

CAPITAL MOBILITY IN GERMANY

Statistical Project Presentation

Syed Azfar Hussain

Department of Mathematics

Illinois State University

Introduction

- **What is capital mobility?**
 - Movement of capital from one country to another.
 - Perfect capital mobility would imply no transaction or other costs in moving capital from one country to another.
- **Why capital mobility is important?**
 - Rise in FDI/FPI.
 - Multilateralization of trade.
 - Advancement in technology.
 - Increase in movement of people across different regions.

Feldstein-Horioka's Condition

Assess the relationship between domestic investment and domestic savings.

$$\left(\frac{I}{Y}\right)_i = \alpha + \beta \left(\frac{S}{Y}\right)_i + \varepsilon_i$$

- The saving-retention coefficient (β) is interpreted as a measurement of international capital mobility.
- With perfect world capital mobility, an increase in the saving rate in country i would cause an increase in investment in all countries (β close to 0).
- In contrast, estimates of β close to 1, would indicate that most of the incremental saving in each country has remained there.

Why Feldstein-Horioka`s condition is a puzzle?

- Economic Theory indicates \longrightarrow Capital flows act to equalize marginal product of capital across nations.
- For example, if the capital flows between OECD countries are reasonably free, this condition should hold true in those countries.
- In contrast, *Feldstein and Horioka* (1980) observed that domestic savings rates and domestic investment rates are highly correlated ($\beta = 0.85-0.95$).
- Feldstein-Horioka`s (1980) findings sparked an immense literature on this subject.

Formal Studies on F-H Puzzle

TIME SERIES STUDIES						
AUTHORS	COUNTRIES	DATA	METHODOLOGY	FINDINGS		
Miller (1988)	USA	1946Q1-1987Q3	ADF and Co-integration test (Engle-Granger 1987)	Saving-retention coefficient is 0.57		
Afxentiou and Serlitis (1993)	Canada	1950-1973	ADF and Co-integration test (Engle-Granger 1987)	Saving-retention coefficient is 0.33		
Esso and Keho (2010)	UEMOA Countries (Benin, Burkina Faso, Cote d'Ivoire, Mali, Niger, Senegal, Togo)	Benin (1982-2005) Burkina Faso (1979-2005) Cote d'Ivoire (1965-2005) Mali (1967-2005) Niger (1980-2005) Senegal (1965-2005) Togo (1980-2005)	Time Series Co-integration: Bounds test (Pesaran et al.- 2001)	<u>Bound Test:</u> Benin and Niger are co-integrated.		
			Granger causality test (Toda and Yamamoto - 1995)	<u>Causality:</u> Benin S→I Cote d'Ivoire S→I Niger S→I		
Nasiru and Haruna (2013)	Nigeria	1980-2011	ADRL Bound Test	Co-integrated in long run.		
			ECM (Error Correction Model)	Negative and significant ECM		
Kumar et al. (2012)	Australia	1960-2007	EG (Engle-Granger test)	<u>1960-2007</u>	<u>1960-1980</u>	<u>1981-2007</u>
			Johansen Maximum Likelihood	GETS → 0.57	GETS → 0.82	GETS → 0.62
			Fully-Modified OLS	EG → 0.53	EG → 0.57	EG → 0.53
			GETS (Hendry's - General to Specific technique)	FMOLS → 0.54	FMOLS → 0.69	FMOLS → 0.65
				JML → 0.50	JML → 0.79	JML → 0.64
			ADRL Bound Test	ADRL → 0.51	ADRL → 0.69	ADRL → 0.62

STUDIES ON OECD COUNTRIES							
AUTHORS	COUNTRIES	DATA	METHODOLOGY	FINDINGS			
Coakley et al. (2004)	12 OECD Countries	1980-2000 (Quarterly)	Time-series panel data techniques	Saving-retention coefficient 0.32			
Giannone and Lenza (2009)	24 OECD Countries.	1970-1999	Factor Augmented Panel Regression technique (Heterogeneous response of S-I to global shocks)	Saving-retention coefficient around 0.18 (relaxation of homogeneity assumption)			
Pelgrin and Schich (2008)	20 OECD Countries.	1960-1999	Panel Error Correction process Panel (dynamic) fixed effects	Error correction coefficient is negative and significantly different from zero.			
Katsimi and Moutos (2007)	25 OECD Countries	1986-2002	OLS <u>Adding Variable to FPH Model:</u> Human Capital Investments	1986-2002 → 0.57 1986-1990 → 0.61 1991-1995 → 0.70 1996-2000 → 0.37 1997-2002 → 0.26			
Christopoulos (2007)	13 OECD Countries.	1885-1992	Panel dynamic OLS	Saving-retention coefficient range around 0.50			
	Pre-Maastricht	1921-1992 & 1950-1992		Pre-Maastricht → 0.79 (1921-1992) & 0.90 (1950-1992)			
Di Iorio and Fachin (2007)	12 EU Countries.	1960-2002	Panel bootstrap tests Country-specific FMOLS	Saving-retention coefficient → 0.59			
Fouquau et al. (2009)	24 OECD Countries.	1960-2000	Panel Smooth Threshold Regression Model.	Saving-retention coefficient → 0.7			
Kumar and Rao (2011)	13 OECD Countries	1960-2007	<u>Additional Variables:</u> 1. Trade openness 2. Country Size 3. Ratio of Current account balance to GDP				
			Panel Co-integration.	<u>Pre-Bretton Woods</u>	<u>Post-Bretton Woods</u>	<u>Pre- Maastricht</u>	<u>Post- Maastricht</u>
			Test for Structural breaks using the Westerlund (2006) method.			0.44	0.24
				0.46	0.26	0.65	0.11
				0.74	0.48		
Sangjoon Jun (2011)	30 OECD Countries	1960-2006	Panel Co-integration test	<u>1960-2006</u>		<u>1960-1974</u>	
			CCR (Canonical co-integrating regression)	CCR= 0.56		CCR= 0.82	
			Dynamic OLS	DOLS=0.61		DOLS=0.80	
			Fully-Modified OLS	FMOLS= 0.56		FMOLS= 0.82	
M. Costantini and L. Gutierrez (2013)	21 OECD Countries.	1970-2008	Panel Co-integration.	Saving-retention coefficient is close to zero.			
			Panel dynamic OLS. Panel Fully-Modified OLS. Panel CUP-FM estimator.	(Assumes cross-sectional dependence through common factors).			

Objective

The main objective of this paper is:

“To empirically identify the stability of causal relationship between savings and investment for Germany, and examine the long run effects of the Maastricht treaty in 1992 on the degree of capital mobility”

- This paper also contributes to the empirical literature by examining the sensitivity of the domestic investment to different forms of savings.

Empirical Model

- The model used in this study is similar to the model used by *Feldstein and Horioka* (1980):

$$(INY)_t = \alpha + \beta (DSY)_t + \gamma DUM_t + \varepsilon_t \quad \dots 1$$

- Dependent Variable is Investment (percent of GDP)
- Independent Variables:
 1. Gross domestic savings (percent of GDP);
 2. Dummy Variable to study the impact of the common currency (0 for 1970 to 2001 and 1 for 2002 to 2014)

Second Equation

$$(INY)_t = \alpha + \beta_0(HHSY)_t + \beta_1(GSY)_t + \beta_2(ESY)_t + \beta_3 DUM_t + \varepsilon_t \quad \dots 2$$

- Dependent Variable is Investment (percent of GDP)
- Independent Variables:
 1. Household savings (percent of GDP);
 2. Government savings (percent of GDP);
 3. Enterprise savings (percent of GDP);
 4. Dummy Variable to study the impact of the common currency (0 for 1970 to 2001 and 1 for 2002 to 2014)

This paper applies comprehensive set of four different time-series estimation methods:

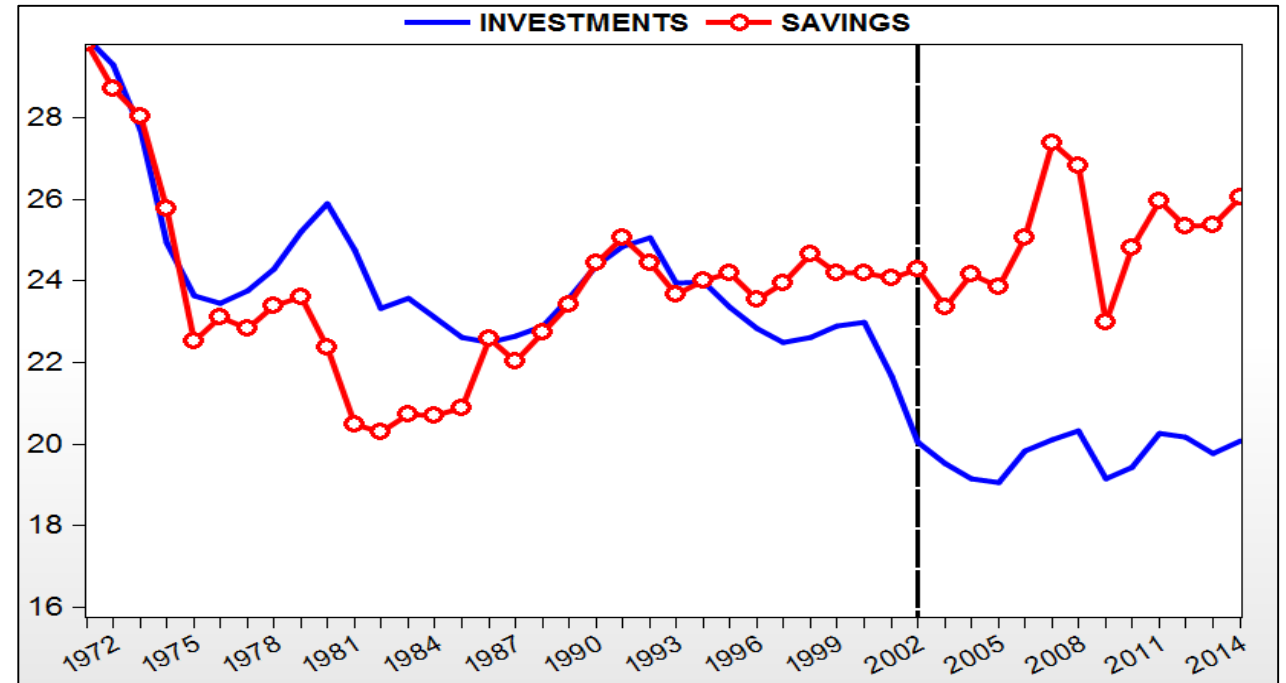
1. Fully-modified Ordinary Least Squares (*FMOLS*) Estimation method
2. Dynamic Ordinary Least Squares (*DOLS*) Estimation method
3. Johansen Maximum Likelihood (*JML*) test
 1. Error Correction Method (*ECM*)
 2. Engle Granger (1987) causality method
4. Autoregressive distributed lag (*ARDL*) bounds tests technique

Data Source

- Data for Gross fixed capital formation and Gross domestic savings is obtained from **World Bank Development Indicators 2015**.
- Data for household savings, enterprise savings and government savings is obtained from **Deutsche Bundesbank** (the central bank of Germany)
- The sample size is from **1970 to 2014**.
- The sample is divided in two parts:
 - Pre Maastricht treaty period (1971 to 1992)
 - Post Maastricht treaty period (1993 to 2014)

Results

- The graphs indicate **dispersion in saving and investment rates** after the Maastricht treaty was signed in 1992.
- Further dispersion in saving and investment rates after the circulation of euro became operational in 2002.



Summary Table

- The summary statistics does not show any unusual behavior.

Table 1. Descriptive Statistics: 1971 to 2014

<i>Variables</i>	<i>DSY</i>	<i>ESY</i>	<i>GSY</i>	<i>HHSY</i>	<i>INY</i>	<i>DUM</i>
<i>Mean</i>	24.096	0.434	0.441	40.709	22.846	0.364
<i>Median</i>	24.054	0.400	0.306	46.639	22.943	0.000
<i>Maximum</i>	29.836	0.824	1.583	56.986	29.967	1
<i>Minimum</i>	20.305	0.150	0.048	20.107	19.069	0
<i>Std. Dev.</i>	2.075	0.210	0.399	13.567	2.581	0.487
<i>Observations</i>	44	44	44	44	44	44

Note: *DSY* is gross domestic savings; *ESY* is enterprise savings; *GSY* is government savings; *HHSY* is household savings; *INY* is gross fixed capital formation (investment), and *DUM* is the dummy variable for EURO currency.

Unit Root test

- Augmented Dickey Fuller (ADF) and Philip Perron (PP) unit root tests confirm that the variables are **stationary** in $I(1)$.

Table 2. Results of ADF and PP unit root tests

<i>Variables</i>		<i>INY</i>	<i>DSY</i>	<i>ESY</i>	<i>GSY</i>	<i>HHSY</i>
<i>ADF Statistics</i>	<i>I(0)</i>	-2.946	-3.538*	-2.385	-3.144	-2.423
	<i>I(1)</i>	-2.950*	-3.062*	-5.429*	-3.315*	-5.432*
<i>PP Statistics</i>	<i>I(0)</i>	-3.087	-3.706*	-2.385	-3.047	-2.538
	<i>I(1)</i>	-3.232*	-3.085*	-5.430*	-4.396*	-5.350*

Note: The ADF statistics and PP statistics are compared with their respective critical values.

* denotes the rejection of null hypothesis (variable has a unit root) at 5% significance level.

JML Estimates for Equation 1.

- The null hypothesis for JML is no cointegration.
- The eigenvalues and trace statistics tests reject the null hypothesis of one long-run relationship at 95% significance level.

Table 3. JML cointegration tests

	<i>Trace</i>		<i>Max-Eigenvalue</i>	
	Test statistics	95%	Test statistics	95%
1971 to 2014				
$r = 0$	36.917	25.872	26.512	19.387
$r \leq 1$	10.405	12.518	10.405	12.518
1971 to 1992				
$r = 0$	20.744	15.495	18.183	14.265
$r \leq 1$	2.562	3.841	2.562	3.841
1993 to 2014				
$r = 0$	24.098	25.872	19.989	19.387
$r \leq 1$	4.109	12.518	4.109	12.518

Note: r is number of cointegrating vectors

Alternate Estimates for Equation 1.

- The estimates for FMOLS for the whole period indicate that around 43% of the domestic savings tends to be invested in domestic markets.
- For the post Maastricht treaty period (1992 onwards) the capital mobility has increased in Germany.

Table 4. Alternative estimates of savings-retention coefficient (β)

	<i>FMOLS</i>	<i>DOLS</i>	<i>JML</i>	<i>ARDL</i>
1971 to 2014				
β	0.430 (3.81)*	0.316 (2.39)*	0.091 (-1.15)	0.298 (2.48)*
<i>DUM</i>	-2.674 (-3.52)*	-3.173 (-4.35)*	-3.191 (6.36)*	-2.195 (-3.00)*
1971 to 1992				
β	0.504 (3.38)*	0.280 (1.71)	0.254 (-2.39)*	0.880 (1.46)
1993 to 2014				
β	0.389 (1.51)	0.521 (1.08)	-0.149 (0.58)	1.275 (1.63)
<i>DUM</i>	-1.977 (-2.41)*	-2.425 (-2.60)*	-4.290 (5.80)*	-1.454 (-0.92)

Note: β is the savings retention coefficient. *DUM* captures the effects of the common currency, euro, it is 1 in the period 2002 to 2014 and zero otherwise. Absolute *t*-ratios are reported in the parenthesis.

* denote the statistical significance at 5% confidence level.

- The estimates for DOLS for the whole period indicate that around **32% of the domestic savings tends to be invested in domestic markets.**
- The coefficient for the dummy variable (*DUM*) for all four estimation technique indicates **negative impact of the initiation of the euro on domestic investment.**
- The estimates for ARDL bounds tests shows the computed *F* statistics **(9.981) is greater than the upper bound of 95% critical value (4.68).** Likewise, for the post Maastricht treaty (1993 to 2014) the is *F* statistics is **5.61 (4.68).**
- JML results were insignificant at 5% level.
- All the four techniques, indicating relatively high degree of capital mobility in Germany.

Table 5. Speed of adjustment coefficient: 1971 - 2014

ECT_{t-1}	JML		$ARDL (2,0)$
	ΔINY	ΔDSY	
λ	-0.489	-0.722	-0.443
	(-5.01)*	(-4.03)*	(-5.99)*

Notes: Absolute t -ratios are reported in parentheses. λ indicate the speed of adjustment from short-run to long-run.

* denote the statistical significance at 5% confidence level.

- In the investment equation the coefficient of the lagged ECT (λ) is significant at 5% level, and has an expected negative sign.
- It indicate that 1% increase in domestic saving fully adjusts domestic investment in just over 2 years time.
- The ARDL result indicate 1% increase in domestic saving fully adjusts domestic investment in approximately 2.5 years.

Granger Causality

- The existence of cointegration implies causality.
- In the saving ratio equation investment is significant at 5% level, implying that there is **bi-directional causality from investment ratio to saving ratio in short run.**
- Domestic saving does not granger cause investment in the short run.

Table 6. Granger causality test: 1971 - 2014

<i>Dependent Variable</i> →	ΔINY_t	ΔDSY_t
ΔINY_t	-	6.85 (0.032)*
ΔDSY_t	2.409 (0.30)	-

Notes : Note: Probabilities are reported in parentheses underneath the Chi-square estimates.

* indicate that the probability is less than 5%.

JML Estimates for Equation 2.

- The eigenvalues and trace statistics tests reject the null hypothesis at 95% significance level.
- The results show that there is long run relationship between investment and different forms of saving ratios in Germany.

Table 7. JML cointegration tests for Equation 2

	<i>Trace</i>		<i>Max-Eigenvalue</i>	
	Test statistics	95%	Test statistics	95%
1971 to 2014				
$r = 0$	91.890	63.876	43.092	32.118
$r \leq 1$	48.799	42.915	26.848	25.823
$r \leq 2$	21.950	25.872	12.960	19.387
$r \leq 3$	8.990	12.518	8.990	12.518
1971 to 1992				
$r = 0$	63.683	63.876	29.655	32.118
$r \leq 1$	34.028	42.915	18.130	25.823
$r \leq 2$	15.898	25.872	10.850	19.387
$r \leq 3$	5.048	12.518	5.048	12.518
1993 to 2014				
$r = 0$	81.974	63.876	46.329	32.118
$r \leq 1$	35.645	42.915	19.486	25.823
$r \leq 2$	16.159	25.872	14.272	19.387
$r \leq 3$	1.887	12.518	1.887	12.518

Note: r is number of cointegrating vectors

Alternate Estimates for Equation 2.

- The estimates for FMOLS, DOLS indicate that household saving ratio is insignificant at 5% level.
- The government saving ratio has a positive impact on investment whereas, enterprise saving negatively affects domestic investment.

Table 8. Alternative estimates for Equation 2

	<i>FMOLS</i>	<i>DOLS</i>	<i>JML</i>	<i>ARDL</i>
1971 to 2014				
<i>HHSY</i>	0.019 (0.721)	-0.088 (-1.222)	0.143 (-3.646)*	0.120 (3.857)*
<i>GSY</i>	7.659 (6.515)*	3.963 (2.017)*	1.678 (-1.046)	6.450 (5.453)*
<i>ESY</i>	-9.251 (-4.260)*	-1.976 (-0.657)	-1.085 (0.371)	-7.465 (-5.00)*
<i>DUM</i>	-3.286 (-5.127)*	-6.236 (-3.678)*	-0.190 (0.197)	-1.112 (-1.681)
1971 to 1992				
<i>HHSY</i>	-0.405 (-2.275)*	-0.805 (-5.646)*	0.939 (2.767)*	-1.852 (-1.394)
<i>GSY</i>	4.717 (2.925)*	-0.936 (-1.264)	0.802 (0.698)	0.395 (0.101)
<i>ESY</i>	8.226 (0.955)	27.555 (4.321)*	-32.500 (-2.286)*	77.922 (1.243)
1993 to 2014				
<i>HHSY</i>	0.008 (0.245)	0.209 (1.431)	0.031 (-2.020)*	0.094 (2.100)*
<i>GSY</i>	16.941 (3.675)*	-2.979 (-0.354)	20.800 (-10.095)*	17.865 (3.760)*
<i>ESY</i>	-12.534 (-5.550)*	-14.055 (-1.466)	-18.339 (12.895)*	-14.081 (-5.170)*
<i>DUM</i>	-3.123 (-8.582)*	-4.554 (-2.841)*	-3.487 (17.940)*	-1.756 (-4.050)*

Note: *HHSY* is household saving ratio; *GSY* is government saving ratio and *ESY* is enterprise savings ratio. *DUM* captures the effects of the common currency, euro, it is 1 in the period 2002 to 2014 and zero otherwise. Absolute *t*-ratios are reported in the parenthesis.

* denote the statistical significance at 5% confidence level.

Alternate Estimates for Equation 2.

- The findings for DOLS, JML and ARDL are similar to the results of FMOLS.
- The common currency, euro, **negatively affects investment ratio indicating that most of the savings within Germany tends to be invested outside.**
- The results indicate that the magnitude of government saving invested locally has increased significantly and the investment of enterprise saving abroad is greater than before.
- The estimates for ARDL model implies that **1% increase in household saving ratio increases domestic investment around 0.12% to 0.15% per year.** However, the magnitude of household saving ratio has decline significantly following the Maastricht agreement in 1992.

Table 9. Speed of adjustment coefficient: 1971 - 2014

ECT_{t-1}	JML				$ARDL (4,2,4,0)$
	ΔINY	$\Delta HHSY$	ΔGSY	ΔESY	
λ	-0.435 (-3.940)*	1.493 (1.404)	0.002 (0.183)	0.0001 (0.005)	-0.951 (-6.03)*

Note: Absolute t -ratios are reported in parentheses. λ indicate the speed of adjustment from short-run to long-run.

* denote the statistical significance at 5% confidence level.

- In the investment equation the coefficient of the lagged ECT (λ) is significant at 5% level, and has an expected negative sign.
- It indicate that 1% increase in domestic saving fully adjusts domestic investment in just over 2 years time.
- The ARDL result indicate that 1% increase in domestic saving fully adjusts domestic investment in in just over 1 year.

Granger Causality estimates for Equation 2.

- In the investment equation all saving ratios are significant at 10% level.
- There is **bi-directional causality from saving ratio to investment in short run.**
- Investment does not granger cause savings in short run.

Table 10. Granger causality test: 1971 - 2014

<i>Dependent Variable</i> →	ΔINY	$\Delta HHSY$	ΔGSY	ΔESY
ΔINY	-	2.568 (0.277)	1.436 (0.488)	5.767 (0.56)
$\Delta HHSY$	5.565 (0.062)*	-	4.327 (0.115)	1.336 (0.513)
ΔGSY	5.047 (0.080)*	0.724 (0.700)	-	0.220 (0.896)
ΔESY	6.464 (0.039)**	0.708 (0.702)	0.192 (0.910)	-

Note: Probabilities are reported in parentheses underneath the Chi-square estimates.

* indicate that the probability is less than 10%; ** indicate that the probability is less than 5%.

Conclusion

- The saving-retention coefficient estimates indicate **HIGH capital mobility in Germany.**

“Feldstein-Horioka puzzle still exist but in weaker form”

- The effect of Maastricht treaty of 1992 has a significantly affected saving and investment relationship.
- The result indicate that the integration of European Union has increased dispersion between savings and investment ratios.

- The results for the sensitivity of domestic investment to different forms of saving ratios suggest that the government savings is mostly invested domestically.
- Private savers in Germany are inclined to invest abroad.
- One can conclude that policies which aim to increase investment through government savings are marginally successful.

“Capital mobility in Germany has increased especially after Maastricht treaty in 1992”

Questions....???

