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# The Threshold Consumption Correlation-Based Approach to International Capital Mobility: Evidence from Advanced and Developing Countries

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## Abstract

Using the consumption correlation-based criterion, this paper analyzes international capital mobility for both advanced and developing countries. We provide evidence that global capital markets are imperfectly integrated for both advanced and developing countries. However, a clear difference between these groups of countries emerges when their consumption growth has stagnated; in developing countries at such times, the opportunity to smooth their consumption drops dramatically.

JEL classification: F3, F4

Keywords: International capital mobility, Panel data approach, Threshold model, Consumption correlation

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# 1 Introduction

International capital mobility is an important research topic in international finance since most countries are now engaged in exchanges of, not only economic goods and services, but also financial assets. Furthermore, different theoretical assumptions regarding the level of a country's integration to the rest of the world lead to different policy implications. For these reasons, much research has been conducted in this area in the past.

There are broadly two categories of methodology when assessing international capital mobility. One is based on macroeconomic variables; the investment-savings (Feldstein and Horioka 1980) and consumption correlation (Obstfeld 1994) criteria. Among them the former approach, which suggests no investment-savings correlation in perfectly integrated markets, dominates the literature. However, there is no definitive conclusion reached in previous studies from this approach. Although international market integration has been advancing over the years and higher integration is observed at the intra-country level rather than in the cross-country context (Atkeson and Bayoumi 1993), it is not clear as to whether this is appropriate for assessing capital mobility.<sup>1</sup> For example, there is still strong evidence against perfect capital mobility even for advanced countries during a period with minimal regulation (Obstfeld and Rogoff 2000), and furthermore it suggests a higher level of integration for developing countries than advanced countries (Sinha and Sinha 2004).<sup>2</sup>

International capital mobility can be also examined using interest parity conditions, and it is probably fair to say that in the long-run there is more evidence of global financial market integration using interest parity conditions than from the investment-savings criterion. For example, MacDonald and Nagayasu (2000) and Camarero et al (2010) have showed that the real interest parity condition holds for a panel of advanced countries in the long-run. Lothian and Wu (2011) instead used the uncovered interest parity (UIP) condition using a long history of data and provided evidence in favor of this condition when the sample period of 1980s is dropped

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<sup>1</sup>In his literature survey, Frankel (1992) summarizes several theoretical approaches for measuring international capital mobility; namely, the investment-savings correlation method (Feldstein and Horioka 1980) and interest parity conditions. Among these quantitative approaches however, Frankel argues that the covered interest parity condition is probably most appropriate for studying capital mobility since this condition relies less on other economic assumptions.

<sup>2</sup>See Apergis and Tsoumas (2009) for a literature survey on the investment-savings relationship. The presence of a non-tradable sector and a significant amount of international aid lead to an interpretation of higher integration in developing countries.

from the analysis. Similarly, Chinn and Meredith (2004) provided support for the UIP for a longer maturity. Furthermore, Taylor (1987) used contemporaneously sampled data to test the covered interest parity (CIP) condition and overwhelmingly supported this condition for advanced countries. In contrast, these interest parity conditions seem to be less supported in the short-run because of the presence of transaction costs, expectations errors, risk premiums, among many other factors (e.g., Sarno 2005).

Against this background, we study global capital market integration based on the consumption correlation criterion for advanced and developing countries while at the same time considering regime-shifts in the data. This criterion has been argued as having a more solid theoretical foundation than the investment-savings criterion (Obstfeld 1986; Taylor 1994) and is viewed as a second best approach since our data set has wide country coverage and includes data from developing countries which often do not possess long historical data on interest rates.<sup>3</sup> Furthermore, the importance of shifts is underlined in our analysis since they have been discussed as one reason for the poor performance of the consumption function (e.g., Koedijk and Smant 1994; Hall et al 1997; Dufrenot and Mignon 2004). Finally, note that our main focus on a cross-country consumption correlation is closely related to the consumption correlation puzzle (Backus et al 1992) which asserts that consumption should be more highly correlated across countries than with domestic output since country-specific income risks are insured in a perfect world.

## 2 Theoretical Model

Obstfeld (1994) used the consumption correlation-based approach in order to assess international capital mobility. This model indicates that there is an equi-proportional increase in consumption between countries when the market is perfectly integrated, and in contrast no correlation must exist between their consumption if the market is completely closed. In the latter case, this implies that consumers cannot smooth their consumption changes, by using financial resources in other countries, in response to an economic shock to the country. This model has been developed for perfectly competitive and open markets and for simplicity is summarized below in the two-country setting (countries  $i$  and  $j$ ).

An economic agent in country  $i$  is assumed to maximize his utility which is a

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<sup>3</sup>Furthermore, generally speaking, it is difficult to obtain high quality savings data.

function of future consumption ( $C_{it}$ ) with a preference shock ( $\xi_{it}$ ), and with the initial period (i.e.,  $t = 0$ ), this objective function is:

$$U_0 = E \left[ \sum_{t=0}^{\infty} \beta_i^t u(C_{it}, \xi_{it}) | I_0 \right] \quad (1)$$

where  $E$  represents expectations of rational consumers and  $I$  an information set. Parameter  $\beta$  is the discount factor ( $0 < \beta_i < 1$ ) and measures the level of patience of consumers, and here this parameter is assumed to be constant over time. The consumers' utility ( $u(\cdot)$ ) is assumed to have a form of a constant relative risk aversion (CRRA) which holds in both countries ( $i$  and  $j$ ). For country  $i$ , this can be expressed as:

$$u(C_i, \xi_i) = \frac{C_i^{1-\theta}}{1-\theta} \exp(\xi_i) \quad (2)$$

The  $\theta$  is a risk aversion coefficient ( $\theta > 0$ ) and is assumed to be the same over time and country following previous studies (Obstfeld 1994).<sup>4</sup> Since the same type of the utility function is used in these countries, their dynamic consumption behaviors are also identical in perfectly competitive and open markets. This can be expressed as (3), based on the Euler equation, where the marginal rate of intertemporal substitution becomes identical in these two countries.

$$\frac{E\beta_i^t C_{it}^{-\theta} \exp(\xi_i)}{C_{i0}^{-\theta}} = \frac{E\beta_j^t C_{jt}^{-\theta} \exp(\xi_j)}{C_{j0}^{-\theta}} \quad (3)$$

The  $C_{i0}$  and  $C_{j0}$  indicate the initial level of consumption for countries  $i$  and  $j$ . In natural log, equation (3) can be written as:<sup>5</sup>

$$\ln C_{it} = \ln C_{jt} + \ln(C_{i0}/C_{j0}) + \ln(\beta_i/\beta_j)(t/\theta) + (1/\theta)(\xi_{it} - \xi_{jt}) \quad (4)$$

This shows that there are equi-proportional changes in consumption between two countries when the capital markets are perfectly open.

Given that our study deals with more than two countries, equation (4) cannot be used directly here. Thus, country  $j$  now represents the rest of the countries (i.e., other than country  $i$ ), and consumption is adjusted using a weight proportional to the population. Thus denoting  $c$  as log real consumption per capita, the statistical

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<sup>4</sup>Das and Sarkar (2010) showed that the constancy of the relative risk aversion parameter from the stock data of major stock markets.

<sup>5</sup>Expectation errors are ignored in equation (3) since they are on average equal to zero based on the assumption of rational expectations.

form of equation (4) can be written as.

$$c_{it} = \alpha_i + \lambda c_{jt} + \xi t + e_{it} \quad (5)$$

where  $i = 1, \dots, N$  and  $t = 1, \dots, T$ . The  $\alpha_i$  is fixed effects ( $\alpha_i = c_{i0} - c_{j0}$ ), and  $e_{it}$  contains the final item in equation (4). Based on the theoretical model (4), we expect  $\lambda = 1$  if the capital market of country  $i$  is perfectly integrated with the rest. Furthermore, data suggest partial integration when  $\lambda > 0$  and no integration when  $\lambda = 0$ .<sup>6</sup> This is probably the simplest form for an analysis of risk sharing, and has been extended to include a number of other economic factors in the past. For example, Lewis (1996) considered nonseparabilities in utilities between traded and nontraded leisure and goods as well as effects of capital market restrictions, and showed that both factors are necessary to explain consumption correlations.<sup>7</sup>

While consideration of these deficiencies may be an important direction for future research, we make only a modest modification to this standard theoretical model by introducing two extra terms. First, following Obstfeld (1994) to model more explicitly imperfect integration, we shall consider a variable which represents domestic resources available for domestic consumption ( $DLR = GDP - G - I$ ). Like consumption ( $c_{it}$ ),  $DLR$  is expressed per capita and in real terms, and should have an equi-proportional effect on  $c_{it}$  when the market is completely closed since consumers rely solely on domestic resources. The introduction of this variable is also motivated by the finding that consumption is actually highly correlated with domestic output in the consumption correlation puzzle literature (e.g., Pakko 1998). Since  $GDP$  and  $DLR$  are highly correlated, our model is similar to the one used in the study of the consumption correlation puzzle.

Second, real oil prices (*Oil*) are included in the model in order to capture a common effect among countries, and can also be viewed as representing uninsured risks.<sup>8</sup> For oil-importing countries, an increase in oil prices is expected to hamper consumption growth. Although our data set does not include the major oil exporters such as the Arab League and Russia, a positive relationship between oil prices and con-

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<sup>6</sup>However, it can be shown that when the risk aversion coefficient ( $\theta$ ) differs across countries, there will be no equi-proportional relationship between consumptions even in perfectly competitive and open markets.

<sup>7</sup>We do not consider issues related to nonseparability due partly to the lack of consistent disaggregated (e.g., traded and nottraded) data over time.

<sup>8</sup>Obstfeld (1994) used oil prices to capture idiosyncratic shocks. But since a panel data method is used and thus a homogeneity restriction is imposed on the parameter, oil prices here represent the common factor and have the same impact on cross-country consumption.

sumption is expected for those countries as it generates extra income. Furthermore, since our specification focuses on the relatively short-term (if not contemporaneous) relationship of consumptions, a positive relationship can be obtained for developing countries since energy price changes only have long-term effects on aggregate indicators such as income (Lee and Chang 2008). In addition, governments often impose energy price controls (Mehrara 2007) which prevent actual prices from being in line with international market prices in the short-run. Then a more general form to test capital mobility can be expressed as:

$$c_{it} = \alpha_i + \lambda c_{jt} + \delta DLR_{it} + \vartheta Oil_t + \phi t + u_{it} \quad (6)$$

If  $u_{it}$  is also assumed to contain idiosyncratic risks as opposed to common risks captured by  $Oil_t$ , high integrated markets can be analyzed using the null hypothesis:  $\lambda = 1$  and  $\delta = 0$ . On the other hand, low integration can be tested using  $\lambda = 0$  and  $\delta = 1$ .

Studies which used this approach to analyze consumption correlation across countries are sparse compared with ones using the investment-savings criterion. Among them, Obstfeld (1994) used this to test risk-sharing behaviors for individual advanced countries and reported mixed results. The results are sensitive to the country and sample period under investigation; for example, evidence of perfect mobility is found for France, Germany and Japan for the period 1973-1988, and that of immobility for Canada and the UK. In addition, high integration is observed from regional data. Boyreau-Debray and Wei (2004) examined domestic capital mobility within Chinese provinces and identified 1990 since when evidence is obtained of perfect mobility. Similarly, Nagayasu (2010) reported that Japanese regions are highly integrated and the integration process had accelerated between 1965 and 1975 along with developments in consumer loan markets.<sup>9</sup>

### 3 Results from A Linear Panel Data Model

One distinguishing feature of this analysis is to investigate global capital mobility including samples of developing countries. Table 1 shows a list of countries under investigation and furthermore explains the composition of country groups (advanced countries, non-advanced countries, euro members, and non-euro members) which will

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<sup>9</sup>The consumption correlation-based approach has been intensively used to analyze risk sharing using micro-data; for example, Townsend (1994) for India, and Ogaki and Zhang (2001) for India and Pakistan.

be used to check the robustness of our findings to country groups.<sup>10</sup> The choice of countries is based entirely on data availability. Data on consumption and domestic resources are expressed in real terms and per capita and are obtained from the Penn World Table (PWT70); they are annual and cover the sample period from 1950 to 2009. Oil prices (Dubai petroleum prices in US dollars) are also expressed in real terms using the US consumer price index, which are all obtained from the International Financial Statistics of the International Monetary Fund (IMF).

A simple investigation of correlation between consumptions ( $\Delta c_i$  and  $\Delta c_j$ ), and  $\Delta DRL$  is reported in Table 2. It suggests that consumption growth is more highly correlated with world consumption growth in advanced countries than in developing countries. In addition, consistent with previous studies on the consumption correlation puzzle (e.g., Pakko 1998) but inconsistent with economic theory (Backus et al 1992), consumption growth is more highly correlated with domestic resources than world economic (consumption) trends.

Next we shall carry out an analysis on international capital mobility using panel data estimation methods; the OLS, and fixed and random effects approaches. Compared with a single country analysis (e.g., Obstfeld 1994), this approach should bring about a more reliable result given the limited time span and should help us draw a general conclusion about a group of countries. Due to the more general specification, the last two estimation methods likely better capture the data generating process. These models can be summarized as follows:

$$\begin{aligned}\Delta c_{it} &= \alpha_i + \lambda \Delta c_{jt-1} + \delta \Delta DLR_{it-1} + \vartheta \Delta Oil_{t-1} + u_{it} \\ u_{it} &= \mu_i + v_{it}\end{aligned}\tag{7}$$

where the residual  $u_{it}$  comprises individual specific effect ( $\mu_i$ ) and the rest ( $v_{it}$ ). Subscripts remain the same as before. In the OLS, the residual in (7) can be simplified as  $u_{it} = v_{it}$ , and in the random effects model  $\mu_i$  is assumed to be random ( $\mu_i \sim IID(0, \sigma_\mu^2)$ ) and  $E(\mu_i, v_{it}) = 0$ . Finally, in order to make our results comparable to those from previous studies, the first differenced version of (6) will be used for our analysis,<sup>11</sup> and in order to circumvent the endogeneity issue, a lagged

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<sup>10</sup>We follow the IMF classification based on the information as of writing.

<sup>11</sup>Obstfeld (1994) used a differenced specification since this data transformation removes the fixed effects which are present in the non-differenced model, and is preferable when non-differenced (consumption) data follow a unit root process. Furthermore, he argues that since a country is normally a small economy relative to the rest of the world, it is appropriate to consider a casual relationship as described in equation (5).



explanatory variable is used in equation (7).<sup>12</sup>

Before a formal analysis, we carry out panel unit root tests to check the stationarity of our panel data (i.e.,  $\Delta c$  and  $\Delta DRL$ ), which is an a priori assumption required for the standard panel data estimation methods.<sup>13</sup> In order to have a better performance to distinguish between statistical hypotheses (e.g., Harris and Tzavalis 1999), we shall use three panel unit root tests (Levin, Lin and Chu 2002; Harris and Tzavalis 1999; the Fisher-type Augmented Dickey-Fuller (ADF)) which investigate the null hypothesis of the unit root against the alternative of stationary data. Since the autoregressive parameter for the first two tests is assumed to be cross-sectionally homogeneous under both the null and alternative hypotheses - unlike some other panel tests - a rejection of the null from the first two tests provides evidence that all series are stationary.

Table 3 reports the results from the panel unit root tests where a cross-sectional average is removed from the original data in order to meet an a priori theoretical assumption of these tests about independent panels. All three tests suggest that this null is strongly rejected for data on consumption growth ( $\Delta c$ ) and domestic resources ( $\Delta DRL$ ). Therefore it is statistically appropriate to employ the conventional panel data estimation methods in order to analyze these data.

Table 4 presents results from equation (7), which are very similar irrespective of different statistical models used for the estimation. We see that consumption in one country is strongly correlated with that in the rest of the countries. The consumption coefficient ranges from 0.053 to 0.081, which is statistically significant. Thus, our results provide support for the significant integration of international capital markets. Furthermore, the correlation (and thus market integration) is found to be higher among advanced countries, especially for euro members. This outcome is in sharp contrast to previous studies using the investment-savings correlation that suggested higher integration for developing countries (Sinha and Sinha 2004), but is consistent with the fact that fewer financial regulations (i.e., barriers) exist in advanced countries.

However, although statistically significant evidence of capital market integration is obtained for both advanced and developing countries, the consumption correlation

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<sup>12</sup>Our decision to use a lagged exogenous variable is due to econometric reasons and also to a lack of available instruments in instrumental variable estimation methods. Econometrically, the introduction of lagged variables implies that consumption requires adjustment time to change in response to exogenous factors. A previous version of this paper (with the sample period 1950-2007) analyzed the contemporaneous relationship and reported a result similar to that presented here.

<sup>13</sup>A univariate Augmented Dickey Fuller test showed that changes in oil prices are found to be stationary.

is far from unity. Our estimates may have been underestimated since our data do not solely focus on non-durable consumer goods which are often essential for everyday life but include durable goods that are less sensitive to the recent state of the economy. Furthermore, lack of consideration of incomplete asset markets (Kollmann 1996) and additional consideration of the utility function, e.g., leisure and non-trade goods (Lewis 1996), may also affect the outcome.

The *DRL* that measures the closeness of the economy is also often reported to be statistically significant with its parameter ranging from 0.008 to 0.026. Interestingly, advanced countries tend to have a high parameter value for  $\delta$ —evidence of closed economy. This result appears to contradict our evidence from the consumption correlation, but may reflect various factors associated with developing countries: a fragile domestic economy in developing countries, heavy reliance on foreign aid, as well as a lack of well-established financial institutions which are required in order to access domestic resources. In this connection, our result is also consistent with the consumption correlation puzzle and Rao and Sharma (2007) who reported a higher correlation between consumption and income (or output) in advanced countries than in developing countries. Thus, in short, unlike developing countries, advanced countries seem to have access to both international and domestic resources in order to smooth their consumption.

Last, but not least, oil prices are also found to be statistically significant in our analyses, and as expected have asymmetric effects on  $\Delta c_i$  among countries. In advanced countries where a market mechanism is more established, an increase in oil prices has adverse effects on consumption, while they contribute to positive consumption growth in non-advanced countries. Since the major oil exporting countries are not included in our group of non-advanced countries, our time (i.e., one-year) lag may not be long enough for increases in oil prices to have adverse effects on their consumption.

To complete the analysis, the joint hypothesis to test both variables is conducted next. Formally, high international capital mobility is tested under the null hypothesis of  $\lambda = 1$  &  $\delta = 0$ , and in contrast low capital mobility is examined by  $\lambda = 0$  &  $\delta = 1$ . Our results in the form of *p*-values (Table 4) confirm the abovementioned conclusion that global capital markets are imperfectly open for both advanced and developing countries; both null hypotheses are strongly rejected by our data regardless of a country group. Our findings thus imply that barriers such as transaction costs, taxes, etc are still significant even in advanced countries. Furthermore, given that there is some evidence of perfect capital mobility within the same country in the

recent sample period (Boyreau-Debray and Wei 2004, Nagayasu 2010), our results also imply that the international capital markets are less integrated than domestic markets.

## 4 The Introduction of Threshold Effects in the Panel of Countries

While our previous results on imperfect global markets match, to some extent, with our expectations, they may be affected by the presence of structural breaks. Shifts in consumption can be generated by several economic factors such as changes in the business cycle (e.g., Koedijk and Smant 1994, Hall et al 1997) and explanatory variables of consumption—output and interest rates (e.g., Dufrenot and Mignon 2004). Furthermore, while it is not obvious from our theoretical model, previous studies (e.g., Haque and Montiel 1989) pointed out that consumers in developing countries face a high level of liquidity constraints, and these constraints are expected to be more conspicuous when their economy is weak. In this regard, Habibullah et al (2006) estimated that about 0.25 to 0.98% of consumers are confronted with liquidity constraints in Asian developing countries, and Carmichael et al (1999) showed that the introduction of liquidity constraints to the model helps us replicate business cycles consistent with actual data for developing countries.<sup>14</sup>

Therefore, we check if consumption correlations are sensitive to economic conditions (i.e., regime shifts). While there are many forms of nonlinearity, we consider the following one-threshold fixed effects panel model (Hansen 1999):<sup>15</sup>

$$\Delta c_{it} = \alpha_i + \lambda_1' \Delta c_{jt-1} I(q_{it-1} \leq \gamma) + \lambda_2' \Delta c_{jt-1} I(q_{it-1} > \gamma) + \delta \Delta DLR_{it-1} + \theta \Delta Oil_{t-1} + e_{it} \quad (8)$$

where the fixed effects are captured by  $\alpha_i$ . Subscripts 1 and 2 represent regimes which are determined by an indicator function ( $I(\cdot)$ ). For regime 1 this function contains a value of one which corresponds to a threshold variable ( $q_{it-1}$ ) being less than a threshold value ( $\gamma$ ) and zero otherwise. Regime 2 is the case where  $q_{it-1}$  is greater than  $\gamma$ . The threshold point is determined by the level of domestic con-

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<sup>14</sup>While we do not investigate further, it should be noted that persistence in consumption reported in previous studies can be generated by a regime shift in the data.

<sup>15</sup>Hansen (1999) considered only the fixed effect panel data model with multiple thresholds. Estimation is based on Hansen's Matlab code.

sumption growth in the previous period, i.e.,  $\Delta c_{it-1}$ . Our model allows time-varying responses of consumption growth ( $\Delta c_{jt}$ ) which is our primary interest, and a focus on the single time-varying variable helps reduce computational burden in our panel data framework.<sup>16</sup> Finally,  $e$  is the residual, and equation (8) will be estimated by the OLS.

When the number of thresholds is greater than one, equation (8) has to be expanded to include another component with multiple threshold points (i.e.,  $\gamma_1, \gamma_2, \dots, \gamma_k$ ) where  $k$  is the number of thresholds. For example, the double threshold model becomes:

$$\begin{aligned} \Delta c_{it} = & \alpha_i + \lambda'_1 \Delta c_{jt-1} I(q_{it-1} \leq \gamma_1) + \lambda'_2 \Delta c_{jt-1} I(\gamma_1 < q_{it-1} \leq \gamma_2) + \lambda'_3 \Delta c_{jt-1} I(\gamma_2 < q_{it-1}) \\ & + \delta \Delta DLR_{it-1} + \theta \Delta Oil_{t-1} + e_{it} \end{aligned} \quad (9)$$

Thus before estimating a threshold equation, the number of breaks needs to be determined and is examined here with the maximum of three possible thresholds using Hansen's likelihood ratio test which analyzes the null hypothesis of  $k - 1$  threshold against the alternative of  $k$  thresholds (see Appendix). Conceptually, this test analyzes if parameters in different regimes are homogenous, i.e.,  $\lambda_1 = \lambda_2 = \dots = \lambda_k$ . Since this statistic does not follow the standard statistical distribution,  $p$ -values will be calculated based on the Monte Carlo method (300 replications).

According to these statistics in Table 5, the presence of thresholds is group-specific, and there is evidence of thresholds when developing countries are included. More precisely, there is evidence of one threshold for a group of non-advanced and non-euro member countries and two thresholds for a group consisting of all countries. In contrast, no evidence of thresholds is reported for advanced and euro member countries. Therefore, there is a sharp contrast among country groups.

Given this information, we re-examine international capital mobility only for the panel of country groups which include developing countries, and results from time-varying consumption are reported in Table 6. Three levels of consumption growth ( $\Delta c_{jL}$ ,  $\Delta c_{jM}$  and  $\Delta c_{jH}$ ) are shown where subscripts  $L$ ,  $M$  and  $H$  indicate growth associated with low, middle and high consumption growth respectively (i.e., Regimes 1, 2 and 3). As before, we obtain a strong positive correlation between consumption in one country with that of the rest, particularly when consumption

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<sup>16</sup>The threshold model which allows both  $c$  and  $DLR$  to be sensitive to regimes is also estimated, but we failed to obtain results due to a singularity problem.

growth is high. But it is interesting to note that a negative consumption correlation is found when consumption growth is low. This negative effect from developing countries is strong enough to bring about a negative correlation between  $\Delta c_i$  and  $\Delta c_j$  when their consumption growth is low and all countries (All) are considered. Together with the results in Table 4, this seems to be evidence that consumers in advanced (and euro-zone) countries can smooth abrupt consumption changes, although not completely, by utilizing access to other countries' resources at any time. In contrast, developing countries have less access to them particularly when their consumption growth is stagnated. With respect to *DLR* and *Oil* which are assumed to be linearly related to  $\Delta c_i$ , the result is generally consistent with that from a linear panel data model, but now the parameters are always statistically significant.

## 5 Conclusion

We assessed international capital mobility in the panel data context for advanced and developing countries based on Obstfeld's theoretical model (1994). The distinguishing features of this paper are 1) to utilize the data from a wide range of countries and 2) to consider the regime-sensitive relationship in the consumption correlation across countries. Given the high consumption correlation and the high correlation between consumption and domestic resources for advanced countries, we could not provide clear evidence that they have more/easier access to international capital markets than developing countries. However, there is a sharp difference between these two groups of countries when their consumption growth slows down. In particular, the opportunity of risk-sharing is rather limited when consumption growth is low in developing countries; a consumption correlation between developing countries and the rest of the world becomes negative. While we acknowledge that our model is open to criticism due to its simplicity, empirical results give useful information particularly when identifying heterogeneities between advanced and developing countries and imply that the correlation based approach yields statistical results more consistent with conventional expectations than the investment-savings approach.

## Appendix

Before estimating a panel threshold fixed effects model, the number of breaks needs to be determined. In this connection, Hansen (1999) has proposed the likelihood rate test with the maximum of three possible thresholds. For illustrative purposes, the null hypothesis of no threshold against the alternative of one threshold can be tested by the following statistics:

$$F_1 = (S_0 - S_1(\gamma))/\sigma^2 \tag{A.1}$$

where  $S_0$  and  $S_1$  are the sum of squared residuals from the model with zero and one threshold respectively, and  $\sigma^2 = S_1(\gamma)/N(T - 1)$ . The estimated value of  $\gamma$  corresponds to the minimum  $S_1(\gamma)$ . Since this statistic does not follow the standard statistical distribution, we shall calculate  $p$ -values based on the Monte Carlo method. In order to test the null of one threshold against two thresholds, we utilize  $S_1$  and  $S_2$  rather than  $S_0$  and  $S_1$  in (A.1) with the corresponding variance.

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Tables

**Table 1. A List of Countries**

Country	Advanced	Euro	Country	Advanced	Euro
Argentina			Luxembourg	*	*
Australia	*		Mauritius		
Austria	*	*	Mexico		
Belgium	*	*	Morocco		
Bolivia			Netherlands	*	*
Brazil			New Zealand	*	
Canada	*		Norway	*	
Colombia			Pakistan		
Congo, Dem. Rep.			Panama		
Costa Rica			Peru		
Cyprus	*	*	Philippines		
Denmark	*		Portugal	*	*
Egypt			Puerto Rico		
El Salvador			South Africa		
Ethiopia			Spain	*	*
Finland	*	*	Sri Lanka		
France	*	*	Sweden	*	
Guatemala			Switzerland	*	
Honduras			Thailand		
Iceland	*		Trinidad & Tobago		
India			Turkey		
Ireland	*	*	Uganda		
Israel	*	*	United Kingdom	*	
Italy	*	*	United States	*	
Japan	*		Uruguay		
Kenya			Venezuela		

Notes: Asterisks suggest that a country corresponds to a group of advanced countries (Advanced) or the euro area (Euro).

**Table 2. The Correlation with Consumption Growth ( $\Delta c_i$ )**

	All	Advanced	Non-advanced	Euro	Non-euro
$\Delta c_j$	0.123	0.326	0.073	0.380	0.093
$\Delta DRL$	0.512	0.650	0.492	0.720	0.495

Notes: The samples include all countries (All), advanced countries (Advanced), non-advanced countries (Non-advanced), euro member countries (Euro), and non-euro member countries (Non-euro).

**Table 3. Panel Unit Root Test Results**

	$\Delta c_i$	P-value	$\Delta c_j$	P-value	$\Delta DRL$	P-value
Levin-Lin-Chu	-24.439	0.000	-25.122	0.000	-22.076	0.000
Harris-Tzavalis	-130.000	0.000	-58.332	0.000	-130.000	0.000
Fisher-ADF	1273.993	0.000	1207.615	0.000	1242.793	0.000

Notes: All tests include country-specific effects and examine the null hypothesis of the unit root test against stationarity. The data are demeaned, and the lag length is equal to one. T-values are shown in the table, and P-values are shown in parentheses. The Fisher-ADF test follows modifications proposed by Choi (2001).

**Table 4. Panel Data Estimation Results (Full Sample)**

Explanatory variables		All	Advanced	Non-advanced	Euro	Non-euro
<b>OLS</b>						
$\Delta c_j$	para	<b>0.060</b>	<b>0.058</b>	<b>0.056</b>	<b>0.079</b>	<b>0.053</b>
	se	<b>0.011</b>	<b>0.009</b>	<b>0.019</b>	<b>0.014</b>	<b>0.014</b>
$\Delta DRL$	para	<b>0.013</b>	<b>0.026</b>	<b>0.011</b>	<b>0.024</b>	<b>0.012</b>
	se	<b>0.002</b>	<b>0.003</b>	<b>0.003</b>	<b>0.004</b>	<b>0.002</b>
$\Delta Oil$	para	0.001	<b>-0.001</b>	<b>0.002</b>	<b>-0.001</b>	<b>0.001</b>
	se	0.000	<b>0.000</b>	<b>0.001</b>	<b>0.001</b>	<b>0.001</b>
Const	para	<b>1.001</b>	<b>1.001</b>	<b>1.001</b>	<b>1.001</b>	<b>1.001</b>
	se	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>
H0: $\Delta c_j=1$ & $\Delta DRL=0$ (p-value)		<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>
H0: $\Delta c_j=0$ & $\Delta DRL=1$ (p-value)		<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>
<b>Fixed Effects</b>						
$\Delta c_j$	para	<b>0.063</b>	<b>0.063</b>	<b>0.058</b>	<b>0.081</b>	<b>0.056</b>
	se	<b>0.011</b>	<b>0.009</b>	<b>0.019</b>	<b>0.014</b>	<b>0.014</b>
$\Delta DRL$	para	<b>0.009</b>	<b>0.021</b>	<b>0.008</b>	<b>0.022</b>	<b>0.008</b>
	se	<b>0.002</b>	<b>0.003</b>	<b>0.003</b>	<b>0.005</b>	<b>0.002</b>
$\Delta Oil$	para	0.001	<b>-0.001</b>	<b>0.002</b>	<b>-0.001</b>	<b>0.001</b>
	se	0.000	<b>0.000</b>	<b>0.001</b>	<b>0.001</b>	<b>0.001</b>
Const	para	<b>1.001</b>	<b>1.001</b>	<b>1.001</b>	<b>1.001</b>	<b>1.001</b>
	se	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>
	sigma_μ	0.001	0.001	0.001	0.001	0.001
	sigma_ν	0.007	0.003	0.008	0.004	0.007
	rho	0.028	0.041	0.025	0.027	0.026
H0: $\Delta c_j=1$ & $\Delta DRL=0$ (p-value)		<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>
H0: $\Delta c_j=0$ & $\Delta DRL=1$ (p-value)		<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>
<b>Random Effects</b>						
$\Delta c_j$	para	<b>0.061</b>	<b>0.061</b>	<b>0.056</b>	<b>0.080</b>	<b>0.054</b>
	se	<b>0.011</b>	<b>0.009</b>	<b>0.019</b>	<b>0.014</b>	<b>0.014</b>
$\Delta DRL$	para	<b>0.012</b>	<b>0.024</b>	<b>0.010</b>	<b>0.023</b>	<b>0.011</b>
	se	<b>0.002</b>	<b>0.003</b>	<b>0.003</b>	<b>0.004</b>	<b>0.002</b>
$\Delta Oil$	para	0.001	<b>-0.001</b>	<b>0.002</b>	<b>-0.001</b>	<b>0.001</b>
	se	0.000	<b>0.000</b>	<b>0.001</b>	<b>0.001</b>	<b>0.001</b>
Const	para	<b>1.001</b>	<b>1.001</b>	<b>1.001</b>	<b>1.001</b>	<b>1.001</b>
	se	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>
	sigma_μ	0.001	0.000	0.001	0.000	0.001
	sigma_ν	0.007	0.003	0.008	0.004	0.007
	rho	0.009	0.022	0.006	0.008	0.008
H0: $\Delta c_j=1$ & $\Delta DRL=0$ (p-value)		<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>
H0: $\Delta c_j=0$ & $\Delta DRL=1$ (p-value)		<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>

Notes: The figures in bold face are statistically significant. More specific information about the significance of parameters (para) is shown with \*\* (1 percent), \* (5 percent) and + (10 percent). Standard errors (se) are also reported in the table. The null hypothesis,  $\Delta c_j=1$  &  $\Delta DRL=0$ , corresponds to perfectly open capital markets, and  $\Delta c_j=0$  &  $\Delta DRL=1$  to perfectly closed capital markets. The rho is a fraction of variance due to  $\mu$ .

**Table 5. Tests of Thresholds for Panel Data**

No of thresholds	All	Advanced	Non-advanced	Euro	Non-euro
1	<b>0.000</b>	0.993	<b>0.007</b>	0.183	<b>0.000</b>
2	<b>0.040</b>	0.080	0.213	0.340	0.120
3	0.287	0.520	0.890	1.000	0.453

Notes: Figures are Bootstrap p-values based on Hansen (1999). The boldfaced figures are statistically significant.

**Table 6. Panel Data Estimation with Thresholds**

Explanatory variables		All	Non-advanced	Non-euro
$\Delta c_{jH}$	para	<b>0.150</b>	<b>0.061</b>	<b>0.055</b>
	se	<b>0.050</b>	<b>0.018</b>	<b>0.013</b>
$\Delta c_{jM}$	para	<b>0.056</b>	--	--
	se	<b>0.011</b>	--	--
$\Delta c_{jL}$	para	<b>-0.146</b>	<b>-0.168</b>	<b>-0.192</b>
	se	<b>0.069</b>	<b>0.075</b>	<b>0.087</b>
$\Delta DRL$	para	<b>0.014</b>	<b>0.002</b>	<b>0.011</b>
	se	<b>0.004</b>	<b>0.001</b>	<b>0.004</b>
$\Delta Oil$	para	<b>0.001</b>	<b>0.011</b>	<b>0.001</b>
	se	<b>0.000</b>	<b>0.004</b>	<b>0.001</b>
Threshold points		1.005 1.018	1.018	1.019

Notes: The threshold variable is  $\Delta c_{it-1}$  and the threshold values are shown in the Threshold Points row. The  $c_{jH}$ ,  $c_{jM}$ , and  $c_{jL}$  indicate levels of consumption growth ( $c_j$ ) lower than the low threshold, within thresholds or those above the high threshold respectively. See also Tables 3 and 4.