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Explaining the Saving-Investment Relationship with Threshold Effects

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There have been many attempts to explain the unreasonably high correlation between domestic saving and investment rates. The threshold testing procedure developed by Hansen (1999) provides a framework for testing the effects of key variables relating to capital mobility in conjunction with the saving-investment relationship. Ho (2003) first applied this method to the saving-investment puzzle controlling for thresholds in country size. Extending this model, this paper reports a number of significant thresholds effects for country- size, trade and financial openness measures, age dependency ratios and trade balances. After controlling for threshold effects the relationship between savings and investment is found to be statistically insignificant. Additionally, controlling for the thresholds effects in a dynamic model of the current account allows for direct comparison between the savings-investment coefficient and adjustments to a country's external balance.

I. Introduction

Among a sample of OECD countries, Feldstein and Horioka (1980) (henceforth FH) find a high correlation between saving and investment rates. The authors test the relationship in a simple OLS framework, $I/Y=\alpha+\beta(S/Y)_i+\varepsilon_i$, where both variables are expressed relative to gross domestic product. FH interpret β as the saving retention coefficient used to measure capital mobility. If β is near one (zero) domestic saving is reinvested domestically and capital is immobile (mobile).

Previous attempts to solve the FH puzzle have focused on a single time-series or across panel of homogenous countries. The panels have usually been grouped by income level, country size, or differing measures of trade openness. The groupings are selected exogenously without regard to an optimal selection procedure. This paper builds on these previous attempts by grouping countries by an observable characteristic that can be statistically tested for regime changing or threshold effects. The saving coefficients are significantly lower, and insignificant from zero after controlling for regime changes in financial openness, trade openness, country size, age dependency ratios, and trade balances. These results suggest saving and investment regressions can provide intuition behind capital mobility when controlling for thresholds using variables that are correlated with greater levels of capital mobility.

Extending an error correction model first used by Jansen (1996) in the saving-investment literature makes the results directly relatable to a country's current account balance. As the saving coefficient approaches zero, a change in the savings rate corresponds to a one for one change in the current account balance, domestic savings is being reinvested abroad. Furthermore, a reduction in the savings coefficient is correlated with a more persistent external balance. A change in the saving rate when the savings coefficient is near unity has no affect on a country's current account balance. These results have important policy implications, especially for countries concerned about large current account deficits.

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This paper is organized as follows: Section II reviews the literature related to the FH puzzle, section III is devoted to explaining the econometric methodology, section IV explains the data and results, and finally, section V concludes.

II. Literature Review

There has been a healthy debate questioning the approach FH used to test for capital mobility. Instead of using variables that measure the demand and supply of capital flows, FH test the relationship between domestic investment and saving rates which ignores interest rate differentials between countries. Their findings of no capital mobility were very surprising. The ending of Bretton Woods started a movement where countries adopted floating exchange rate regimes and removed capital controls to encourage international investment. The high correlation between saving and investment rates has been named one of the six puzzles within international macroeconomics by Obstfeld and Rogoff (2000).

The saving-investment puzzle has been extended to different samples by applying FH regressions to measure capital mobility.[1] Researchers undertook confirmatory analysis by testing the relationship in settings for which capital is expected to be highly mobile. This included grouping countries by levels of trade openness and country-size. AmirKhalkhali and Dar (2007) find no systematic relationship between trade openness and capital mobility. Tobin (1983), Baxter (1993), and Ho (2003) control for country-size. Coakley et al. (1999), Kasuga (2004), Payne and Kumazawa (2006) find saving coefficients decrease for lower income countries. Bahmani-Oskooee and Chakrabarti (2005) control for openness and country size. Vamvakidis and Wacziarg (1998) control for openness and population growth. The above papers succeed in reducing the savings coefficient, but the coefficient remains positive and statistically significant.

Recently the emphasis has shifted away from using saving and investment rates as a measure of capital mobility into modeling the adjustment behavior of a country's current account imbalance. The current account is saving less investment, thus a strong correlation can be explained by a binding long-run budget constraint (Sinn 1992, Coakley, et al. 1996, and Taylor 2002). In the long run a country cannot sustain growing current account imbalances. Eventually investment will decrease or saving will increase, both variables will converge to a sustainable current account balance. This will result in a high correlation between saving and investment rates. The long-run relationship has been modeled in an error correction framework (Jansen 1996), dynamic panel model (Coakley et al. 2004), panel cointegration tests (Banerjee and Zanghieri 2003), mean group estimators (Coakley 1996), and autoregressive distributive lag estimators (Corbin 2004).

This paper provides two main contributions. First, using a procedure developed by Hansen (1999) this paper shows previous results are biased upward by ignoring multiple regime changes. Threshold effects are superior to other methods which exogenously divide the data into arbitrary groupings. Fouquau et al. (2007) use a panel smoothing threshold approach to test the saving-investment relationship. They test the relationship for 24 OECD countries using trade openness, country size, current account balance, and age dependency ratios. This paper focuses on the changing relationship across income levels and includes additional variables that are important for measuring capital mobility. Second, the saving coefficient has important policy implications as it measures a country's ability to run a sustained current account imbalance. Extending the thresholds to a dynamic model of the current account allows for countries to better understand the speed of adjustments mechanism in relationship to the threshold break points.

[1] For a complete literature review see Coakley et al (1996) or Apergis and Tsoumas (2009).

III. Methodology

Hansen (1999) provides the framework for testing if threshold effects are present. Within the literature it is common place to exogenously group countries by trade openness, financial openness, and country size. The threshold procedure will endogenously group countries together by finding the optimal break in a particular threshold variable. In addition to testing the standard variables both trade balances and age dependency ratios are also tested for threshold effects.

A. Threshold Effects

Following Hansen (1999), threshold effects are tested in a fixed-effect framework.[2] The first step is to determine the appropriate number of thresholds (or regime switches) for each variable. The restricted model with no threshold effects is first estimated:

$$i_{it} = \alpha_i + \beta s_{it} + e_{it} \tag{1}$$

where $i = 1, ..., N$, $t = 1, ..., T$, $i_{it} = (I / GDP)$, and $s_{it} = (S / GDP)$. The next step in finding the optimal threshold value is to estimate an unrestricted regression that splits the data into regimes according to all possible threshold values. The optimal threshold value is selected as it minimizes the residual sum of squares in the following regression:

$$i_{it} = \alpha_i + \beta_1 s_{it} I(q_{it} \le \gamma) + \beta_2 s_{it} I(q_{it} > \gamma) + e_{it} \tag{2}$$

where q_{it} is a scalar threshold variable and $I(\cdot)$ is the indicator function that takes a value of one when the threshold condition in the bracket is satisfied, zero otherwise. The error term is assumed to be independent and identically distributed with mean zero and finite variance σ^2 .

Instead of searching continuously over all possible threshold values the search is limited to the following quantiles {10%, 10.25%, 10.5%, 10.75%, 11%,..., 90%}. The bottom and top tenth percentiles are omitted during the grid search. Trimming the sample will remove the possibility of the results being driven by extreme outliers. After selecting the optimal threshold value it is important to determine if a threshold effect is statistically significant. The null hypothesis of no threshold effect is

$$H_0 : \beta_1 = \beta_2. \tag{3}$$

$\beta_1 = \beta_2$ is tested by a likelihood ratio test. Under the null hypothesis γ is not identified thus Hansen suggests a bootstrapping procedure to simulate the asymptotic distribution of the likelihood ratio test:

[2] The Hansen procedure is only applicable for fixed effects and does not extend to testing for random effects. The threshold estimation procedure is conducted using data in mean deviation form (within estimation) and it is not clear how to test for random effects.

$$F_1 = \frac{S_0 - S_1(\hat{\gamma})}{\sigma^2} \quad (4)$$

where $\sigma^2 = \frac{1}{n(T-1)} S_1(\hat{\gamma})$, S_0 are the sum of squared errors from the restricted regression and $S_1(\hat{\gamma})$ are the sum of squared errors from the unrestricted regression. The null hypothesis of no threshold effect is rejected for large values of the likelihood ratio. Once the single threshold is estimated the process extends to models with double and triple threshold break points.

To determine the second threshold break, the following model is estimated:

$$i_{it} = \alpha_i + \beta_1 s_{it} I(q_{it} \le \gamma_1) + \beta_2 s_{it} I(\gamma_1 < q_{it} \le \gamma_2) + \beta_3 s_{it} I(\gamma_2 < q_{it}) + e_{it} \quad (5)$$

The second threshold is selected to minimize the joint sum of squares taking the first threshold as given. In order to ensure sufficiently large samples within each regime the second break point is restricted to be at least 10 percentile points larger or smaller than the first threshold value.

Instead of testing for the existence of a threshold the likelihood ratio test for a second threshold effect is:

$$H_0 : \beta_1 = \beta_2 = \beta_3. \quad (6)$$

Bai (1999) shows that the second threshold is asymptotically efficient opposed to the first threshold. Bai suggests a refinement estimator to fix the second threshold and then re-estimate the first threshold. If a second threshold effect is found statistically significant then a third threshold effect is estimated. A bootstrapping procedure is used to construct asymptotically valid p-values and critical values for the likelihood ratio test. One thousand bootstrap replications are used for each threshold variable. A threshold break is deemed statistically significant if the p-value is less than 0.10.

The next step is to estimate the saving and investment relationship for each threshold. Country fixed-effects are implemented to control for exogenous shocks while time fixed-effects are used to control for business cycle effects. To control for income effects the data are split into different sub-samples by real GDP per capita: high income countries include those with average income levels greater than $9,000, middle income countries include countries with average real income between $3,000 and $9,000, and low income countries have an average real income less than $3,000.

It is reasonable to suspect the threshold values will be different across income levels. For example, high income countries have more developed financial systems and offer similar rates of return on investments. The separation of saving and investment rates is likely to stem from domestic saving decisions pertaining to the demographics of a particular country. Middle income countries tend to be more risky and do not have the domestic resources for financing readily available. These countries are forced into using the global capital markets where variables such as trade openness, financial openness, and trade balances will play a large role in foreign investment decisions. Middle income countries tend to have high saving Asian economies mixed with Eastern European, Latin American, and some African economies. Finally, lower income countries have an entirely unique set of issues. These countries do not have developed financial systems and it is highly likely the threshold variables being tested in this paper will not offer a great insight into the explanation of the saving-investment relationship.

B. Current Account

A number of explanations have been given for the existent of a high correlation between saving and investment rates. A widely held explanation to the puzzle revolves around a country's current account imbalance. Over time countries are restricted in their ability to run continual current account imbalances,

this directly implies saving and investment rates will move together over time.[3] A natural extension in the saving-investment literature was to test for cointegration between both variables. Jansen (1996) first incorporated an error correction model (ECM) to test the long-run saving-investment relationship. Unfortunately, Hansen's procedure does not allow for lagged dependent variables. In order to circumvent this issue the thresholds parameters estimated in the previous section will be applied to Jansen's ECM:

$$\Delta i_t = \alpha + \beta \Delta s_t + \gamma (s_{t-1} - i_{t-1}) + \varepsilon_t \tag{7}$$

where $i = I / Y$ and $s = S / Y$. The ECM incorporates both short-run and long-run dynamics. In terms of the saving-investment relationship an ECM measures how annual changes in saving rates affect investment rates through β, and the speed of adjustment for a country's current account imbalance, γ. Although incorrect, it is commonly assumed the error correction model can only be used if both saving and investment rates are non-stationary. The vector error correction model in equation (7) is a more restricted version of a general autoregressive distributed lag model. The more general ADL(1,1) model does not require the variables to be non-stationary.[4]

Using the error correction model and national accounting identities that show the current account is the difference between saving and investment, testing for thresholds in the saving-investment regression will explain changes in current account balances. By subtracting Δs_t from both sides the equation can be adjusted to show the long run relationship of the current account:

$$\Delta i_t - \Delta s_t = \alpha + \beta \Delta s_t - \Delta s_t + \gamma (s_{t-1} - i_{t-1}) + \varepsilon_t . \tag{8}$$

Rearranging equation 8 and using the current account identity the long-run current account is:

$$\Delta ca_t = \tilde{\alpha} + \tilde{\gamma} ca_{t-1} + \tilde{\theta} \Delta s_t + \varepsilon_t \tag{9}$$

where $ca_t = CA / Y = S / Y - I / Y$, $\tilde{\alpha} = -\alpha$, $\tilde{\theta} = (1 - \beta)$, and $\tilde{\gamma} = -\gamma$. The speed of adjustment in the current account can be measured by γ. The half-life of current account imbalances, the time it takes for an imbalance to be cut in half, is equivalent to $\ln(.5) / \ln(1 + \tilde{\gamma})$. Equation (9) allows for a direct comparison between the saving coefficients and the current account. If the saving coefficient β equals 1 a change in domestic saving rates leaves the current account unchanged. As the coefficient approaches zero a change in domestic saving is invested abroad causing an increase in the current account. The above model is an extension of Taylor (2002) which he suggests a basic AR(1) model to evaluate the speed at which the current account moves back to its equilibrium value. Taylor's equation assumes θ=0.

IV. Data and Results

National accounting data are from the Penn World Table 6.2 (Heston and Summers 2006). The data set is a balanced panel with 137 countries from 1970 through 2003. Saving rates are calculated as the residual of GDP less household consumption and government expenditures. Investment rates include

[3] A large subset of the saving-investment literature focuses on the time-series properties of saving and investment rates. Both variables are usually found to be non-stationary despite being expressed in a ratio to gross domestic product.

[4] For this case the general ADL(1,1) model is: $i_t = \alpha + \beta s_t + (\gamma - \beta) s_{t-1} + (1 - \gamma) i_{t-1} + \varepsilon_t$.

private residential and gross fixed capital investment. Country size is measured as country i's GDP relative to the mean of the world's GDP for each year. Trade openness is the sum of exports and imports relative to GDP. Trade balance is exports less imports relative to GDP. Age dependency variables are from the World Bank and measure the percent of a country's population between 0-14 and over 65. The financial openness variable is the sum of external assets and liabilities relative to GDP. These data are from Lane and Milesi-Ferretti (2006).[5] Middle Eastern countries and Luxembourg are excluded.[6]

The key threshold variables reported in this paper are trade and financial openness, country size, age dependency ratios, and trade balance. The saving coefficients should decrease for smaller, open countries.. This hypothesis is well documented in the literature (see Ho 2003, Baxter 1993, Bahmani-Oskooee and Chakrabarti 2005, and Coakley 2004). Trade balances are directly related to the current account and capital inflows. Higher levels of trade imbalances correspond with greater current account imbalances which results in a lower saving and investment relationship. Countries with a large fraction of their population over 65 year should have higher savings coefficient, while countries with a large fraction of the population below 14 years should have lower savings coefficient. Countries with large numbers of retirees, domestic saving must finance retirement accounts, investment decisions will tend to focus on safer assets located at home. These countries will also have a greater stock of saving and will not need to resort to global capital markets for funding. Conversely, countries with a younger population can make investment into more risky assets and seek out the highest global returns. Additionally, following the life-cycle hypothesis countries with higher measures of younger dependents will have fewer saving and be forced to borrow from global markets. (Herbertsson and Zoega 1999).

A. Threshold Effects

Table 1 provides the results testing for threshold effects and reports the p-values for all samples. As expected there are a number of statistically significant thresholds. Using the entire sample of countries trade openness and younger age dependency ratios have one threshold above the median quantile and at the median quantile, respectively. Two thresholds are found significant for financial openness, country-size, and older age dependency ratios. Financial openness thresholds occur below the median and at the 75th quantiles; country-size thresholds occur above the median and below the 25th quantiles; older age dependency ratios exhibit thresholds above the 75th and below the median quantiles. Trade balance has three significant thresholds above the 75th, and below the median and 25th quantiles, respectively.

Low income countries only have two variables with significant thresholds. One threshold is found significant in financial openness and two thresholds are significant in trade balances. The threshold in financial openness occurs around the median value, whereas the threshold values in trade balances are occurring near the extreme minimum and maximum values.[7]

Middle income countries have a number of significant thresholds. Two significant thresholds are found for trade openness at the median and 75th quantiles; financial openness below the 25th and above the 75th quantiles; and country size above the 75th and between the 25th and median quantiles. Three significant thresholds are found for trade balance above the 75th, at the 25th, and below the 25th quantiles; younger age dependency ratios at the median and below the 25th quantiles; and older age dependency ratios above the 75th and below the 25th quantiles.

[5] Lane and Milesi-Ferretti have data for 88 countries from 1975 to 2003.

[6] In order to minimize short term fluctuations from the threshold variables frequently moving across the break point each variable is tested using four year rolling averages. The results are consistent without using rolling averages.

[7] Double threshold break points are only estimated when the first threshold is also significant. The double threshold model operates under the assumption that one significant threshold must also be significant. This result occurs for thresholds in country-size.

Table1: Threshold Test Results – P-Values

	Threshold	All Countries	Low Income	Middle Income	High Income
	Single	0.000	0.377	0.000	0.000
Trade Openness	Double	0.215	0.264	0.001	0.275
	Triple	0.425	0.496	0.107	0.310
	Single	0.000	0.005	0.000	0.000
Financial Openness	Double	0.046	0.211	0.068	0.218
	Triple	.0194	0.234	0.257	0.269
	Single	0.000	0.008	0.000	0.000
Trade Balance	Double	0.032	0.085	0.000	0.000
	Triple	0.002	0.354	0.000	0.518
	Single	0.000	0.270	0.000	0.000
Country Size	Double	0.063	0.021	0.053	0.091
	Triple	0.231	0.349	0.009	0.219
	Single	0.000	0.190	0.000	0.000
Pop ages 0-14	Double	0.216	0.180	0.005	0.013
	Triple	0.376	0.382	0.006	0.066
	Single	0.000	0.363	0.000	0.000
Pop ages 65+	Double	0.042	0.195	0.000	0.092
	Triple	0.190	0.289	0.005	0.290

Complete tests results are available from the author upon request
P-values are obtained from 1000 bootstrap replications

Table 2: Summary Statistics

	Income Level	Min	25th Percentile	Median	75th Percentile	Max
Trade Openness	All	0.02	0.43	0.60	0.95	3.99
	Low	0.02	0.38	0.57	0.81	2.33
	Mid	0.06	0.43	0.57	0.93	2.18
	High	0.08	0.48	0.71	1.14	3.09
Financial Openness	All	0.07	0.64	1.01	1.56	17.95
	Low	0.07	0.51	0.93	1.37	4.99
	Mid	0.12	0.64	0.93	1.33	14.98
	High	0.21	0.75	1.24	2.28	17.90
Trade Balance	All	-120.80	-10.00	-3.42	0.62	37.90
	Low	-120.80	-17.26	-8.46	-2.08	28.92
	Mid	-46.04	-7.11	-3.35	0.12	24.97
	High	-23.05	-2.32	0.12	2.71	37.90
Country Size	All	0.00	0.03	0.13	0.77	39.88
	Low	0.00	0.01	0.04	0.12	19.63
	Mid	0.00	0.08	0.23	0.93	6.05
	High	0.01	0.12	0.66	2.02	39.88
Pop ages 0-14	All	14.19	28.68	41.29	44.90	50.36
	Low	23.80	42.39	44.66	46.29	50.36
	Mid	17.39	35.46	40.80	44.37	49.37
	High	14.19	19.62	23.26	27.84	44.78
Pop ages 65+	All	1.68	3.09	3.99	7.17	18.78
	Low	1.68	2.79	3.16	3.59	7.08
	Mid	2.08	3.28	4.00	4.89	13.95
	High	2.52	8.36	11.28	14.05	18.78

High income countries have one significant threshold for trade openness at the median quantile; financial openness below the 25th quantile; and country size between the 25th and median quantiles. Two significant thresholds are found in trade balances above the 75th and below the 25th quantiles; and older age dependency ratios at the median and below the 25th quantiles. Younger age dependency ratios have three significant thresholds at the 25th and above the 75th percentile.

In summary, low income countries have the fewest number of thresholds whereas middle income countries tend to have the most statistically significant thresholds. There are a few reasons that can explain these results. First, low income countries tend to have weak financial systems, large amounts of foreign aid, and poor governments that are not accounted for in the estimation procedure. These variables are more likely to explain the low correlation between saving and investment rates, not age dependency ratios, country-size, and openness measures. Middle income countries tend to span across diverse regions which include emerging Latin American, Asian, and Eastern European economies. These countries have attracted large amounts of foreign capital but have vastly different demographic factors (e.g. Asian economies are notably for high levels of capital mobility with high saving rates combined with large percentage of the population over 65). It is not surprising to find a number of different thresholds given the diverse countries in the sample. Finally, higher income countries are generally larger and more closed. The threshold variables have smaller variances which help to explain why fewer threshold breaks exist.

B. Regression Results

Tables 3 through 6 present the results for the panel regressions controlling for each threshold break and report the threshold values, savings coefficients, and standard errors for regressions that include both time and country fixed-effects.

Table 3 presents the results when all countries are tested for threshold effects. The saving coefficient without the presence of threshold effects is 0.153 and significant at the one-percent level. Countries that are relatively closed and have a large economy are considered the driving force behind high saving investment correlations. The most open countries have a savings coefficient of 0.063; meanwhile relatively closed countries have a much higher savings coefficient of 0.331. Country-size has a coefficient of 0.031 for the smaller countries in the 25th quantile and a coefficient of 0.597 for large countries above the 75th quantile. This confirms previous hypotheses that large, closed countries are the motivating cause behind high saving coefficients. The most financially open countries have a saving coefficient insignificant from zero, and the least open countries have a coefficient of 0.392. As expected the lowest saving coefficients correspond to the most financially open countries which implies these countries have the greatest degree of capital mobility.

A country's trade balance also provides intuition for the higher saving coefficients. Countries that have large trade surpluses or extremely large trade deficits have a savings coefficient that is statistically insignificant. Countries with a higher number of younger dependents have low saving coefficient of 0.086, but the coefficient increases to 0.369 for countries with a higher percentage of older dependents.

The results are different when the sample is split by income levels. Table 4 provides the results for low income countries. When pooling across low income countries the saving coefficient is 0.109 and statistically significant at the one-percent level. Only the results for which a threshold was found statistically significant are reported. Countries that have a financial openness measure above the median value are consider open and have a savings coefficient of 0.005. Countries that do not run large trade imbalances have the largest savings coefficient of 0.217. The coefficients reported for low income countries are lower compared to middle and high income countries. This is likely caused by a number of factors that have been previously mentioned.

Table 3: Regression Estimates with Threshold Estimates (All Countries)

Threshold Variable	Regressor	N-Fixed Effects		N and T- F.E.	
		β_i	S.E	β_i	S.E
Saving Rates	$S_{i,t}$	0.153***	0.016	0.158***	0.016
Trade Openness	$S_{i,t}I(x_{it}>0.713)$	0.063***	0.0.21	0.090***	0.022
	$S_{i,t}I(x_{it}\leq 0.713)$	0.331***	0.022	0.288***	0.022
Financial Openness	$S_{i,t}I(x_{it}>1.38)$	0.033	0.057	0.044	0.059
	$S_{i,t}I(0.794<x_{it}\leq 0.713)$	0.146***	0.035	0.128***	0.035
	$S_{i,t}I(x_{it}\leq 0.794)$	0.392***	0.043	0.319	0.043
Trade Balance	$S_{i,t}I(x_{it}>2.76)$	-0.124**	0.052	-0.093	0.053
	$S_{i,t}I(-7.56<x_{it}\leq 2.76)$	0.002***	0.040	0.197***	0.042
	$S_{i,t}I(-15.5<x_{it}\leq -7.56)$	0.222***	0.033	0.218***	0.035
	$S_{i,t}I(x_{it}\leq -15.5)$	-0.037	0.026	-0.020	0.024
Country Size - GDP	$S_{i,t}I(x_{it}>.495)$	0.597***	0.031	0.573***	0.029
	$S_{i,t}I(0.027<x_{it}\leq 0.495)$	0.174***	0.022	0.150***	0.021
	$S_{i,t}I(x_{it}\leq 0.027)$	0.031	0.025	0.059	0.025
Population 0-14	$S_{i,t}I(x_{it}>40.3)$	0.086***	0.020	0.089***	0.020
	$S_{i,t}I(x_{it}\leq 40.3)$	0.335***	0.021	0.338***	0.020
Population 65+	$S_{i,t}I(x_{it}>11.9)$	0.698***	0.036	0.581***	0.034
	$S_{i,t}I(3.38<x_{it}\leq 11.9)$	0.188***	0.021	0.202***	0.020
	$S_{i,t}I(x_{it}\leq 3.38)$	0.070***	0.025	0.064***	0.024

***,**,* denote statistical significance at the 1,5,and 10 percent level.

Table 4: Regression Estimates with Threshold Estimates (Low Income Countries)

Threshold Variable	Regressor	N-Fixed Effects		N and T- F.E.	
		β_i	S.E	β_i	S.E
Saving Rates	$S_{i,t}$	0.109***	0.024	0.120***	0.024
Financial Openness	$S_{i,t}I(x_{it}>1.19)$	0.005	0.041	-0.015	0.041
	$S_{i,t}I(x_{it}\leq 1.19)$	0.205***	00.64	0.169***	0.063
Trade Balance	$S_{i,t}I(x_{it}>3.00)$	0.120	0.083	0.127	0.082
	$S_{i,t}I(-26.6<x_{it}\leq 3.00)$	0.217***	0.023	0.224***	0.024
	$S_{i,t}I(x_{it}\leq -26.6)$	-0.088**	0.041	-0.070	0.042

***,**,* denote statistical significance at the 1,5,and 10 percent level.

Table 5 presents the results for middle income countries. The savings coefficient is 0.245 and significant at the one-percent level. The coefficient is higher than both the entire sample and low income countries, but have more threshold effect that show periods of perfect capital mobility. The saving coefficients are insignificant for countries with values of trade openness, financial openness, trade balance, and younger age dependency ratios greater than the highest threshold values. Additionally, the coefficient is insignificant for countries with measures of country-size and older dependency ratios that are lower than the lowest threshold values. In other words, capital is perfectly mobile for small economics, countries with high measures of trade and financial openness, large trade imbalances, larger percentages of young dependents, and lower ratios of older dependents.

Equally important, variables that exhibit multiple threshold breaks have saving coefficients that increase in magnitude. For example, as countries become more closed the saving coefficient increases from -0.022 for the most open economies to 0.563 for the most closed economies. A similar result exists as countries increase in size. Small economies have a savings coefficient of -0.005, medium economies

0.528, and large economies display little evidence of perfect capital mobility with a savings coefficient of 0.712. A similar pattern is also present for age dependency ratios. These results confirm not only when countries have perfect capital mobility, but also what conditions restrict capital mobility and the degree to which capital flows are restricted.

Table 5: Regression Estimates with Threshold Estimates (Middle Income Countries)

Threshold Variable	Regressor	N-Fixed Effects		N and T- F.E.	
		β_i	S.E	β_i	S.E
Saving Rates	$S_{i,t}$	0.245***	0.024	0.254***	0.022
Trade Openness	$S_{i,t}I(x_{it}>0.971)$	-0.022	0.028	0.038	0.027
	$S_{i,t}I(.645<x_{it}\leq.971)$	0.224***	0.053	0.214***	0.051
	$S_{i,t}I(x_{it}\leq.645)$	0.563***	0.029	0.527***	0.031
Financial Openness	$S_{i,t}I(x_{it}>1.63)$	0.088	0.129	0.113	0.128
	$S_{i,t}I(0.712<x_{it}\leq1.63)$	0.121***	0.046	0.136***	0.048
	$S_{i,t}I(x_{it}\leq0.712)$	0.627***	0.051	0.523***	0.052
Trade Balance	$S_{i,t}I(x_{it}>2.77)$	-0.026	0.069	-0.017	0.068
	$S_{i,t}I(-7.73<x_{it}\leq2.77)$	0.407***	0.058	0.343***	0.057
	$S_{i,t}I(-12.4<x_{it}\leq-7.73)$	0.197***	0.049	0.222***	0.027
	$S_{i,t}I(x_{it}\leq-12.4)$	-0.137	0.028	-0.103	0.027
Country Size - GDP	$S_{i,t}I(x_{it}>1.08)$	0.712***	0.058	0.706***	0.057
	$S_{i,t}I(.159<x_{it}\leq1.08)$	0.528***	0.034	0.487***	0.033
	$S_{i,t}I(x_{it}\leq.159)$	-0.005	0.024	0.028	0.023
Population 0-14	$S_{i,t}I(x_{it}>40.9)$	0.035	0.027	0.056	0.026
	$S_{i,t}I(32.3<x_{it}\leq40.9)$	0.379***	0.037	0.368***	0.034
	$S_{i,t}I(x_{it}\leq32.3)$	0.656***	0.040	0.650***	0.036
Population 65+	$S_{i,t}I(x_{it}\leq7.19)$	0.627***	0.043	0.540***	0.038
	$S_{i,t}I(3.21<x_{it}\leq7.19)$	0.318***	0.029	0.349***	0.027
	$S_{i,t}I(x_{it}\leq3.21)$	-0.091***	0.030	-0.098***	0.028

***,**,* denote statistical significance at the 1,5,and 10 percent level.

Table 6: Regression Estimates with Threshold Estimates (High Income Countries)

Threshold Variable	Regressor	N-Fixed Effects		N and T- F.E.	
		β_i	S.E	β_i	S.E
Saving Rates	$S_{i,t}$	0.414***	0.028	0.154***	0.024
Trade Openness	$S_{i,t}I(x_{it}>0.738)$	-0.035	0.026	0.035	0.023
	$S_{i,t}I(x_{it}\leq0.738)$	0.893***	0.034	0.658***	0.038
Financial Openness	$S_{i,t}I(x_{it}>0.618)$	0.062	0.039	0.063*	0.034
	$S_{i,t}I(x_{it}\leq0.618)$	0.722***	0.063	0.632***	0.061
Trade Balance	$S_{i,t}I(x_{it}>4.90)$	-0.099***	0.037	0.020	0.032
	$S_{i,t}I(-8.36<x_{it}\leq4.90)$	0.471***	0.042	0.354***	0.037
	$S_{i,t}I(x_{it}\leq-8.36)$	-0.133	0.065	-0.034	0.061
Country Size	$S_{i,t}I\ (x_{it}>0.423)$	0.708***	0.040	0.503***	0.043
	$S_{i,t}I\ (x_{it}\leq.423)$	-0.022	0.027	0.055**	0.025
Population 0-14	$S_{i,t}I\ (x_{it}>30.8)$	-0.108	0.066	-0.139***	0.054
	$S_{i,t}I\ (19.7<x_{it}\leq30.8)$	0.288***	0.071	0.203***	0.056
	$S_{i,t}I\ (x_{it}\leq19.7)$	0.787***	0.064	0.564***	0.059
Population 65+	$S_{i,t}I\ (x_{it}\leq11.4)$	0.631***	0.062	0.443***	0.050
	$S_{i,t}I\ (6.54<x_{it}\leq11.5)$	0.142***	0.037	0.241***	0.029
	$S_{i,t}I\ (x_{it}\leq6.54)$	-0.059	0.045	-0.053	0.039

***,**,* denote statistical significance at the 1,5,and 10 percent level.

Table 6 presents the results for high income countries. The savings coefficient without threshold effects is 0.141 and significant at the one-percent level. The coefficients for all variables appear as expected. The saving coefficients are statistically insignificant from zero when countries are within the upper thresholds of trade openness, financial openness, trade balance, and the younger age dependency ratios and within the lower thresholds of country size, trade balance, and older age dependency ratios. These results are very similar to those found for middle income countries. Smal, open countries with high ratios of younger dependents, and low ratios of older dependents are likely to have greater measures of capital mobility.

High income countries are able to rely on internal financing and not global capital markets. This is evident by saving coefficients approaching one for relatively large, closed economies with large percentages of older residents. The threshold value for trade openness is near the median value, which suggests all countries below the median value of trade openness have a savings coefficient near one, 0.893. Countries in the upper half of the distribution for country size and upper third for population have saving coefficients of 0.708 and 0.728, respectively. Reiterating, high income countries have regimes of perfect and imperfect capital mobility.

In summary, the coefficients for trade openness, financial openness, country size, and age dependency ratios appear as expected in all samples. Small open economies have saving coefficients near zero while large closed countries have coefficients closer to unity. Countries with a larger percentage of younger dependents have perfect capital mobility; meanwhile as countries age capital mobility slows drastically. These results are amplified as income levels increase, providing more evidence economies are investing domestic savings into retirement accounts. Furthermore, countries with higher ratios of younger dependents will have lower levels of savings and are more likely to resort to external financing for domestic projects. As income levels increase not only do the result show cases for perfect capital mobility but also display evidence of imperfect capital mobility. For lower income countries appropriately modeling capital mobility should include added measures reflecting governance, property rights, stability, and foreign aid.

C. Current Account Dynamics

Understanding the determinants of the saving and investment relationship is important as it pertains to measuring capital mobility and a country's current account balance. Tables 7 through 10 present the results for equation (9). The results confirm the saving coefficient relates to a country's ability to run persistent current account balances. From equation (10) Taylor (2002) argues β is a summary statistic measuring the convergence speed of the current account. For high values of β (in absolute value) the country experiences short lived current account imbalances and have difficulty smoothing external shocks. The error variance term (σ) measures shocks to the current account. A large (small) variance suggests countries are more (less) vulnerable to external disturbance in the current account.

The results for the entire sample are presented in table 7. Comparing across tables 3 and 7 shows a strong correlation between a lower savings coefficient ($\beta = 0$ or $\theta = 1$) and more persistent (small γ), and volatile (high σ) current account balances. When a country's level of trade openness falls into the highest threshold the current account balance has a half-life of 10.1 years compared to a half-life of 5.0 years when trade openness is in the lower threshold.[8] Increased persistence in current account imbalances corresponds with lower saving coefficients. The saving coefficients in each of these regimes are 0.063 and 0.331, respectively. Financially open countries have a half-life of 5.7 years with a saving coefficient of 0.033, but financial closed countries have a half-life of 2.4 years with a saving coefficient

[8] Half-life is defined as the period in which it takes the current account imbalance to halve.

of 0.392. Additionally, small countries are able to run current account balances with a half-life of 10.6 years, but large countries experience a half-life of 2.3 years. The saving coefficient increases from 0.031 for the smaller economics to 0.597 for larger economies.

There is also a strong relationship between low saving coefficients and more volatile current account balances measured by σ. For all variables the lower saving coefficients correspond with greater current account volatility and higher persistence. Regimes where countries experience prolonged imbalances (e.g. high measures of trade openness or small economies) are more prone to external shocks (σ increases).

The results presented in Tables 4 and 8 show a similar relationship between the saving coefficients and the statistics relating to the current account for low income countries. There is a strong correlation between lower saving coefficients and greater current account persistence. For example, high values of financial openness have a savings coefficient of 0.005 and a current account half-life of 10.3 years. Whereas low values of financial openness have a savings coefficient of 0.205 and a current account half-life of 4.3 years. Countries that have trade balances in the highest threshold have the shortest current account half-life of 3.1 years.

The results for middle income countries are presented in Tables 5 and 9. Middle income countries appear to have less persistent current account imbalances (high measures of γ) when compared to low

Table7: Current Account Dynamics – Pooled across all countries

	Threshold	γca_{t-1}	S.E.	$\theta \Delta s_t$	S.E.	σ	R^2	T
Current Account	ALL	-0.077***	0.012	1.000***	0.020	0.027	0.762	4191
Trade Openness	High	-0.066***	0.016	1.040***	0.028	0.035	0.821	1682
	Low	-0.128***	0.014	0.925***	0.020	0.026	0.747	2508
Financial Openness	High	-0.0113**	0.050	1.109***	0.064	0.031	0.738	852
	Middle	-0.164***	0.027	0.919***	0.039	0.022	0.709	939
	Low	-0.252***	0.032	0.829***	0.033	0.021	0.538	933
Trade Balance	High	-0.210***	0.043	0.965***	0.048	0.034	0.799	635
	Upper Mid	-0.293***	0.026	0.834***	0.023	0.027	0.685	2153
	Lower Mid	-0.232***	0.037	0.866	0.034	0.028	0.814	741
	Lowest	-0.037	0.022	1.121***	0.034	0.040	0.900	659
Country Size GDP	High	-0.220***	0.025	0.836***	0.046	0.025	0.519	1355
	Middle	-0.099***	0.013	0.959***	0.019	0.026	0.806	1776
	Low	-0.047**	0.020	1.068***	0.032	0.035	0.852	1058
Population 0-14	High	-0.066***	0.016	1.037***	0.022	0.031	0.840	2285
	Low	-0.139***	0.016	0.856***	0.037	0.029	0.614	1905
Population 65+	High	-0.171***	0.036	0.0617***	0.088	0.017	0.333	520
	Middle	-0.092***	0.019	1.005***	0.034	0.033	0.765	2220
	Low	-0.065***	0.015	1.007***	0.020	0.028	0.847	1449

***,**,* denote statistical significance at the 1,5,and 10 percent level.

Table 8: Current Account Dynamics – Pooled across low income countries

	Threshold	γca_{t-1}	S.E.	$\theta \Delta s_t$	S.E.	σ	R^2	T
Current Account	ALL	-0.048***	0.008	1.074***	0.012	0.027	0.848	1749
Financial Openness	High	-0.065***	0.029	1.018***	0.028	0.019	0.907	299
	Low	-0.149***	0.039	0.895***	0.050	0.010	0.686	586
Trade Balance	High	-0.209***	0.043	1.073***	0.048	0.039	0.845	160
	Middle	-0.070***	0.011	0.987***	0.013	0.023	0.850	1324
	Low	-0.046**	0.021	1.190***	0.028	0.040	0.909	263

***,**,* denote statistical significance at the 1,5,and 10 percent level.

and high income countries. Middle income countries are better suited to smooth external shocks. Countries that are relative open and have small economies are able to run persistent current account balances. Countries in the upper regime of trade openness experience a current account half-life of 8.7 years, whereas closed economies experience external adjustment twice as fast. Meanwhile small economies have a current account half-life of 14.4 years compared to large economies with a half-life of 2.8 years. Following previous results there is strong correlation between low saving coefficients (high measure of θ) and higher measures of σ, current account volatility.

Tables 6 and 10 provide the results for high income countries. High income countries have more persistent current account balances than middle income countries. This is a reasonable result given high income countries have relatively stable governments, growth, and credible monetary authorities. These factors will dampen the threat of current account reversals. The United States provides a good example for high income countries sustaining large current account imbalances. Comparing across regressions, the link between low saving coefficient and high current account persistence is also consistent with previous results. When trade openness, financial openness, and country-size have saving coefficients near zero the current account has a half-life of 8.9, 6.5, and 8.4 years, respectively.

In summary, this section shows a lower saving coefficient corresponds with more persistence in current account imbalances. As capital mobility increases countries become more exposed to external shocks and face greater current account volatility. Thresholds corresponding with high levels of capital mobility were able to sustain current account imbalances with half-lives nearly twice as long as thresholds corresponding with lower levels of capital mobility.

Table 9: Current Account Dynamics – Pooled across middle income countries

	Threshold	γca_{t-1}	S.E.	$\theta \Delta s_t$	S.E.	σ	R^2	T
Current Account	ALL	-0.117***	0.012	0.899***	0.018	0.030	0.681	1287
Trade Openness	High	-0.075***	0.018	0.906***	0.031	0.035	0.780	303
	Middle	-0.123***	0.029	0.910***	0.04	0.033	0.770	248
	Low	-0.228***	0.023	0.872***	0.032	0.029	0.613	734
Financial Openness	High	-0.105***	0.010	1.253***	0.132	0.057	0.782	139
	Middle	-0.143***	0.032	0.997***	0.051	0.025	0.721	502
	Low	-0.322***	0.065	0.654***	0.067	0.027	0.427	296
Trade Balance	High	-0.322***	0.046	0.841***	0.044	0.038	0.774	181
	Upper Mid	-0.298***	0.029	0.798***	0.029	0.036	0.610	792
	Lower Mid	-0.0386***	0.086	0.748***	0.067	0.034	0.687	145
	Low	-0.045**	0.025	1.005***	0.032	0.032	0.879	166
Country Size GDP	High	-0.328***	0.044	0.609***	0.063	0.033	0.425	260
	Middle	-0.190***	0.025	1.011***	0.037	0.029	0.690	495
	Low	-0.079***	0.013	0.908***	0.022	0.031	0.801	530
Population 0-14	High	-0.116***	0.016	0.924***	0.025	0.034	0.747	634
	middle	--0.253***	0.027	0.811***	0.031	0.033	0.702	469
	Low	-0.202***	0.046	0.860***	0.078	0.030	0.523	182
Population 65+	High	-0.116***	0.043	0.897***	0.063	0.021	0.690	119
	Middle	-0.155***	0.016	0.855***	0.023	0.036	0.675	873
	Low	-0.085***	0.019	1.012***	0.033	0.031	0.803	293

***,**,* denote statistical significance at the 1,5,and 10 percent level.

Table 10: Current Account Dynamics – Pooled across high income countries

	Threshold	γca_{t-1}	S.E.	$\theta \Delta s_t$	S.E.	σ	R^2	T
Current Account	All	-0.098***	0.012	0.916***	0.022	0.022	0.618	1155
Trade Openness	High	-0.016***	0.014	1.008***	0.027	0.025	0.756	549
	Low	-0.265***	0.026	0.391***	0.044	0.019	0.237	605
Financial Openness	High	-0.107***	0.021	0.957***	0.033	0.019	0.604	768
	Low	-0.484***	0.093	0.429***	0.104	0.025	0.219	132
Trade Balance	High	-0.031	0.028	1.063***	0.034	0.022	0.859	200
	Middle	-0.264***	0.024	0.783***	0.029	0.021	0.557	840
	Low	-0.265***	0.060	0.914***	0.086	0.029	0.586	114
Country Size GDP	High	-0.205***	0.022	0.586***	0.040	0.019	0.317	716
	Low	-0.070***	0.016	0.998***	0.030	0.027	0.755	438
Population 0-14	High	-0.109***	0.030	1.002***	0.037	0.032	0.850	179
	Upper Mid	-0.220***	0.032	0.768***	0.053	0.027	0.528	323
	Upper Low	-0.210***	0.037	0.683***	0.068	0.031	0.331	535
	Low	-0.202***	0.030	0.498***	0.055	0.018	0.323	297
Population 65+	High	-0.181***	0.024	0.661***	0.045	0.017	0.370	544
	Middle	-0.120***	0.022	0.821***	0.045	0.028	0.509	424
	Low	-0.099***	0.026	1.014***	0.038	0.029	0.835	185

***,**,* denote statistical significance at the 1,5,and 10 percent level.

V. Conclusion

The FH Puzzle provides insight into capital mobility but can also be used to measure current account dynamics. Using Hansen's (1999) approach measuring threshold effects in non-dynamic panels shows the estimates of saving coefficients are potentially biased from the failure to account for structural breaks or regime changing effects. Consistent with previous studies, low measures of trade openness and large countries are more likely to have high saving coefficients. The use of a measure to capture financial openness shows capital mobility increasing over time which is seen in a low saving coefficient for more financially open countries. Additionally, testing the saving-investment relationship for age demographic variables shows middle and high income countries have a savings coefficient near zero for large fractions of their population under the age of 14 and small percentages above 65. Expanding the threshold results to a dynamic model of the current account shows countries with lower savings coefficients have more persistent current account imbalances, but have more exposure to external shocks.

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