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A Heterogeneous Dynamic Panel Approach to The Feldstein-Horioka Puzzle: Evidence from The European Union Countries

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Abstract

This study investigates whether the Feldstein and Horioka puzzle concerning domestic saving-investment relationship is supported by the data of the European Union (EU) countries using Cross-Sectional Augmented Error Correction Model (CS-ECM), Cross-Sectional ARDL (CS-ARDL) and Cross-Sectional Augmented Distributed Lag Model (CS-DL), the recent heterogeneous dynamic panel approaches which are robust to cross-sectional dependence and slope heterogeneity. The findings of the study imply high capital mobility for the EU countries over 1995-2021, and thus reject the existence of the Feldstein-Horioka puzzle.

Keywords: Saving, investment**,** Feldstein-Horioka puzzle, Heterogeneous Dynamic Panel

JEL Codes: E21, E22, F21, C33

1. Introduction

Since the beginning of the 1980s, the world has become more and more interconnected. Globalization has intensified, especially after 1989, with the collapse of the Soviet Union and the end of the Cold War in 1991. The emergence of a more integrated world economy brought together an increase in economic freedom and the removal of barriers to goods and services as well as free flow of labor and capital among the borders. The number of studies on the correlation between domestic savings and domestic investments have increased after the 1980s and gained pace in 1990s with the increase in globalization and financial liberalization. Drakos et al. (2018) and Younas and Chakraborty (2011) imply that globalization and financial liberalization have triggered the degree of capital mobility over time.

According to the standard economic theory in a world of perfect capital mobility, capital can move freely across the borders in search for higher yields. This in turn causes the savings to fly to any country that would offer higher yields. As a result, the correlation between domestic saving and domestic investment rates might

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be very low. In such a case, domestic investments are not only financed by domestic savings but also benefit from the supply of loanable funds all around the world.

There has been a vast literature on the correlation between domestic saving and investment since the seminal study, "Domestic Saving and International Capital Flows" conducted by Feldstein and Horioka in 1980. The high savings retention coefficient which they found between domestic savings and investments even when capital is perfectly mobile has been called Feldstein-Horioka puzzle since then. Obstfeld and Rogoff (2000) define it as one of the six major international macroeconomics puzzles.

The purpose of this study is to scrutinize the validity of the Feldstein–Horioka (F-H) puzzle for the 27 European Union countries over the period 1995-2021. To the author's knowledge even though there are some studies investigating the F-H puzzle for the EU countries for different time spans, there is no study which incorporates the recent heterogeneous dynamic panel approaches, cross-sectionally augmented error correction (CS-ECM), Cross-Sectional ARDL (CS-ARDL) and cross-sectionally augmented distributed lag (CS-DL), which are robust to cross-sectional dependence and heterogeneity. Ignoring cross-sectional dependence might cause the estimation results to be biased and inconsistent; on the contrary, these three methods fit well with the nature of the data and thus bring reliable results. Besides the novelty of the econometric approaches, by investigating the degree of capital mobility for the 27 EU countries over the 1995-2021 period, this study brings to light whether the stage of "free movement of capital between member states" established by the Maastricht Treaty has been successful. Since, the findings indicate a high level of capital mobility for the EU countries over the 1995-2021 period, the study confirms that the stage of "free movement of capital between member states" established by the Maastricht Treaty has been successful.

The estimation of long-run relationships is a very crucial issue in economics. Therefore, using dynamic panel data models, in which the parameters of interest capture both the long-run effects and the speed of adjustment in the long run, have become very popular in the last decades.

The panel dynamic ordinary least squares (DOLS) method developed by Mark and Sul (2003) and the panel fully modified ordinary least square (FMOLS) approach proposed by Pedroni (2001) and Phillips and Moon (1999) are among the frequently used methods to estimate long run coefficients in the panel data analysis. These methods, however, do not allow for error cross-section dependence. As mentioned by Baltagi and Pesaran (2007) cross section dependence can stem from spatial or spillover effects, or could be due to unobserved (or unobservable) common factors. Hoechlle (2007) states that overlooking cross-sectional correlation in panel data can pave the way to extremely biased statistical results. In this study, in order to investigate the F-H puzzle for EU countries, CS-ECM proposed and developed by Lee et al. (1997) and Pesaran et al. (1999), CS-ARDL method of Chudik and Pesaran (2015) and CS-DL approach developed by Chudik et al., (2013, 2015, 2016) which take into account the cross-sectional dependence and country heterogeneity have been employed.

The rest of the paper is organized as follows. Section 2 reviews the related literature. Empirical methodology, data and empirical findings are presented in Section 3. Section 4 concludes the study.

2. Literature Review

There is an ample literature on the Feldstein-Horioka (F-H) puzzle, covering different countries, country groups and periods, some with supporting and some with challenging evidence. In this section some examples from this literature are presented, albeit the sheer number of the publications makes the task quite difficult.

Martin Feldstein and Charles Horioka's (1980) article "Domestic Saving and International Capital Flows" begins with the following questions: "How internationally mobile is the world's supply of capital? Does capital flow among industrial countries to equalize the yield to investors? Alternatively, does the saving that originates in a country remain to be invested there? Or does the truth lie somewhere between these two extremes?" The answers they gave to these questions conceived a puzzle –aptly called F-H puzzle- considered by Obstfeld and Rogoff (2000) as one of the six major puzzles in international macroeconomics. Feldstein and Horioka's study of 16 OECD countries demonstrated that savings tend to remain in the countries where they are done showing that perfect capital mobility does not exist. To put it differently "international differences in domestic savings rates among major industrial countries have corresponded to almost equal differences in domestic investment rates". They also stated that their findings do not conflict with "the existence of substantial international flows of long-term portfolio and direct investments" and also with the international mobility of short-term capital.

There are many studies which confirm the existence of F-H puzzle. Feldstein and Bacchetta (1991) update the F-H analysis for 23 OECD countries and 9 EEC countries and find high correlation between domestic savings and investments. They find the savings retention coefficients as 0.791 and 0.524 respectively for the 23 OECD countries and 9 EEC countries over the 1960-1986 period, thus confirming the existence of the F-H puzzle. Tsouikis and Alyousha (2001) consider the F-H approach as an indicator of international capital mobility and by using Granger causality tests among the saving-GDP and investment-GDP ratios, with a sample of seven industrialized countries, they find evidence which support the F-H puzzle although they also argue that the international capital mobility increased after 1980. Khundrakpam and Ranjan (2010) focus on India for two different periods. First between 1951-1991 and then between 1951-2007. The findings of their study provide undisputed support for the F-H puzzle. They find a strong cointegration between investment and saving in both periods, although capital mobility was lower during the first period characterized by a more closed economy with restricted exchange rates and controlled capital flows. Jamilov (2013) uses Dynamic OLS (DOLS), Fully Modified OLS (FMOLS) and Pooled Mean Group (PMG) estimation techniques to estimate the long run relationship between saving and investment for a panel of 6 countries of the Caucasus over the period 1996 to 2010. The findings reveal a high and positive correlation between saving and investment, which provides support for low capital

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mobility. The author then compares the capital mobility estimates with the Index of Economic Freedom (IEF)[2] ranking for each country and concludes that the ranking justifies the capital mobility estimates of the study.

Johnson and Lamdin (2014) investigate the F-H relationship before and during the euro crisis for 17 European Union and 10 Eurozone countries. The authors find a positive and significant correlation between savings and investments. They further state that the correlation was higher at the peak of the euro crisis. Andrade and Syssoyeva-Masson (2015) try to measure the degree of financial integration in the Enlarged Europe by using the F-H methodology. Using quantile regression approach for panel data models, they find that capital was highly mobile among EU-24 countries. They state that domestic investments and national savings are more closely related in countries with low investment levels. Pata (2018) examines the validity of the F-H puzzle for the E7 countries over the period between 1989 -2015. The author employs augmented mean group (AMG) and common correlated effects mean group (CCEMG) estimators, which are robust to heterogeneity and cross sectional dependence to find out the long term relationship between domestic saving and investment. He concludes that the F-H hypothesis is valid for the E7 countries both in the short run and in the long run. Bibi and Jalil's (2016) article tests the F-H puzzle using the CCEMG estimator for a large group of countries over the period of 1980 to 2015. Using this method allows them to capture slope heterogeneity and moreover, it is robust to structural breaks and cross sectional dependence. Their findings support the F-H argument that the mobility of international capital is low; however, developments in the financial sector, governance and judicial environment can increase it. Among the latest studies, Yilanci and Kilci (2021) investigate the F-H puzzle for the Next Eleven (N-11) countries over 1990-2017 using recent panel data methods. They estimate the long run coefficients using the AMG estimator. Their findings reveal that F-H puzzle is valid for the N-11 countries.

On the contrary, there are some studies which reject the F-H hypothesis. For example, Blanchard and Giavazzi (2002), in their study based on OECD and European Union countries, argue that there has been a decrease in the correlation between national saving and investment in highly integrated regions, indicating the end of the puzzle as stated in their title. They state that increasing positive dependence of saving on income per capita and a negative dependence of investment on income per capita might be the reason behind the decline in the correlation between national saving and national investment. Giannone and Lenza, in their 2009 study, argue that the F-H puzzle can be rationalized with a general equilibrium approach. They use a factor-augmented panel regression that enables them to "isolate idiosyncratic sources of fluctuations". They state that although the correlation between saving and investment rates had not changed significantly, capital mobility among OECD countries had kept

[2] IEF measures the degree of economic freedom based on 12 pillars of economic freedom such as property rights, government integrity, judicial effectiveness, government spending, tax burden, fiscal health, business freedom, labor freedom, monetary freedom, trade freedom, investment freedom and financial freedom. Each country is assigned a score out of 100 based on its performance across these 12 pillars. A higher score indicates a greater degree of economic freedom. For more information visit https://www.heritage.org/index/about

on rising since Feldstein and Horioka's 1980 article. According to Giannone and Lenza, their approach provides a basis for heterogeneous responses of saving and investment rates to global shocks. The findings of their study reveal that the correlation between saving and investment rates decreases over time, and this finding is compatible with the view of increasing international capital mobility. Ketenci (2012) investigates the degree of capital mobility for 23 European Union countries in the presence of structural breaks over the period between 1995 and 2009, employing the hypothesis proposed by Feldstein and Horioka (1980). The findings of this study do not support the existence of the Feldstein–Horioka Puzzle in the EU countries, except Belgium.

Some studies provide ambiguous or partial justification/rejection about the validity of the F-H puzzle. Drakos et al (2018) analyze the F-H puzzle for the EU-14 countries for the 1970-2015 period using maximum likelihood panel cointegration methodologies. The findings of the study reveal that the Feldstein–Horioka puzzle is partially valid for the panel of EU-14 countries. The authors state that this finding indicates a moderate level of capital mobility, which is in coherence with the macroeconomic experience of these countries during the period under investigation. Kisangani (2006) approaches the puzzle from a different perspective by looking at the relationship between economic growth and democracy in Africa. In the study, generalized method of moments (GMM), cointegration and vector error correction models, with data from 37 African countries are used, offering conflicting results. Eyuboglu and Uzar (2020) examine the saving-investment relationship for the Lucky Seven countries[3] over 1990-2017. The authors use the Westerlund (2006, 2007) approach to detect the cointegration and then use CCEMG and AMG estimation methods to see the effect of savings on investments. The findings of their study reveal that for three of the countries in lucky seven the F-H coefficient is high, while when considered for the whole panel the coefficient becomes low and insignificant. Therefore, they conclude that F-H is not valid for the panel.

To sum up, the literature has paid a good deal of attention to the correlation between domestic saving and investment since the seminal study, "Domestic Saving and International Capital Flows" conducted by Martin Feldstein and Charles Horioka, published in The Economic Journal in 1980. There are many studies validating and many others rejecting the F-H puzzle. This study investigates the F-H puzzle for the 27 EU countries over the period 1995-2021. Since EU has removed capital barriers across its member states with the introduction of the single market plan in 1993, the novelty of this study is to capture capital mobility across the 27 EU member states over the period 1995-2021 using novel heterogeneous dynamic panel approaches. By investigating the degree of capital mobility for the 27 EU countries over the 1995-2021 period, this study investigates whether the stage of "free movement of capital between member states" established by the Maastricht Treaty has been successful.

[3] The "lucky seven" countries are Malaysia, Indonesia, India, Kenya, Mexico, Colombia and Poland. These are new emerging market countries with promising sustainable economic growth and improvements in governance quality.

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3. The model, data and methodology

In this section, we present the baseline model, the data, the statistical tests conducted; second generation panel unit root tests and cross-sectional dependence tests, and the CS-ECM, CS ARDL and CS-DL estimation techniques. [4]

Feldstein-Horioka (1980)'s conventional equation (Equation 1) is used as a baseline for the analysis. Feldstein-Horioka (1980) estimate Equation 1 to assess the relationship between domestic savings and domestic investments.

$$\left(\frac{I}{Y}\right)_i = \propto + \beta \left(\frac{S}{Y}\right)_i + e_i \quad (1)$$

where, $\left(\frac{I}{Y}\right)_i$ is the ratio of gross domestic investment as a share of GDP in country i, $\left(\frac{S}{Y}\right)_i$ is the ratio of gross domestic saving as a share of GDP in country i and β is the saving retention coefficient.

In a world with perfect capital mobility, when a country's saving rate increases it would affect the investment in all countries. The extent of world-wide capital mobility is captured by the saving retention coefficient (β) in Equation 1. The smallest value that β can take is zero, which signifies perfect capital mobility. As the value of β converges to 1, capital mobility declines. When β is 1, then there is perfect capital immobility. This is an extreme situation in today's world because 100 per cent capital immobility means that the country uses only its domestic savings for its domestic investments.

Data

The dataset covers a panel of 27 EU countries over the period 1995-2021. The data for the gross national savings as a share of GDP and the gross fixed capital formation as a percentage of GDP has been gathered from the World Bank Statistical database. Both variables are used in natural logarithms in the analysis. Table 1 provides the descriptive statistics for the two variables.

Table 1. Descriptive statistics of variables

	Observation	Mean	Standard Deviation	Minimum Value	Maximum Value
invest	729	3.088	0.194	1.493	3.994
save	729	3.158	0.320	1.983	4.160

Source: Authors' calculations

[4] Although both panel dynamic ordinary least squares (DOLS) and the panel fully modified ordinary least square (FMOLS) estimators are widely used to capture long run relationships in the literature, they are not robust to cross sectional dependence.

Cross-sectional Dependence Tests

Before estimating the model, to select the proper estimation method, it is necessary to evaluate whether the variables are cross-sectionally dependent or not, since ignorance of cross-sectional dependence might cause the estimation results to be biased and inconsistent.

Chudik et al. (2011) mention four types of cross sectional dependence. When the exponent of cross-sectional dependence (α) is equal to zero, then there is weak cross sectional dependence. If it lies between 0 and 0.5 semi-weak cross sectional dependence exists. When α is between 0.5 and 1 there is semi-strong cross sectional dependence. Finally, when α is equal to 1 strong cross-sectional dependence is detected in the data.

In this study, two tests are conducted to check for the existence of cross-sectional dependence on the investment and saving variables. The first test relies on the study conducted by Bailey, Kapetanios, and Pesaran (2016, 2019).[5] This method allows the estimation of the exponent of cross sectional dependence in residuals directly. As can be seen from the first column of Table 2 (CD1), the estimated exponent of cross-sectional dependence (alpha) is well above 0.5 for all the variables and hence it can be concluded that all the variables have cross sectional dependence.

Another way to investigate the existence of cross-sectional dependence is to test for semi-weak and weak cross-sectional dependence suggested by Pesaran (2015).[6] This method does not allow for the estimation of the exponent of cross sectional dependence directly, but it indirectly tests for whether alpha (α) <0.5. The null hypothesis states that the errors are weakly-cross-sectional dependent. As can be seen from the CD2 column of Table 2, the results of the second cross-sectional dependence test (CD2) confirm the findings of the CD1 cross-sectional dependence test.

Both test results show that investment (invest) and saving (save) variables inhibit cross-sectional dependence. The first test confirms it with alpha values that are greater than 0.5 while the second test confirms it with the p values that are below 0.05.

Table 2. Cross sectional Dependence Test Results

Variables	**CD1**	**CD2**
	alpha	p-value
invest	0.930	0.000
save	0.957	0.000

Source: Authors' calculations

[5] xtcse2 command is used to estimate the exponent of cross sectional dependence using Stata 17.
[6] xtcd2 command is used in Stata 17.

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Panel Unit Root Tests

Baltagi and Pesaran (2007) mention that the first generation panel unit root tests developed in the 1990s neglect cross-sectional dependence and this negligence might cause significant size distortions.

Since the variables of this study exhibit cross-sectional dependence, firstly, the second generation unit root (cross-section augmented Dickey-Fuller (PESCADF) test proposed and developed by Pesaran (2007) which runs the t-test for unit roots in heterogeneous panels with cross-section dependence is employed. [7] The null hypothesis assumes that all series are non-stationary. As can be seen from Table 3 the p-values of invest and save variables are well above 0.05 at their levels, so they are not stationary at their levels. The p value for the first difference of both variables is below 0.05 so the null hypothesis is rejected and hence it can be concluded that they are stationary.

Secondly, following Pesaran (2007), cross-sectional augmented IPS (CIPS) test is used. This test is a second generation unit root test that takes into account the existence of cross-sectional dependence for heterogeneous panel data. The null hypothesis of the test is non-stationarity. If the CIPS value is lower than the critical value, then the null hypothesis is rejected; in other words the variable is stationary. As can be seen from the Table 3, the CIPS values are lower than the critical values[8] at their first differences. This means that invest and save variables are non-stationary at their levels but stationary at their first differences.

The CIPS statistics corroborate the findings of the Pesaran's cross-section augmented Dickey-Fuller (PESCADF) statistics.

Table 3. Second generation panel unit root tests

Tests	CIPS		PESCADF	
Variables	Level	First-difference	Level	First-difference
	CIPS value	CIPS value	P-value	P-value
invest	-1.769	-4.454***	0.190	0.000***
save	-1.676	-4.853***	0.943	0.000***

Note: ***, **,* indicate statistical significance at 1%, 5%, 10%.

Source: Authors' calculations

[7] pescadf command in Stata runs the t-test for unit roots in heterogeneous panels with cross-section dependence, proposed by Pesaran (2003).

[8] Critical values are -2.07, -2.15 and -2.3 for 10 percent, 5 per cent and 1 per cent significance levels respectively.

Methodology and Empirical Findings

To search for the validity of the F-H puzzle for the EU countries conventional F-H equation (Equation 1) is used. To estimate the long run relationship between the ratio of gross domestic investment as a share of GDP in country i and the ratio of gross domestic saving as a share of GDP in country i, heterogeneous dynamic panel data estimation techniques are used. Long run relationships between the explanatory variable(s) and the steady state value of the dependent variable can be estimated using dynamic models.

In line with the equations presented in Ditzen (2018) a dynamic panel ARDL (1, 1) model with heterogeneous coefficients can be written as:

$$y_{it} = \mu_i + \lambda_i y_{i,t-1} + \beta_{0,i} x_{i,t} + \beta_{1,i} x_{i,t-1} + u_{it} \tag{2}$$

i=1,…..N and t=1,…..T

where, $y_{i,t}$ is the dependent variable, $x_{i,t}$ is the independent variable.

Pesaran (2006) and Chudik and Pesaran (2015b) come up with an estimator to estimate Equation (2) by adding the $\sqrt[3]{T}$ lags of the cross-sectional averages. Then the estimated equation turns into:

$$y_{i,t} = \mu_i + \lambda_i y_{i,t-1} + \beta_{0,i} x_{i,t} + \beta_{1,i} x_{i,t-1} + \sum_{l=0}^{PT} \gamma'_{i,l} \bar{z}_{t-1} + e_{i,t} \tag{3}$$

where $\bar{\mathbf{z}}_{t-1} = (\bar{y}_t, \bar{x}_t)' = \left(\frac{1}{N} \sum_{i=1}^{N} y_{it}, \frac{1}{N} \sum_{i=1}^{N} x_{it} \right)'$

are the cross sectional averages of the dependent and independent variables.

$\gamma_{i,l} = (\gamma_{y,i,l}, \gamma_{x,i,l})'$ are the estimated coefficients of the cross-sectional averages. If it is assumed that in the long run all the variables converge to their long run equilibrium values then $y_t^* = y_{t-1}^* = y^*$ and $x_t^* = x_{t-1}^* = x^*$,

When the long run values of all variables are incorporated, then Equation 2 becomes:

$$y^* = \mu_i + \lambda_i y^* + \beta_{0,i} x^* + \beta_{1,i} x^* + u_{it} \tag{4}$$

$$(1 - \lambda_i) y^* = \mu_i + (\beta_{0i} + \beta_{1i}) x^*$$

$$y^* = \frac{\mu_i}{1-\lambda_i} + \frac{\beta_{0i} + \beta_{1i}}{1-\lambda_i}$$

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$$\theta_i = \frac{\beta_{0,i}+\beta_{1,i}}{1-\lambda_i} \quad (5)$$

By means of CS-ECM, CS-ARDL and CS-DL methods, the long run parameter in Equation (5) can be estimated.

Before using the long run parameter, the Westerlund (2007) error correction panel test is used to check for panel cointegration. As seen in Table 4. this test reports both the group mean test statistics (Gt, Ga) and panel test statistics (Pt, Pa). The p-values of the test statistics reject the null hypothesis of no cointegration. Thus, it can be stated that there is cointegration between gross national savings as a share of GDP and the gross fixed capital formation as a percentage of GDP.

Table 4. Westerlund (2007) ECM panel cointegration test results

Statistic	Value	Z-value	P-value
G_t	-2.572	-1.400	0.081*
G_a	-15.461	-2.784	0.003**
P_t	-13.485	-2.919	0.002**
P_a	14.407	-4.744	0.000***

Note: ***, **,* indicate statistical significance at 1%,5%,10%

Source: Authors' calculations

The last step is to estimate Equation (5) using CS-ECM, CS-ARDL and CS-DL approaches.

To do that, firstly CS-ECM approach proposed and developed by Lee et al. (1997) and Pesaran et al., (1999) is used. In this approach, Equation (3) is transformed into an error correction model (ECM).

$$\Delta y_{i,t} = \mu_i - \Phi_i(y_{i,t-1} - \theta_{1,i}x_{i,t}) - \beta_{1,i}\Delta x_{i,t} + \sum_{l=0}^{PT} \gamma'_{i,l}\bar{z}_{t-1} + e_{i,t} \quad (6)$$

where $\theta_i = \frac{\beta_{0,i}+\beta_{1,i}}{1-\lambda_i}$, $\Phi_i = 1 - \lambda_i$ is the error-correction speed of adjustment to the new equilibrium. and $(y_{i,t-1} - \theta_{1,i}x_{i,t})$ is the error correction term.

Unless $\Phi_i = 0$ then, it can be stated that there is a long run relationship (Pesaran et al., 1999).

As demonstrated in Table 5. the value of the error-correction speed of adjustment parameter is -0.576. Since this value is between -1 and 0, it can be concluded that the error correction mechanism works and there is long run equilibrium. This finding means that the 57.6% of the disequilibrium is adjusted every period. The long run effect of saving on investment is positive and significant and any increase in savings increases investments in the long run.

As mentioned by Chudik et al., (2016) besides CS-ECM method, the cross-sectionally augmented ARDL (CS-ARDL) method can be used to search for the existence of long run relationship between the variables.

CS-ARDL approach is employed as the second estimation method in this study. As mentioned in Ditzen (2021), Equation 2 in a general ARDL (py, px) model can be written as:

$$y_{i,t} = \mu_i + \sum_{l=1}^{p_y} \lambda_{l,i}\, y_{i,t-1} + \sum_{l=0}^{p_x} \beta_{1,i} x_{i,t-1} + \sum_{l=0}^{p} \gamma'_{\,i,l} \bar{z}_{\,t-1} + e_{i,t} \quad (7)$$

From Equation (7) LR coefficients are found by:

$$\hat{\theta}\text{cs} - \text{ARDL, i} = \frac{\sum_{l=0}^{p_x} \hat{\beta}_{1,i}}{1 - \sum_{l=1}^{p_y} \lambda_{1,i}} \quad (8)$$

As seen in Table 5 the adjustment term is between -1 and 0 which is an indication of long run equilibrium. As expected, the findings of the CS-ECM and CS-ARDL approaches both show that there is a positive and significant long run relationship between savings and investments.

Lastly, the CS-DL method, developed by Chudik et al. (2016) which allows the direct estimation of the long run coefficient is used to find the long run effect in equation (5). According to Chudik et al. (2016), the CS-DL approach adheres to a distributed lag specification that does not include the lags of the dependent variable but incorporates the lags of the dependent variable, while also taking into account the residual factor error structure and weak cross-section dependence of idiosyncratic errors. CS-DL estimators are robust to endogeneity, residual serial correlation and possible breaks in ε_{it}. Moreover, CS-DL estimators are robust to cross-sectional dependence and therefore the CS-DL approach is employed to find out whether F-H holds for the EU countries over 1995-2021.[9]

The result of the CS-DL estimation shows that the value of the saving retention coefficient, β, is 0.309, which means that the capital is highly mobile across the member states. This finding implies that the F-H puzzle does not hold for the EU countries over the period 1995-2021.

Table 5: Dynamic common correlated effects estimators

	CS-ECM		**CS-ARDL**		**CS-DL**	
	Coef.	P>IzI	Coef.	P>IzI	Coef.	P>IzI
Adjust. Term	-0.576***	0.000	-0.576***	0.000	-	-
Long-Run Est.	-0.491	0.759	-0.491	0.759	0.309**	0.045
Note: ***, **,* indicate statistical significance at 1%, 5%, 10%						

Source: Authors' calculations

[9] The long run coefficients are estimated in the line with "Estimating long run effects and the exponent of cross-sectional dependence: an update to xtdcce2" article by Jan Ditzen (2018, 2021).

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4. Conclusion

This study investigates the validity of the F-H puzzle for the EU countries over 1995-2021 using the recently developed heterogeneous dynamic panel data estimation methods. Since both variables have cross-section dependence, second generation panel unit root tests which take into account cross-section dependence are employed. The two unit root test results show that the variables are I(1). Westerlund (2007) error correction based test has been used to check for panel cointegration. Both panel and mean group statistics reject the null hypothesis of no cointegration, which means that there is cointegration between gross national savings as a share of GDP and the gross fixed capital formation as a percentage of GDP. Finally, the analysis searches for the existence of a long run relationship between domestic savings and domestic investments for the 27 EU countries covering the period of 1995-2021 and then estimates the saving-retention coefficient by taking into account cross sectional dependence using novel approaches such as CS-ECM, CS-ARDL, CS-DL. The findings of the CS-ECM and CS-ARDL both justify the existence of the long run relationship between domestic savings and investments. CS-DL method confirms the finding of a positive and significant interaction between the two variables. Moreover, according to the CS-DL estimation results, the saving retention coefficient is 0.309, which indicates a high level of capital mobility across the EU members.

In line with studies such as Blanchard and Giavazzi (2002), Giannone and Lenza, Ketenci (2012), this study finds that the F-H puzzle is not valid for the EU countries over 1995-2021 period. The results of the study confirm that the stage of "free movement of capital between member states" established by the Maastricht Treaty has been successful since the results indicate a high level of capital mobility for the EU countries over the 1995-2021 period.

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