rho y_{it-1} + \beta FI_{it} + \gamma Z_{it} + u_i + \nu_t + \varepsilon_{it} \qquad (3\text{-}2)$$

There are two potential endogeneity issues in this model. First, the lagged dependent variable (y_{it-1}) as a control variable is correlated with the unobserved country fixed effect (u_i). To deal with this problem, we use the GMM estimation proposed by Arellano and Bond (1991). Second, other independent variables (FI_{it}, Z_{it}) may be correlated with the error term (ε_{it}). We use sequences of lagged values of y_{it-1}, FI_{it} and Z_{it} as instruments in our estimations.

3.3. Empirical Results

3.3.1 Baseline Estimations

The fixed effect model results show in Table 3.1. We regress the standard deviations real GDP growth (Model I, II, III and IV), and consumption growth (Model V, VI, VII and VIII) on the measures of financial integration and control variables described in the previous section. Generally, most of the control variables are insignificant in their effect on standard deviations of real GDP and consumption growth (σ_{GDPG} and σ_{CONG}). Two exceptions that are the natural log of population (lnPOP) and the term of trade (ToT). Natural log of population has negative effect on the volatilities of both GDP and consumption growth. The terms of trade (ToT) which indicates the amount of import goods that can be purchased by a given level of export goods is considered as a benefit to a country. In our fixed effect estimations, terms of trade has significantly negative effect on the volatility of consumption growth[5].

Considering the impact of financial integration, we first observe that the effect of de jure measure of integration (KAOPEN) is insignificantly negative for the standard deviations of GDP growth (σ_{GDP}) and consumption growth (σ_{CONG}). This result implies that relaxing the restrictions of financial integration barriers has no effect on stabilizing the economy.

Before we turn into decomposition of capital flows into inflow and outflows, let us first examine the overall effect. For the effects of de facto measures of financial integration (IFIGDP and GEQY), we find that IFIGDP have insignificant effects on the volatility of GDP and consumption growth which is consistent with the previous studies by Razin and Rose (1994) and Buch, Dopke, and Pierdzioch (2002). Considering the capital flow in equity (GEQY), we find that higher degree of financial integration in equity brings higher volatility in output growth. This finding is consistent with the studies of Easterly, Islam, and Stiglitz (2001), Gavin and Hausmann (1996) and Kose, Prasad, and Terrones (2003), and implies that capital flow in equity investment (portfolio investments and FDI) is crucial to the volatility in output. However, the capital flows in equity have no effect on consumption growth volatility.

[5] The significance disappears in our dynamic panel estimations in Table 3.2.

By decomposing the de facto measure of financial integration, we separate the international investment position into external assets and external liabilities as shares of GDP. The GDP share of external assets indicates the stock value of capital outflow (TA/GDP). The GDP share of external liabilities indicates the stock value of capital inflow (TL/GDP). From Table 3.1, we find that higher external assets is associated with significantly lower consumption growth volatility (lower σ_{CONG}), and the higher external liabilities is significantly associated with higher consumption growth volatility. The empirical results are consistent with our intuition described in section 3.1. The finding implies the risk-diversification which is one of the key benefits from international financial integration is determined by the external assets (capital outflow). *Higher level of external assets leads to lower consumption growth volatility*. However, this effect is insignificant for the output growth volatility. One explanation may be the *wealth effect*. Since the consumption is related to consumer wealth, consumer with more wealth the fluctuation of consumption may be more stable. As a result, the volatility of consumption would be lower for the countries which hold more external assets. In contrast, the level of external liabilities (capital inflow) has opposite effect on consumption growth volatility. Due to the country with more external liabilities exposes to the risk from the other countries, *higher level of external liabilities leads to higher economic volatility*. However, the significances disappear in terms of output growth volatility. This result can be explained that the benefit of risk-diversification and the drawback of exposing to the risk from abroad are more associated with wealth instead of output level.

Considering different types of capital flows, generally, external assets and liabilities of equity have no effect on economic volatility. One exception is the effect of external assets of equity (TEqA/GDP) which has positive effect on GDP growth volatility[6]. For effects of external assets and liabilities of debt (TDeA/GDP and TDeL/GDP), we find the same directions TA/GDP and TL/GDP. Clearly, the major effects on economic volatility are from the capital flows in debts. The country that holds more external debts from other countries is associated with lower economic volatility. The country that has more external debts (the debt is owed to creditors outside the country) is associated with higher economic volatility.

[Insert Table 3.1 here]

To incorporate the dynamic property of economic volatility, we apply the dynamic panel analysis, and re-estimate the models. Results, presented in Table 3.2 are similar to those in Table 3.1 with the exception that the terms of trade (ToT) term becomes insignificant. The effect of KAOPEN is still insignificant. Higher IFIGDP and GEQY bring higher volatility in growth. Of course, the main interest of this paper is the study of external assets (capital outflow) and external liabilities (capital inflow). Our results are consistent with those from the fixed effects approach discussed previously. The benefit of risk-diversification as manifested by the external assets (capital outflow), are associated with less economic volatility. On the other hand, higher levels of external liabilities (capital inflow) imply that the country is exposed to the additional risk from countries that are the holders (owners) of home country's assets, and raises economic volatility. Similarly, these effects are more significant in consumption growth volatility.

[Insert Table 3.2 here]

[6] However, the effect of external assets in equity (TEqA/GDP) becomes insignificant in dynamic panel estimations (Table 3.2).

3.3.2 OECD vs. Non-OECD Estimations

From the previous studies, the effect of international financial integration on economic volatility is influenced by the economic environment (Easterly, Islam and Stiglitz, 2001; O'Donnell, 2001; Kose, Prasad and Terrones, 2003; Bekaert, Harvey and Lundblad, 2006; Prasad et. al., 2007; Wang and Wen, 2013). In this paper, we separate the whole sample countries into two groups, OECD and Non-OECD countries, and see if the international financial integration brings different effects.

Table 3.3a and 3.3b shows the result based on fixed effect model. Most of the control variables are insignificant except the natural log of population (lnPOP) and the trems of trade (ToT) in Non-OECD countries for consumption growth volatility (σ_{CONG}). Especially for the terms of trade, the finding indicates that the benefit of ToT is crucial for the Non-OECD countries for stabilizing the consumption growth volatility.

The de jure measure of financial integration, KAOPEN, is significantly negative in both output and consumption growth volatility for OECD countries, but is insignificant for Non-OECD countries. This result is consistent with the studies by O'Donnell, (2001). International financial market deregulation is associated with lower economic volatility in the OECD countries, but does not affect the volatility in Non-OECD countries. However, considering the de facto measure of financial integration, the coefficients of IFIGDP and GEQY are positive and significant for OECD countries indicating the financial integration raises the economic volatility.

The main interest of this paper is to examine the distinct effects of external assets (capital outflow) and liabilities (capital inflow) on volatility. Once we separate the sample into OECD and Non-OECD groups, we find the coefficients of TA/GDP (external assets divided by GDP) and TL/GDP (external liabilities divided by GDP) are insignificant for both OECD and Non-OECD countries in terms of GDP growth volatility, but significant in both OECD and Non-OECD countries in terms of consumption growth volatility with signs consistent with our expectation. This result is consistent with the outcomes in Table 3.1, and indicates that the benefit of risk-diversification from financial integration is significant for consumption growth volatility.

Considering different types of capital flows, Table 3.3a Model IV shows that the external equity assets and liabilities (TEqA/GDP and TEqL/GDP) yield results that are contrary to our expectation. Higher accumulation of capital outflow to foreign equity is associated with higher output volatility, and higher accumulation of capital inflow to domestic equity is associated with lower output volatility. This result implies that as far as *equity* capital is concerned, the benefits of risk-diversification for OECD countries may not carry through its outflow, nor do the drawbacks (from the added exposure to risk) carry through its inflow[7]. Considering the effects on consumption volatility in Model VIII, External equity assets and liabilities have no effects on consumption volatility, and external debt liabilities (TDeL/GDP) are significantly positive to consumption volatility. In other words, for OECD countries, holding more external assets in both equity and debt may not be able to lower the economic volatility, and borrowing capital from abroad by issuing debt (external debt liabilities) will raise the volatility of consumption growth. For Non-OECD countries, the effects of KAOPEN, IFIGDP and GEQY are insignificant. However, the directions of capital flows have significant effects on consumption

[7] This result contrary to our expectation is insignificant in the dynamic panel estimations in Table 3.4a.

volatility, confirming our expectation: higher TA/GDP is related to lower volatility; higher TL/GDP is related to higher volatility. This result indicates the effects of capital flows are crucial to consumption growth instead of output growth for Non-OECD countries. Checking the different types of capital flows, we find the source of the effects of capital flows is mainly from the external debt. Moreover, higher external debt asset (TDeA/GDP) is related to lower volatility in both output and consumption growth, higher external debt liabilities (TDeL/GDP) is related to higher volatility. This result indicates that holding more external debt assets is associated with more stable economy, and more external debt liabilities held by the foreign is associated with higher economic volatility for Non-OECD countries.

[Insert Table 3.3a here]

[Insert Table 3.3b here]

Also, we examine the effects of financial integration on volatility under the dynamic panel framework (Table 3.4a and 3.4b). Unsurprisingly, the results are quite similar. In general, the effects from de jure measure of financial integration (KAOPEN) are insignificant for both OECD and Non-OECD countries. For the de facto measure of integration (IFIGDP and GEQY), we find higher degree of financial integration is related to higher economic volatility in OECD countries, and this effects are insignificant for Non-OECD countries. The results for external assets and liabilities are similar with fixed effect estimations. Both TA/GDP and TL/GDP are insignificant for OECD countries in terms of output and consumption volatilities, but significant on consumption volatility for Non-OECD countries with signs matched our expectation. Considering different types of capital flows, the economic volatility is not affected by the external assets and liabilities in equity and external assets in debt for OECD countries. However, the significantly positive effect of the external debt liabilities on consumption growth volatility shows that higher external debt liabilities will increase the volatility of consumption growth. In the case of Non-OECD group, we find the consumption growth volatility is still significantly affected by the external debt (accumulation of capital flows in debt). Higher external debt asset is associated with lower consumption volatility, higher external debt liabilities is related to higher consumption volatility.

[Insert Table 3.4a here]

[Insert Table 3.4b here]

3.4 Concluding Remarks

In this paper, we unveil a critical part in the discussion of the channel between financial integration and economic volatility, *directions of capital flow*. The effect on economic volatility depends on level of external assets (capital outflow) and external liabilities (capital inflow). Intuitively, the risk-sharing benefit is determined by capital outflow, and lowers the economic volatility. On the other hand, a country exposes to the risk from abroad through the capital inflow, and higher level of external liabilities is associated with higher economic volatility.

We re-examine the effect of financial integration on economic volatility based on 116 countries over the period 1975-2010. The empirical results indicate that relaxing the restrictions of financial integration barriers might lower GDP and consumption growth volatility of growth. However, the effects are not significant. Considering the effects of de facto measures of financial integration, we find that countries with higher external positions are associated with higher economic volatility, especially for the OECD countries.

Considering the directions of capital flows, we find that financial integration driven by capital outflow (higher external assets) benefits the consumption smoothing (lower consumption growth volatility). Higher level of external liabilities is associated with higher consumption growth volatility, and implies the country is exposed to the risk from abroad. Examining different types of capital flows, we are able to identify the sources of the effects on external assets and liabilities. The critical part of external positions that affect the consumption growth volatility is external debt. The country which holds more external debt assets from other countries is associated with lower economic volatility. The country that has more external debt liabilities (the debt is owed to creditors outside the country) is associated with higher economic volatility.

Considering the effects of international financial integration in OECD and Non-OECD countries, we find the benefit of risk-diversification from external assets is not significant for OECD countries, but is crucial for Non-OECD countries. On the other hand, external liabilities have no effect for OECD countries, but have significantly positive effect on volatility in Non-OECD countries. Similar result can be found in the external debt assets and liabilities for Non-OECD countries, and indicates the effects of different directions in capital flows are mainly determined by the external debt.

This paper answers the relationship between financial integration and economic volatility, and provides an interpretation of how the directions of capital flows (external assets and liability) affect economic volatility. Moreover, by examine different types of capital flows, the benefit of risk-diversification which lower the economic volatility is mainly from the external debt assets (accumulation of capital outflow in debt), and the additional risk from financial integration which raises the economic volatility is mainly induced by the external debt liabilities (accumulation of capital inflow in debt). The findings contain insightful policy implications, and have the potential for further investigation.

Several questions remain for further research. First, can capital flows in debt be thought of as *"ex-post"* and capital flows in equity as *"ex-ante"*? If so, could such an ex-ante/ex-post distinction explain the differences in the effects on consumption versus output growth volatilities? The idea here would be the potential difference between the ex-ante and ex-post instruments in their role in consumption smoothing. In the same vein, could the greater sensitivity of consumption growth volatility to change in external assets and liabilities stem from ex-ante risk-sharing over output and the ex-post response over consumption? Second, instead of using standard deviation to measure the economic volatility, should one consider other volatility indices (e.g. VIX) to capture the property of economic volatility as short-term shocks? Third, since the effects of capital flows are determined by external debt (assets and liabilities), should one consider the potential difference in the impact of public versus private debt? These are among questions that we will consider in further pursuit of the present line of inquiry.

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Tables

Table 3.1 Effects of Financial Integration on Economic Volatility (Fixed effect model)

Dependent Variable	GDP Growth Standard Deviation (σ_{GDPG})				Consumption Growth Standard Deviation (σ_{CONG})			
Model	I	II	III	IV	V	VI	VII	VIII
lnPOP	-2.2546 (0.9041)**	-2.3983 (0.8911)***	-2.1910 (0.8918)**	-1.8303 (0.9105)**	-2.9044 (1.0660)***	-2.8853 (1.0542)***	-2.5688 (1.0462)**	-2.1754 (1.0638)**
lnRGDP	-0.5431 (0.4761)	-0.4638 (0.4891)	-0.4195 (0.5032)	-0.3081 (0.4968)	-1.4292 (0.7910)*	-1.5002 (0.7997)*	-0.9023 (0.8337)	-0.7031 (0.8653)
YoS	-0.0371 (0.1789)	-0.0432 (0.1767)	-0.0237 (0.1763)	-0.0265 (0.1714)	-0.0880 (0.1969)	-0.0953 (0.2007)	-0.0113 (0.1851)	-0.0531 (0.1729)
Openness	0.0079 (0.0047)	0.0058 (0.0051)	0.0088 (0.0050)*	0.0063 (0.0052)	0.0098 (0.0057)*	0.0096 (0.0065)	0.0141 (0.0060)**	0.0179 (0.0057)***
ToT	0.0053 (0.0034)	0.0050 (0.0034)	0.0054 (0.0034)	0.0046 (0.0032)	-0.0075 (0.0030)**	-0.0079 (0.0030)**	-0.0073 (0.0031)**	-0.0083 (0.0029)***
KAOPEN	-0.1582 (0.0933)*	-0.1746 (0.1010)*	-0.1492 (0.0903)	-0.0716 (0.0903)	-0.1220 (0.1400)	-0.1197 (0.1457)	-0.1026 (0.1417)	-0.0683 (0.1408)
IFIGDP	0.0642 (0.0860)				0.0058 (0.1009)			
GEQY		0.2174 (0.1240)*				0.1439 (0.2308)		
TA/GDP			-0.1576 (0.2748)				-0.8106 (0.2747)***	
TL/GDP			0.2510 (0.1968)				0.7025 (0.2027)***	
TEqA/GDP				1.0541 (0.4997)**				0.0005 (0.5468)
TEqL/GDP				-0.3749 (0.3827)				0.1566 (0.4805)
TDeA/GDP				-0.5674 (0.2911)*				-1.2140 (0.3710)**
TDeL/GDP				0.4955 (0.1534)***				1.1250 (0.3259)***
Constant	28.3702 (11.4407)**	29.2341 (11.3940)**	26.4692 (11.2518)**	22.4695 (11.3170)**	44.0829 (14.2459)***	44.4683 (14.0917)***	35.2093 (14.3859)**	29.8452 (14.8291)***
R^2 (within)	0.1589	0.1616	0.1606	0.1767	0.1021	0.1131	0.1180	0.1387
Obs.	828	812	828	802	836	820	836	806

Notes: 1.Robust standard errors are in parentheses.
2. *, **, *** indicates coefficient different from null at 10%, 5%, 1% significance level respectively.

Table 3.2 Effects of Financial Integration on Economic Volatility (Dynamic panel data model)

Dependent Variable	GDP Growth Standard Deviation (σ_{GDPG})				Consumption Growth Standard Deviation (σ_{CONG})			
Model	I	II	III	IV	V	VI	VII	VIII
$\sigma_{GDPG}(t-1)$	0.2271 (0.0466)***	0.2198 (0.0419)***	0.2198 (0.0491)***	0.2252 (0.0449)***				
$\sigma_{CONG}(t-1)$					0.3264 (0.0525)***	0.3247 (0.0534)***	0.3063 (0.0537)***	0.2991 (0.0555)***
lnPOP	-0.2221 (0.0586)***	-0.2548 (0.0605)***	-0.1874 (0.0589)***	-0.1973 (0.0622)***	-0.3333 (0.0784)***	-0.3526 (0.0760)***	-0.2307 (0.0760)***	-0.2225 (0.0812)***
lnRGDP	-0.0795 (0.1654)	-0.1475 (0.1723)	-0.0452 (0.1692)	-0.0665 (0.1810)	-0.6691 (0.2493)***	-0.6106 (0.2499)**	-0.4541 (0.2610)*	-0.4749 (0.2804)*
YoS	-0.0865 (0.0729)	-0.0703 (0.0707)	-0.0828 (0.0682)	-0.0871 (0.0734)	-0.0057 (0.1007)	-0.0108 (0.0987)	-0.0351 (0.1113)	-0.0196 (0.1142)
Openness	0.0011 (0.0250)	0.0001 (0.0028)	0.0030 (0.0024)	0.0027 (0.0029)	-0.0016 (0.0028)	-0.0001 (0.0032)	0.0022 (0.0027)	0.0047 (0.0029)
ToT	0.0096 (0.0062)	0.0088 (0.0063)	0.0104 (0.0065)	0.0122 (0.0063)*	-0.0019 (0.0036)	-0.0013 (0.0037)	0.0004 (0.0035)	0.0009 (0.0035)
KAOPEN	-0.1195 (0.0752)	-0.0938 (0.0774)	-0.1067 (0.0789)	-0.0837 (0.0752)	-0.1196 (0.1021)	-0.1209 (0.0928)	-0.1408 (0.1094)	-0.1482 (0.1033)
IFIGDP	0.0654 (0.0306)**				0.1212 (0.0453)***			
GEQY		0.2580 (0.1079)**				0.1315 (0.1380)		
TA/GDP			-0.2479 (0.1929)				-0.7816 (0.2033)***	
TL/GDP			0.3762 (0.1994)*				1.0288 (0.2373)***	
TEqA/GDP				-0.0614 (0.4110)				-0.6134 (0.6161)
TEqL/GDP				0.5561 (0.4475)				0.5961 (0.5718)
TDeA/GDP				-0.3861 (0.2036)*				-0.8390 (0.2715)***
TDeL/GDP				0.4166 (0.2140)*				1.1229 (0.3049)***
Constant	4.6940 (1.3786)***	5.6052 (1.5484)***	3.7326 (1.7714)**	3.7383 (1.7698)**	11.5072 (1.8894)***	11.1753 (1.9921***	8.1274 (1.9487)***	7.9255 (2.1783)***
Obs.	607	597	607	588	619	609	619	600
AR(2) test p-value	0.376	0.415	0.333	0.600	0.249	0.253	0.320	0.250
Hansen p-value	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Notes: 1.Robust standard errors are in parentheses.
2. *, **, *** indicates coefficient different from null at 10%, 5%, 1% significance level respectively.

Table 3.3a Effects of Financial Integration on Economic Volatility (OECD countries)

Dependent Variable	GDP Growth Standard Deviation (σ_{GDPG})				Consumption Growth Standard Deviation (σ_{CONG})			
Model	I	II	III	IV	V	VI	VII	VIII
lnPOP	-0.5831 (1.7446)	-1.1709 (2.0419)	-0.5714 (1.7536)	0.1120 (2.3561)	-2.1485 (2.1149)	-3.1291 (1.8996)	-2.3769 (2.1101)	-3.0619 (2.1320)
lnRGDP	-0.7820 (0.8139)	-0.6538 (0.8230)	-0.8070 (0.8469)	-0.3293 (0.7969)	0.8083 (1.6145)	1.0371 (1.5662)	1.2992 (1.5176)	1.5814 (1.5700)
YoS	0.2154 (0.1375)	0.1992 (0.1413)	0.2163 (0.1375)	0.1582 (0.1337)	0.1475 (0.1964)	0.1091 (0.1746)	0.1284 (0.1886)	0.0746 (0.1687)
Openness	-0.0046 (0.0087)	-0.0085 (0.0105)	-0.0047 (0.0086)	0.0028 (0.0120)	-0.0126 (0.0104)	-0.0180 (0.0107)	-0.0107 (0.0100)	-0.0131 (0.0121)
ToT	0.0047 (0.0114)	0.0027 (0.0102)	0.0047 (0.0114)	0.0008 (0.0108)	0.0177 (0.0113)	0.0141 (0.0105)	0.0178 (0.0112)	0.0144 (0.0116)
KAOPEN	-0.4371 (0.1322)***	-0.3980 (0.1234)***	-0.4370 (0.1327)***	-0.3328 (0.1302)**	-0.3746 (0.1589)**	-0.3039 (0.1433)**	-0.3756 (0.1563)**	-0.2895 (0.1430)*
IFIGDP	0.1131 (0.0421)**				0.1518 (0.0468)***			
GEQY		0.3178 (0.1556)*				0.4084 (0.1824)**		
TA/GDP			0.1494 (0.1738)				-0.5592 (0.2846)*	
TL/GDP			0.0804 (0.1571)				0.7920 (0.2872)**	
TEqA/GDP				1.3452 (0.7043)*				-0.4084 (0.8404)
TEqL/GDP				-1.2739 (0.6925)*				0.6855 (0.7699)
TDeA/GDP				0.3875 (0.3310)				-0.5718 (0.3376)
TDeL/GDP				0.0944 (0.2197)				0.8083 (0.2856)***
Constant	15.1761 (19.0127)	20.2714 (20.9208)	15.3191 (19.0991)	3.7112 (25.0592)	12.5726 (26.8561)	20.9534 (26.3975)	9.7757 (24.9566)	14.4875 (29.3716)
R^2 (within)	0.3141	0.3138	0.3142	0.3304	0.2503	0.2586	0.2672	0.2865
Obs.	212	211	212	211	212	211	212	211

Notes: 1.Robust standard errors are in parentheses.

2. *, **, *** indicates coefficient different from null at 10%, 5%, 1% significance level respectively.

Table 3.3b Effects of Financial Integration on Economic Volatility (Non-OECD countries)

Dependent Variable	GDP Growth Standard Deviation (σ_{GDPG})				Consumption Growth Standard Deviation (σ_{CONG})			
Model	I	II	III	IV	V	VI	VII	VIII
lnPOP	-2.1913 (1.4179)	-2.4404 (1.4944)	-2.0789 (1.4030)	-2.3405 (1.4464)	-3.4995 (1.7205)**	-3.3677 (1.7587)*	-2.8826 (1.7137)*	-3.1595 (1.7863)*
lnRGDP	-0.4649 (0.5306)	-0.3546 (0.5568)	-0.3571 (0.5656)	-0.3400 (0.5714)	-1.7104 (0.8647)*	-1.7795 (0.8662)**	-1.2196 (0.9019)	-1.0512 (0.9337)
YoS	-0.1832 (0.2638)	-0.1902 (0.2651)	-0.1587 (0.2624)	-0.1368 (0.2687)	-0.1954 (0.2897)	-0.2043 (0.2975)	-0.0605 (0.2807)	-0.0765 (0.2696)
Openness	0.0092 (0.0052)*	0.0068 (0.0057)	0.0102 (0.0053)**	0.0077 (0.0057)	0.0118 (0.0062)*	0.0119 (0.0075)	0.0166 (0.0065)**	0.0208 (0.0066)***
ToT	0.0052 (0.0035)	0.0049 (0.0036)	0.0052 (0.0035)	0.0048 (0.0035)	-0.0081 (0.0030)***	-0.0086 (0.0030)***	-0.0081 (0.0031)**	-0.0086 (0.0030)***
KAOPEN	-0.0511 (0.1118)	-0.0786 (0.1217)	-0.0425 (0.1080)	0.0317 (0.1063)	-0.0432 (0.1722)	-0.0540 (0.1778)	-0.0284 (0.1758)	0.0094 (0.1683)
IFIGDP	0.0292 (0.1247)				-0.0557 (0.1208)			
GEQY		0.1956 (0.1732)				0.0879 (0.3367)		
TA/GDP			-0.1819 (0.3309)				-0.8761 (0.2802)***	
TL/GDP			0.1988 (0.2260)				0.6192 (0.2346)***	
TEqA/GDP				1.0072 (0.6610)				0.5478 (0.8171)
TEqL/GDP				-0.4577 (0.4542)				-0.5618 (0.7207)
TDeA/GDP				-0.6871 (0.3189)**				-1.6846 (0.5105)***
TDeL/GDP				0.5100 (0.1978)**				1.4885 (0.5090)***
Constant	27.3823 (16.3078)	28.9466 (16.9559)*	25.1632 (16.2623)	27.7945 (16.4957)*	51.8372 (19.9669)**	51.0359 (20.2966)**	40.6012 (20.0813)**	41.8784 (20.7355)**
R^2 (within)	0.1653	0.1674	0.1668	0.1820	0.1085	0.1165	0.1230	0.1492
Obs.	616	601	616	591	624	609	624	595

Notes: 1.Robust standard errors are in parentheses.
2. *, **, *** indicates coefficient different from null at 10%, 5%, 1% significance level respectively.

Table 3.4a Effects of Financial Integration on Economic Volatility (OECD countries, Dynamic panel data model)

Dependent Variable	GDP Growth Standard Deviation (σ_{GDPG})				Consumption Growth Standard Deviation (σ_{CONG})			
Model	I	II	III	IV	V	VI	VII	VIII
$\sigma_{GDPG}(t-1)$	-0.0047 (0.1309)	0.0628 (0.1073)	0.0639 (0.2186)	-0.0053 (0.1405)				
$\sigma_{CONG}(t-1)$					0.1190 (0.1453)	0.2020 (0.1220)*	0.0306 (0.1247)	-0.0183 (0.1882)
lnPOP	0.3004 (0.5448)	-0.2866 (0.2423)	-0.1012 (0.6045)	0.2657 (0.5275)	-0.0824 (0.2684)	0.0497 (0.2223)	-0.2332 (0.3861)	-0.4121 (0.6184)
lnRGDP	-0.9529 (1.5798)	-1.125 (1.3168)	-0.6328 (2.0911)	-0.7641 (1.5521)	-1.2738 (1.4094)	-1.0885 (1.0059)	-0.7069 (1.1556)	-1.9803 (1.5659)
YoS	-0.0492 (0.3788)	0.3322 (0.4946)	0.0668 (0.3270)	-0.0592 (0.5877)	0.1178 (0.1989)	0.1385 (0.1106)	0.0919 (0.3508)	0.177 (0.2040)
Openness	0.0120 (0.0227)	-0.0194 (0.0182)	-0.0130 (0.0196)	0.0026 (0.0184)	-0.0094 (0.0077)	-0.0048 (0.0075)	-0.0136 (0.0113)	-0.0171 (0.0246)
ToT	0.0178 (0.0148)	0.0057 (0.0138)	0.0078 (0.0133)	0.0113 (0.0129)	0.0090 (0.0168)	0.0124 (0.0063)**	0.0200 (0.0114)*	0.0363 (0.0175)**
KAOPEN	-0.6642 (0.4085)	-0.4670 (0.2435)*	-0.3584 (0.6691)	-0.6262 (0.3914)	-0.4744 (0.2978)	-0.5461 (0.2780)**	-0.6193 (0.5552)	-0.2602 (0.4109
IFIGDP	0.1441 (0.0786)*				0.1736 (0.0584)***			
GEQY		0.7182 (0.4077)*				0.4386 (0.1437)***		
TA/GDP			-0.5305 (1.7213)				-1.247 (1.4319)	
TL/GDP			1.0528 (1.8290)				1.6409 (1.4117)	
TEqA/GDP				0.6375 (1.4033)				-3.5507 (2.9872)
TEqL/GDP				-0.6136 (2.1134)				3.0824 (3.8377)
TDeA/GDP				-0.1488 (1.6318)				-2.2286 (1.7366)
TDeL/GDP				1.0097 (1.0347)				3.1673 (1.8540)*
Constant	7.4168 (13.1860)	13.5781 (10.7419)	8.4761 (18.7740)	6.6779 (13.1611)	14.0032 (13.4398)	10.0222 (10.7250)	9.1441 (12.2441)	20.5419 (18.9124)
Obs.	159	159	159	159	159	159	159	159
AR(2) test p-value	0.019	0.025	0.047	0.018	0.103	0.106	0.039	0.134
Hansen p-value	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Notes: 1.Robust standard errors are in parentheses.
2. *, **, *** indicates coefficient different from null at 10%, 5%, 1% significance level respectively.

Table 3.4b Effects of Financial Integration on Economic Volatility (Non-OECD countries, Dynamic panel data model)

Dependent Variable	GDP Growth Standard Deviation (σ_{GDPG})				Consumption Growth Standard Deviation (σ_{CONG})			
Model	I	II	III	IV	V	VI	VII	VIII
$\sigma_{GDPG}(t-1)$	0.2306 (0.0520)***	0.2144 (0.0546)***	0.2094 (0.0516)***	0.2231 (0.0500)***				
$\sigma_{CONG}(t-1)$					0.3242 (0.0493)***	0.3258 (0.0570)***	0.3273 (0.0620)***	0.2932 (0.0731)***
lnPOP	-0.2370 (0.0628)***	-0.2865 (0.0715)***	-0.2087 (0.0785)***	-0.2676 (0.1007)***	-0.3904 (0.0892)***	-0.4274 (0.1133)***	-0.2794 (0.0880)***	-0.2911 (0.1137)***
lnRGDP	-0.0257 (0.2755)	0.1143 (0.2634)	0.0031 (0.2680)	0.4085 (0.3815)	-0.6675 (0.3595)*	-0.5698 (0.4800)	-0.3538 (0.3282)	-0.2731 (0.4118)
YoS	-0.0913 (0.0970)	-0.1571 (0.0992)	-0.0879 (0.0981)	-0.2075 (0.1358)	-0.0121 (0.1242)	-0.0125 (0.1563)	-0.0141 (0.1094)	-0.0284 (0.1476)
Openness	0.0008 (0.0032)	-0.0022 (0.0033)	0.0024 (0.0030)	-0.0015 (0.0043)	-0.0025 (0.0035)	-0.0024 (0.0050)	0.0021 (0.0038)	0.0031 (0.0046)
ToT	0.0100 (0.0069)	0.0083 (0.0067)	0.0101 (0.0072)	0.0126 (0.0071)*	-0.0016 (0.0041)	-0.0016 (0.0044)	0.0028 (0.0039)	0.0022 (0.0046)
KAOPEN	-0.0218 (0.0981)	0.0206 (0.0810)	0.0151 (0.0989)	-0.0478 (0.1031)	-0.0128 (0.1226)	-0.0319 (0.1255)	-0.0360 (0.1334)	-0.0534 (0.1489)
IFIGDP	0.0461 (0.0505)				0.1820 (0.0964)*			
GEQY		0.3249 (0.2278)				0.2602 (0.2671)		
TA/GDP			-0.4306 (0.2777)				-0.9833 (0.2945)***	
TL/GDP			0.5801 (0.2709)**				1.3243 (0.3529)***	
TEqA/GDP				-0.1387 (1.0161)				0.1418 (1.1665)
TEqL/GDP				0.9793 (0.8119)				0.4698 (1.0326)
TDeA/GDP				-0.3633 (0.4213)				-1.3393 (0.3959)***
TDeL/GDP				0.3239 (0.3066)				1.6008 (0.4219)***
Constant	4.4648 (1.9748)**	4.5683 (1.9989)**	3.5508 (2.8225)	1.5617 (2.6097)	11.9931 (2.5761)***	11.7061 (3.1782)***	7.0778 (2.6600)***	6.8849 (3.4440)**
Obs.	448	438	448	429	460	450	460	441
AR(2) test p-value	0.888	0.929	0.764	0.784	0.178	0.184	0.208	0.187
Hansen p-value	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Notes: 1.Robust standard errors are in parentheses.
2. *, **, *** indicates coefficient different from null at 10%, 5%, 1% significance level respectively.

Appendix:

Data source

Sources	Variables
Penn World Table 7.1	Population; Real GDP per capita; Trade openness; Term of trade
Barro-Lee Educational Attainment Dataset (Barro and Lee, 2010)	Year of schooling
The Chinn-Ito Index (Chinn and Ito, 2008)	KAOPEN
External Wealth of Nations Dataset (Lane and Milesi-Ferretti, 2007)	IFIGDP; GEQY; External assets; External liabilities

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Works In Progress:

- Financial Integration, Risk Diversification, and Growth (with Hamid Mohtadi)

- Financial Integration and Economic Volatility (with Hamid Mohtadi)

Conference: U of Wisconsin Madison : 10th Midwest International Economic Development Conference April 2013
Presentation: "International Capital Mobility Revisited: Resurrecting the Feldstein-Horioka Hypothesis"
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