3. HIGH-INCOME COUNTRIES AND THE FELDSTEIN-HORIOKA PUZZLE: ECONOMETRIC EVIDENCE FROM DYNAMIC COMMON-CORRELATED EFFECTS MODEL

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Abstract

This paper reexamines the magnitude of international capital mobility under the Feldstein-Horioka puzzle in the context of 29 high-income countries over the 1980-2019 period. The puzzle is also revisited by employing the Dynamic Common-Correlated Effects method to incorporate the issues of cross-sectional dependence and heterogeneity. Moreover, the study investigates the role of macroeconomic and social factors, such as labor share of income, welfare-relevant technological progress, financial development, government expenditure, and political globalization, to go further beyond the traditional findings in the existing literature. The empirical results are based on three main headings. First, the findings confirm the existence of the Feldstein-Horioka puzzle. In other words, there is a lack of international capital mobility among high-income countries. Second, by using the interaction terms for financial development, government expenditure, and political globalization with the savings ratio, the immobile characteristics of international capital can be reduced by further implications of a higher rate of government expenditure. Finally, the results show that having more unequal distribution of income among capital and labor intensifies the domestic investment-saving nexus for an aggregate economy since the financial assets become more shrinking away from flowing out of the host country.

Keywords: Feldstein-Horioka puzzle, international capital mobility, financial integration, panel cointegration, dynamic common correlated effects

JEL Classification: C23, F20, F47

1. Introduction

The common consensus in the economics discipline is that international financial market integration has substantially been achieved by most of the world economies. Therefore, the

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increasing degree of capital mobility across countries has given rise to a large body of literature over recent years. In particular, along with the development of new information and communication technologies, providing easy access to knowledge, and growing integration of financial markets have also led to an excess amount of capital transfers between the countries, especially the high-income countries. The proponents of this positive nexus have argued that efficient allocation of capital resources is produced by a higher degree of financial integration, which then allows for a more diversified portfolio and smoothened consumption level. However, it is also noted that more integration could spread cross-border shocks in financial markets to other systems (Hassan *et al*., 2014: 480) and thereby could lead to an increase in the risk level of financial contagion (Beine *et al*., 2010). In the context of this suspicion about the implementation of more complicated financial relations across countries, policy-makers primarily foreground the degree of capital mobility for measuring its effects on different economic parameters and policy-related components. Such a theoretical approach was proposed by Feldstein and Horioka (1980), who questioned the sensitivity of domestic investment to the changes in domestic savings in the presence of a growing international financial market integration and an increasing degree of capital mobility through most of the industrialized and developing economies. The main rationale behind this approach, however, attempts to show that the correlation between domestic investment and domestic saving is unambiguously high for some of the sample countries from the OECD region even though the capital is prone to be mobile. In this sense, their methodology refers to paradoxical outcomes, and thus, it is labeled as Feldstein-Horioka (hereafter F-H) puzzle in the related literature (Obstfeld and Rogoff, 2000). For instance, Sinha and Sinha (2004) also call, in fact, this contradiction for given parameters as the mother of all puzzles in the field of international economics. According to Coakley *et al.* (1998: 170), the term puzzle is referred "...to awkward empirical facts that refuse to comply with their established theoretical frameworks", which to a large extent leaves unsettled the relationship between economic theory and empirical outcomes.

One of the most significant points to have a better understanding of the F-H puzzle depends on the case for looking at the link between globalization (especially financial globalization) and the global flows of investment (Lane and Milesi-Ferretti, 2017). In parallel to an increasing degree of globalization across the globe, the benefits and costs of international capital flows have become a crucial research topic in the existing literature (Lucas, 1990; Alfaro *et al*., 2008; Ahmed and Zlate, 2014; Forbes *et al*., 2015; Eichengreen *et al*., 2018; Coppola *et al*., 2021). Along with the integration of international capital markets between developed and emerging economies, the deepening of that integration has raised two major questions (Pietrobelli and Zamagni, 2000: 314): (i) does the integration of international capital markets promote a better allocative efficiency? and (ii) does it break the possible constraint to a country's investment stimulated by the insufficient level of domestic savings? Therefore, the globalization of capital markets has also entailed the arguments towards a trade-off between the potential benefits and the short-term instability that may be emerged from sudden flows of capital (Albuquerque, 2003; Forbes and Warnock, 2012; Converse *et al*., 2019). In addition, this increasing level of international capital flows has induced a constraint for national governance over monetary and fiscal policies, which was labeled as the open-economy trilemma (*i.e*., a country cannot simultaneously apply the following three economic strategies: (i) fixed exchange rates, (ii) open capital market, and (iii) monetary policy-oriented for domestic aims (Obstfeld, 1998). More importantly, there is a strong linkage between the foreign capital inflows and the domestic investment rate, in which the former is conditional on their being employed to increase the latter (Manzocchi, 1999). According to Obstfeld (1998), however, the advantage of foreign finance, especially for the

emerging economies, should be examined closely due to several reasons as it: (i) loosens liquidity constraints, (ii) allows an intertemporal reallocation of consumption and savings, (iii) promotes domestic financial institutions to become more efficient, and (iv) enhances the policies towards a limit over unexpected and uncontrolled speculative capital outflows together with preventing an increase in domestic interest rates.

The crucial point of the F-H puzzle is that the excess savings can be freely transmitted to the countries where there is a need for a higher level of investment in the presence of unconstrained mobility of capital across countries. Therefore, it is assumed that the domestic investment is independent of the domestic savings but a function of foreign savings. However, the empirical findings of this economic logic fall short of the expectations, in which the correlation between domestic savings and domestic investment is still relevant for most countries, especially the OECD countries. As Alexakis and Apergis (1994) rightfully specify that this contradictory relationship appears to be the most interesting economic outcome in the international finance literature, where international capital integration is at its highest level. The challenging results thus produce a great number of explanations for the reasons of the F-H puzzle such as sample selection and size problem, simultaneity bias, interconnected financial shocks, misspecification error, omitted variable bias, and non-linearity issues. Even though the criticisms on these findings have been produced important details to solve the F-H puzzle, there is still no common consensus for why domestic investment is a function of domestic savings rather than international savings. In other words, the high correlation for the domestic basis of savings-investment relationship can be termed as home bias instead of mobility (Bibi and Jalil, 2016: 234).

Indeed, the F-H puzzle has been investigated from different perspectives, thus the reassessing of the F-H puzzle is not a new concern. While the bulk of literature about the causes of this puzzle limits its scope only by looking at different samples, time span, and methodologies, the recent studies are extended the existing set of findings by way of including additional indicators, which are largely profound for the change in conventional pearls of F-H puzzle. However, many of these studies ignore the effects of current dynamics on this given issue. For instance, the level of financial development, the degree of income inequality, the labor market conditions, the political environment, and the economic shocks are to a large extent excluded from their research agenda by almost all of the recent studies. This study seeks to analyze the effects of these contemporary issues in the context of the F-H puzzle, and thus, it attempts to bring a new perspective to the literature.

Although this study aims to show that the benchmark findings of Feldstein and Horioka (1980) and Feldstein (1983) are empirically significant where the home bias effects are prevalent in the allocations of domestic savings for several reasons, the time-specific saving-retention coefficient can be negatively affected in time through the incorporation of all the above-mentioned factors to the traditional Feldstein-Horioka regression. If this is the case, then it can be translated into the expression that all these potential factors are extensively influential for increasing the degree of capital mobility across different economies. The major aim of this paper is to empirically show whether the mentioned concern exists for high-income countries.

Moreover, besides the exclusion of time-specific factors (*e.g.*, labor force participation rate, the growth rate of total private income, the ratio of the number of retirees over the age of 65 to the population aged 20-65, the ratio of the number of younger dependents to the working-age population, the benefit-earnings replacement ratio or the social security program, and the labor force participation rate of older men) from the regression analyses, most of the studies have ignored the presence of heterogeneity of regression slope assumption where

the dependent variable and any covariate(s) should have the same slopes across all levels of the categorical grouping factors. This case makes great sense since each country in the sample has a different saving-retention coefficient. In addition, two more issues can change the original findings of Feldstein and Horioka (1980) and their followers. First, the economic shocks might be influential in the saving behavior of individual households, irrespective of the degree of capital mobility. For instance, they may consider domestic savings as a safe haven than foreign savings for the case of domestic investment. Therefore, the regression analysis should consider the effects of these economic shocks on the F-H puzzle. Second, the high degree of positive correlation between financial market integration and cross-sectional dependence should be kept in view since each sample country can be a seminal effect upon the others in terms of the financial system.

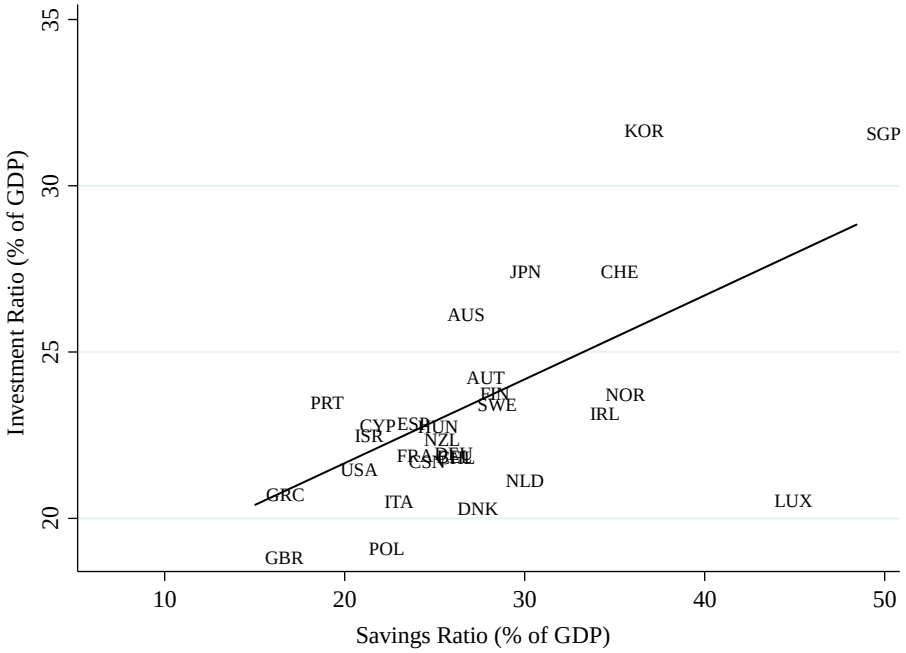
By taking into consideration of all these shortcomings in recent studies, this paper attempts to fill these gaps by making the following contributions to the literature. First, this study rethinks the F-H puzzle for selected high-income economies where their financial systems are highly developed and are largely open to foreign capital. Second, it benefits from the newly emerged model, which is called the dynamic common-correlated effects, to test the validity of heterogeneity of regression slope assumption and the dynamic heterogeneous panel estimators for a longer time series cross-sectional data. Finally, the paper uses first and second generations of panel cointegration tests (*e.g.,* Kao, 1999; Pedroni, 1999, 2004; Westerlund, 2007) to estimate the long-run validity of F-H assumption in the presence of different testing methods for panel unit-root (*e.g*., Taylor and Sarno, 1998; Im *et al*., 2003; Pesaran, 2007; Bai and Ng, 2004, 2010). In this regard, Figure 1 presents the relationship between domestic investment and domestic savings over the 1980-2019 period for 29 high-income countries.

In the light of these descriptive discussions and the theoretical underpinnings, the contribution of this paper to the relevant literature provides five different outputs. First, the major findings of Feldstein and Horioka (1980), which were produced for the OECD countries, are also significant for high-income countries. Second, the Feldstein-Horioka puzzle is also statistically valid for the long-term period, covering the time range from 1980 to 2019. Third, even if such macroeconomic and social factors (*i.e*., labor share of income, welfare-relevant technological progress, financial development, government expenditure, and political globalization) are included in the baseline specification, which is proposed for the investment-saving nexus, the significance of Feldstein-Horioka puzzle is still statistically prevalent. Fourth, the empirical findings directly lead us to argue that unlike the mainstream vision there are still many problems towards the financial integration among the high-income economies. Finally, the presence of an increasing degree of uneven distribution of income intensifies the domestic investment-saving nexus for an aggregate economy, since the financial assets become more shrinking away from flowing out of the host country.

In that vein, the paper neglects the low- and middle-income countries in the empirical specifications. It depends on three reasons why the empirical investigations get rid of comprising those countries. First, the major aim of this study is to show that the Feldstein-Horioka puzzle is still significant in the high-income economies, where there is a bulk of evidence for the argument that the degree of financial integration in those countries was well above the rest of the low- and middle-income economies. Second, the additional explanatory variables were also significantly and directly effective on the investment-saving nexus in high-income economies relative to the others. Finally, the major focus on high-income economies was shaped towards the rate of investment and the rate of saving in which the

linkage among those indicators was much consolidated as compared to the low- and middle-income economies.

Figure 1. The Investment-Saving Nexus, 1980-2019



Note: The country abbreviations are as follows: AUS: Australia, AUT: Austria, BEL: Belgium, CAN: Canada, CHL: Chile, CYP: Cyprus, DNK: Denmark, FIN: Finland, FRA: France, DEU: Germany, GRC: Greece, HUN: Hungary, IRL: Ireland, ISR: Israel, ITA: Italy, JPN: Japan, KOR: Korea Republic, LUX: Luxembourg, NLD: Netherlands, NZL: New Zealand, NOR: Norway, POL: Poland, PRT: Portugal, SGP: Singapore, ESP: Spain, SWE: Sweden, CHE: Switzerland, GBR: United Kingdom, USA: United States of America. These countries are also the selected sample of high-income countries that we use in the empirical analysis.

All in all, the rest of the paper is structured as follows. Section 2 reviews the existing literature. Section 3 explains the theoretical framework of the F-H puzzle and the econometric methodology. Section 4 describes the dataset. Section 5 introduces the empirical results and considerations. The last part concludes.

2. Literature Review

In the last four decades, a large number of studies have attempted to analyze the F-H puzzle. Whereas some of these empirical researches found that the claims on the F-H puzzle are significant across different countries (Feldstein, 1983; Feldstein and Bachetta, 1991; Sinn, 1992; Watson, 2001; Gunji, 2003; Schmidt, 2016), another strand of studies argued that there are also other factors which all have powerful effects on the rejection of common

perspective (Obstfeld, 1986; Jansen and Schulze, 1996; De Vita and Abbott, 2002; Katsimi and Zoega, 2016). Therefore, the literature on the F-H puzzle shows no sign of abating.

On the one hand, the first strand of literature has attempted to show that there is a high correlation between domestic savings and domestic investment under perfect capital mobility. The study of Feldstein and Bachetta (1991) on 23 OECD countries showed that the domestically determined relationship between savings and investment is highly correlated but the saving-retention coefficient declined over time due to the reasons such as the removal of barriers to international capital flows, the newly developed hedging markets, and the growing modern institutions in the financial sector. Golub (1990) conducted a study on 16 OECD countries for two sub-periods, 1970-1980 and 1980-1986, and confirmed the same findings of the F-H puzzle. On the other hand, Coakley and Kulasi (1997), Jansen (1998) and Shibata and Shintani (1998) argued that the intertemporal budget constraint is the major reason for the positive relationship between domestic savings and investment under perfect capital mobility and highly integrated financial markets. According to these kinds of empirical findings, if the level of domestic investment exceeds the current amount of total domestic savings in any country, this gap is filled by the transfer of foreign capital, and thereby, necessitates the emerging of an equal amount of current account deficit. Therefore, if this country provides the sustainability of this deficit in the current account, the ongoing positive cointegration of domestic saving-domestic investment nexus will be prevailing over time, though the capital is highly mobile across countries. For instance, this positive relationship among the two indicators is the result of the current account volatility compared to the perfect capital mobility (Sachs, 1981; Ghosh, 1995; Coakley and Kulasi, 1997). In case of using both public and monetary policies, they are also supported this sustainability phenomenon, and thus, they strengthen the domestic link among these two indicators (Summers, 1988; Narayan, 2005a). However, Tesar (1991) noticed that the empirical findings supporting the F-H puzzle are particularly linked to the sample selection process, in which the advanced economies have much higher levels of domestic savings and domestic investment compared to the low-income economies, and therefore, they are more prone to use domestically produced financial resources, even in the presence of a growing degree of capital mobility. For instance, the low-income countries will be confronted more with foreign capital mobility, and thus, the saving-retention coefficient will be much lower than the industrialized countries (Murphy, 1984; Tesar, 1991). In addition to these factors, domestic savings and domestic investment may be correlated due to several economic factors such as identification problem and the failure of real interest rate parity condition (Coakley *et al.*, 1998), omitted variable bias due to the exclusion of productivity shocks, population dynamics, changes in government expenditure and changes in interest rates from the analysis (Baxter and Crucini, 1993), the determinants of economic growth (Hamada and Iwata, 1989), the failure of financial markets integration (Cardia, 1992), the differences in transaction cost between internal and external investment (Niehans, 1992), legal obstacles and tax impediments (Devereux, 1996), the influence of domestic law (Gunji, 2003), the differential in exchange rate regimes (Edwards, 2004), endogeneity problem (Kasuga, 2004), the time inconsistency (Baxter and Crucini, 1993), intertemporal budget constraint (De Vita and Abbott, 2002), the sensitivity of saving and investment to the economic regime (Ho, 2002), home country bias problem (Hasan and Simaan, 2000), sample sensitivity (Cadoret, 2001), non-linear current account dynamics (Chortareas *et al*., 2004), and the policy regime changes (Sarno and Taylor, 1998).

On the other hand, the second stream of literature approves the high correlation between domestic savings and domestic investment through the rejection of the low capital mobility

assumption. In other words, many of those studies argued that this high correlation may be significant as empirical evidence, even in the presence of perfect capital mobility, due to the changes in exogenous variables (Sinn, 1992; Taslim, 1995). Taslim (1995) argued that economic growth and systematic intervention by government policies are two factors, which change the dynamics of savings and investment. However, Murphy (1984) and Sinn (1992) found that the effect of country size is the leading phenomenon for a highly correlated relationship between savings and investment, where the advanced countries are comparatively less dependent on foreign funds than the rest of the other economies. In particular, the country size can have highly significant impact on interest rates (Sinn, 1992) and as countries become larger for their financial needs, they then start to finance their economies by domestic funds (Harberger, 1980). For the first case, large countries have potentially been influential on interest rates due to a relatively higher level of domestic savings, which incur downward pressure on world interest rates and boost the investment in the host country. In the second case, however, if the country is large enough, investors are more prone to use domestic financial funds, where much of transaction costs are eliminated by doing this way and much safer than to engage in financial transactions. For instance, Payne and Kumazawa (2006) found that the saving-retention coefficient is much lower in developing countries compared to developed countries. Therefore, the correlation between savings and investment is weak in the first group of countries due to the presence of foreign aid (Isaksson, 2001), varying financial market conditions (Kasuga, 2004), and the openness degree of an aggregate economy (Wong, 1990), which thereby directly means that the country size matters. Vamvakidis and Wacziarg (1998) also argued that the conventional arguments on the F-H puzzle can be altered when developing countries are explicitly added into empirical discussions because of the following reasons: First, there might be occurred an international diversification due to heterogeneous financial motives and factor endowments. Second, in the presence of uncertainty and risk-return considerations, developing countries provide many areas for diversification of financial risks, and thus, they attract a large number of investors to invest in developing financial markets compared to the industrial countries. Third, the developing countries are varied in terms of their access to foreign capital, and thus, they may affect the saving-investment relationship to a large extent, irrespective of the degree of capital mobility.

Furthermore, as Bibi and Jalil (2016) express that all of these empirical studies on the F-H puzzle can be divided into three parts in terms of their estimation techniques. The first set of initial findings were based upon the cross-sectional data and were founded by employing Ordinary Least Square (OLS) estimators, which indicated that there is a low degree of capital mobility in the international economy and the saving-retention coefficient is high enough to confirm the F-H puzzle (*e.g.*, Feldstein, 1983; Murphy, 1984; Sinn, 1992). However, the other part of these studies has also used the same method but found a low or no correlation between these given two variables that pointing out a lack of international capital mobility (*e.g.*, Bayoumi *et al*., 1999; Obstfeld and Rogoff, 2000).

This challenging framework leads researchers to discuss the validity of the F-H puzzle in line with the growing scale of time series analysis, and thus, it leads to the emergence of the second set of studies, where the same type of controversies remains in the literature. In particular, based on error correction methods and autoregressive distributed lags approaches, some of the studies (*e.g.*, Jansen, 1996; Narayan, 2005a, 2005b; Caporale *et al*., 2005) found that the high correlation between domestic savings and domestic investment is statistically significant and has a long-run relationship among each other, which confirms the empirical findings of Feldstein and Horioka (1980) that the international capital mobility

is low. On the other side of the discussion, Barros and Gil-Alana (2015) and Ma and Li (2016) noted that the empirical findings do not support the long-run estimates for the saving-investment relationship that implies the presence of high international capital mobility, where the saving-retention coefficient is low enough. Alakbarov and Bayar (2021) also document that domestic investments were mostly financed through external capital inflows; and thus, the empirical outputs indicate that they are contradicted with the results of Feldstein-Horioka for the sample of 21 emerging markets during the 1994-2016 period using the panel cointegration and panel causality tests.

Finally, the third strand of studies utilizes their estimation by way of using panel data methods. Some of the common reasons to use this method can be ranged as follows (Hsiao, 2007): (a) providing of more accurate inference of model parameters, (b) having a great capacity for capturing the complexity of the sample, (c) having more control for the impact of omitted variables, (d) having the power to uncover dynamic relationships, (e) generating more accurate predictions for individual outcomes through a pooling of the data, and (f) simplifying power of the statistical inferences such as nonstationary time series and measurement errors. For instance, based on the advantages of panel data analysis, the empirical considerations provide a considerable amount of explanations towards the evidence of a high degree of international capital mobility among the countries (De Wet and Van Eyden, 2005; Payne and Kumazawa, 2005; Guillaumin, 2009; Bangake and Eggoh, 2011; Mosikari *et al*., 2017), but also there are others (Mamingi, 1997; Adedeji and Thornton, 2007; Murthy, 2009) which reject the findings validating the high value of saving-retention coefficient that implying a moderate degree of capital mobility. Moreover, some of the studies (*e.g*., Kumar *et al*., 2014; Chen and Shen, 2015) also considered the issue of structural breaks in their series emerging due to changes in the political environment and the obstacles in the use of pro-liberalized policies for perfect capital mobility.

However, if we look at the general context of the estimations based on panel data methods, some of the major shortcomings may be brought into the picture. First, while a large body of literature utilizes their findings by way of incorporating a different sample of countries, many of them refrain from using a larger time span of data, mostly due to data unavailability or the lack of some basic variables. Second, they incorrectly treat the panel units as homogeneous, in which they cannot be held in a long time series data (Bibi and Jalil, 2016: 238). Third, the inclusion of panel units into the models with different kinds of socio-economic and political frameworks will possibly bring to the rejection of cross-sectional dependence. However, together with a growing scale of capital movements and financial integration across countries, this assumption will be much important in those circumstances than the circumstances of the earlier period due to economic downturns, changes in technological progress, and growing scale of financial problems. All kinds of reasons and others have also the power to affect the saving-retention coefficient in the empirical investigations by way of changing the saving-investment relationship, irrespective of the degree of capital mobility. Therefore, this study will contribute to the literature by being aware of these factors and by employing the dynamic heterogeneous panel estimators for longer panel data.

3. Theoretical Framework and Methodology

The main rationale for the F-H hypothesis is constituted of measuring the degree of international capital mobility across high-income countries. Along with more integrated financial markets all over the world economies, the model predicts that domestic investment is increasingly financed by foreign savings. Therefore, the correlation between domestic

savings and domestic investment becomes lower over time though the capital mobility is at its highest degree, which is denoted by the *β* coefficient referred to as the saving-retention coefficient. Whereas the degree of capital mobility is high, it is expected that the *β* coefficient to be low (or close to zero), implying that the correlation between domestic savings and domestic investment is not significant. However, the model also notes that the inverse case is expected where the *β* coefficient is relatively high (or close to one) for the case that the cross-border capital mobility is limited. In the context of this logical background, the model is specified as follows:

$$\left(\frac{I}{Y}\right)_i = \alpha + \beta\left(\frac{S}{Y}\right)_i + u \tag{1}$$

where: $\left(\frac{I}{Y}\right)_i$ is the investment ratio for country *i*, $\left(\frac{S}{Y}\right)_i$ is the saving ratio for country *i*, α is the intercept, *β* is the saving-retention coefficient indicating the effects of the rate of changes in investment on the rate of savings, and *u* is the error term. According to Eq. (1), the *β* coefficient is varied from zero to one, that is, $0 \leq \beta \leq 1$. Therefore, the model produces three possible outcomes for the economy as a whole. First, if the *β* coefficient comes close to zero, this means that total savings will finance the international investment, and equivalently the domestic investment will be financed by foreign saving. In other words, the theoretical expression of this situation is that international capital is perfectly mobile across the countries. Second, if the *β* coefficient comes close to one, there exists no financial integration in the international environment, and thus, the domestic investment is totally financed by the domestic saving in which the international capital mobility is completely limited. Third, if the *β* coefficient varies between zero and one, the capital mobility will be varied over time and thereby will be changed across the countries in control of the exogenous variables. The term of a puzzle for the F-H study comes from the second case since the empirical findings of F-H show that the saving-retention coefficient is very close to one for the sample of 16 OECD countries, implying a low degree of capital mobility and low level of financial integration. However, this result is challenging and controversial since the capital movements in the OECD countries were relatively high than the rest of the others. Therefore, the contradiction between the expectations and the empirical reality leads to label the arguments of F-H as puzzling.

This study uses panel data for 29 high-income countries over the 1980-2019 period obtained from different data sources such as the World Indicators Database of World Bank, Penn World Tables 10, KOF Globalization Indices, and Financial Structure Database. Having specified the above model and considering the related assumptions, our model is going to be estimated by Eq. (2):

$$\left(\frac{I}{Y}\right)_{it} = \alpha + \beta_1\left(\frac{S}{Y}\right)_{it} + \beta_2\left[FD * \left(\frac{S}{Y}\right)\right]_{it} + \beta_3\left[LABSH * \left(\frac{S}{Y}\right)\right]_{it} + \beta_4\left[GOV * \left(\frac{S}{Y}\right)\right]_{it} + \beta_5\left[POL * \left(\frac{S}{Y}\right)\right]_{it} + \beta_6\left[TECH * \left(\frac{S}{Y}\right)\right]_{it} + u_{it} \tag{2}$$

where: $\left(\frac{I}{Y}\right)$ is the ratio of domestic investment to GDP, $\left(\frac{S}{Y}\right)$ is the ratio of domestic saving

to GDP, *FD* is financial development index, *LABSH* is the labor share coefficient, *GOV* is the ratio of total final consumption of government sector to GDP, *POL* is the political globalization index, *TECH* is the welfare-relevant total factor productivity index, and *u* is the error term. Following the empirical strategy of Bibi and Jalil (2016), the model introduces the control variables as interaction terms with savings ratio to assess the effects of variables related to the socio-economic framework on the domestic investment within the case of the F-H puzzle. Therefore, the estimated models will reflect the interaction effects of these variables on domestic investment by considering domestic savings. The negative *β* coefficients of interaction terms imply that the domestic savings may decrease over time. This directs us to range some possible hypotheses each of which will be empirically tested in Section 5.

***H*1.** There is a high correlation between domestic savings and domestic investment in the presence of a high degree of capital mobility.

***H*2.** There is a low (or no) correlation between domestic savings and domestic investment in the presence of a high degree of capital mobility.

***H*3.** There is a mild relationship between domestic savings and domestic investment in the presence of a high degree of capital mobility.

While the F-H puzzle is valid if the first hypothesis (*H*1) is statistically significant, it is not prevailing if the second hypothesis (*H*2) is accepted. However, the results will be inconclusive for the third hypothesis (*H*3) to make an argument towards whether the F-H puzzle is validated or not.

For the technique of analysis, the saving-retention coefficient and the other *β* coefficients of interaction terms will be estimated by the Dynamic Common-Correlated Effects (DCCE) method of Chudik and Pesaran (2015) for heterogeneously dynamic panel data models with weakly exogenous regressors. The higher values of the coefficients signal the validity of *H*1 and the lower values of the coefficients show that the *H*2 is accepted. If the values of the coefficients converge to 0.50, it indicates the validity of *H*3. Therefore, we shall estimate Eq. (2) in the context of slope heterogeneity assumption and panel cointegration when there is a cross-sectional dependence among the countries and the series suffer from structural breaks. On the one hand, the DCCE is a very new technique to estimate the heterogeneous dynamic panel data models thus the present paper will contribute to the literature on the F-H puzzle by asking that the saving-retention coefficient is statistically significant and close to one or not in the control of other variables. It allows for both mean group, pooled, and pooled mean group estimations. On the other hand, the DCCE supports instrumental variable regressions even for the case that there is a small sample time series bias by way of using the jackknife or recursive mean method. In addition, it is proper for both balanced and unbalanced panels and also considers the cross-sectional dependence. However, by the inclusion of lagged dependent variables, which are not strictly exogenous, the estimators may become inconsistent. To solve this problem, Chudik and Pesaran (2015) argued that the estimator gains consistency if $P_T = \sqrt[3]{T}$ cross-section means are included in the regression. Following the above-mentioned assumptions about the DCCE method, the heterogeneous dynamic panel data model is estimated in the following Eq. (3):

$$y_{it} = \lambda_i y_{it-1} + \beta_i x_{it} + \sum_{l=0}^{P_T} \delta_i' \overline{z}_{t-l} + \varepsilon_{it} \quad (3)$$

where: $\overline{z}t = (\overline{y}_t, \overline{y}_{t-1}, \overline{x}t)$. Cross-sectional dependence (CD) will be tested through the

method produced by Pesaran (2004), which is defined as in Eq. (4):

$$CD = \sqrt{\frac{2T}{N(N-1)}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}ij\right)} \Rightarrow N(0,1) \quad (4)$$

where: $\hat{\rho}ij$ denotes the sample estimate of the correlation of the residuals.

Following the determination of whether the series are stationary or not, we will test the long-run domestic saving-investment relationship. First, we employ first-generation panel cointegration tests proposed by Kao (1999) and Pedroni (1999, 2004). While Kao (1999) proposes a model in which the intercepts and common slopes vary across the cross-sections, the panel cointegration test provided by Pedroni (1999, 2004) allows for heterogeneity in intercepts and trend coefficients across the units. However, they all ignore to deal with cross-sectional dependence. Therefore, in the second case, we also employ the second-generation panel cointegration test to account for cross-sectional dependence proposed by Westerlund (2007). The next issue is to estimate the long-run cointegration among the series by using a panel Augmented Mean Group estimator developed by Bond and Eberhardt (2009) and Eberhardt and Teal (2010).

The final step is to estimate the short- and long-run coefficients using the DCCE method developed for the Stata program by Ditzen (2018) to take into account the estimation of heterogeneously determined panel estimators. In that vein, DCCE provides a consistent estimator for both heterogeneous panels and robust estimators for cross-sectional dependence. Therefore, Eq. (2) is estimated through the use of the DCCE methodology to assess the validity of the F-H puzzle for high-income countries where the degree of capital mobility and financial integration are relatively high compared to the rest of the other countries.

4. Data Description

The present paper investigates the validity of the F-H puzzle employing the dataset derived from different sources. First, the critical point is to reveal which data is much robust for estimating the change in domestic investment to GDP ratio. The existing literature is divided into two parts for this case. On the one hand, traditional wisdom uses gross fixed capital formation to measure domestic investment. However, the major shortcoming of this variable is that there is no division between the sectors. In other words, it accounts for a total investment of all sectors, which may create some potential problems for countries where the role of the private sector is limited, and thereby, inaccurately evaluates the effects of domestic savings on domestic investment. On the other hand, there are also other studies, which decompose the total investment considering different sectors. However, this method is also problematic in case of making an aggregate analysis in some circumstances for the validity of the F-H puzzle. Hence, we employ the first type of variable to estimate domestic investment, which is measured as a gross fixed capital formation to GDP ratio. To create balance for the saving-investment relationship in the context of data measurement, we estimate the domestic savings to GDP ratio as the difference between GDP and final consumption expenditure (total consumption). Since the domestic investment is grounded on gross terms, the gross term of domestic saving is coherent in terms of the estimation procedure.

Moreover, to go beyond the existing literature on the F-H puzzle, we also include macroeconomic and political variables into the analysis. First and foremost, we employ the

income inequality data to assess the effects of distributional factors in which the saving behavior is logically correlated to the changes in income of the households. Second, the degree of financial development is also correlated to the differential effects of the degree of financial integration across the countries. In the theoretical context, more developed financial systems need a more financially integrated economic environment. Therefore, we use the overall financial development index which is the weighted average of both financial market development and financial institutions development. Third, we use the data for government expenditures (% of GDP) to capture whether the total revenue of the government is spent on investment-led production by way of savings channel. For instance, if there is a net transfer of government to income-holders by different economic channels, they may increase their level of purchasing or they may use these extra resources in foreign countries by transferring their income. On the same ground, we employ the political globalization indicator as a proxy for assessing the effects of international organizations, international treaties, and treaty partner diversity on domestic investment. Finally, we also use an additional variable such as the welfare-relevant technological change to account for macroeconomic and structural change effects on domestic savings. On the one hand, Table 1 presents descriptive statistics for 29 high-income countries. On the other hand, Table 2 summarizes the variables using in the empirical part and explains their sources.

Table 1. Descriptive Statistics

Variables	Mean	Max.	Min.	Std. Dev.	J-B.	Skw.	Kurt.
Investment Ratio (% of GDP)	23.2	46.2	10.1	4.39	788.1	1.09	6.39
Savings Ratio (% of GDP)	25.9	58.8	7.54	8.37	546.2	1.28	5.18
Financial Development Index	58.3	100	0	19.6	22.4	-0.20	2.45
Labor Share of Income	58.1	73.8	31.9	6.50	77.8	-0.59	3.46
Government Expenditure (% of GDP)	18.6	27.9	8.17	4.29	22.8	-0.27	2.60
Welfare-Relevant Total Factor Productivity Index	0.95	1.34	0.62	0.11	6.01	-0.11	3.27
Political Globalization Index	83.5	99.1	43.1	12.5	219.9	-1.06	3.29

Table 2. Variables and the Sources

Variables	Abbreviation	Source
Investment Ratio (% of GDP)	INV	World Bank, World Development Indicators
Savings Ratio (% of GDP)	SAV	World Bank, World Development Indicators
Financial Development Index	FD	IMF
Labor Share of Income	LABSH	Penn World Tables 10
Government Expenditure (% of GDP)	GOV	World Bank, World Development Indicators
Welfare-Relevant Total Factor Productivity Index	TECH	Penn World Tables 10
Political Globalization Index	POL	KOF Globalization Index

Note: The number of observations for each variable is 1,073 and the number of countries is 29.

5. Empirical Results

The unit-root tests of multivariate augmented Dickey-Fuller (MADF) (Taylor and Sarno, 1998), cross-sectional augmented Dickey-Fuller (CADF) (Pesaran, 2007), cross-sectional dependence of Im, Pesaran, Shin (CIPS) (Im *et al*., 2003) and panel analysis of nonstationarity in the idiosyncratic and common components (PANIC) (Bai and Ng, 2004, 2010) are estimated to determine the stationary level of the panel data series. The main rationale for using different types of unit-root tests is to constitute a strong basis for panel cointegration analysis, which holds for the variables to be integrated of the same order. It is evident from Table 3 that the variables are to a large extent non-stationary and thereby contain unit-roots in case of existing heterogeneity in the whole model and cross-sectional dependence in the variables but integrated of order one at 1% level of significance.

Table 3. Panel Unit-Root Test Results

	MADF	CADF	CIPS	PANIC				
				MQ_c	MQ_f	P_a	P_b	PSMB
INV_{it}	348.3	-2.226 (0.004)	-1.789	-10.733	-7.031	-3.219 (0.001)	-2.249 (0.012)	-1.849 (0.032)
ΔINV_{it}	1118.5	-4.091 (0.000)	-4.773					
SAV_{it}	298.8	-2.106 (0.027)	-1.915	-9.011	-2.617	0.856 (0.804)	0.839 (0.799)	0.117 (0.547)
ΔSAV_{it}	2136.9	-4.065 (0.000)	-5.341					
$(LABSH)_{it}$	379.5	-2.232 (0.004)	-1.820	-12.995	-10.385	-0.687 (0.246)	-0.624 (0.266)	-0.502 (0.308)
$\Delta(LABSH)_{it}$	1380.3	-3.777 (0.000)	-4.993					
$(TECH)_{it}$	239.1	-2.166 (0.012)	-1.816	-18.365	-12.602	1.123 (0.869)	1.201 (0.885)	0.829 (0.796)
$\Delta(TECH)_{it}$	1553.1	-4.245 (0.000)	-5.054					
$(SAV*FD)_{it}$	369.8	-2.157 (0.013)	-2.177	-10.838	-6.686	0.099 (0.539)	0.094 (0.538)	-0.131 (0.448)
$\Delta(SAV*FD)_{it}$	1218.5	-4.158 (0.000)	-5.580					
$(SAV*GOV)_{it}$	206.6	-2.416 (0.000)	-2.258	-13.42	-13.39	1.388 (0.917)	1.582 (0.943)	1.569 (0.942)
$\Delta(SAV*GOV)_{it}$	1528.5	-4.621 (0.000)	-5.766					
$(SAV*POL)_{it}$	213.1	-2.296 (0.001)	-2.014	-9.485	-7.24	0.765 (0.778)	0.783 (0.783)	0.451 (0.674)
$\Delta(SAV*POL)_{it}$	1455.6	-4.233 (0.000)	-5.529					

Note: The test statistics are provided for testing the MADF panel unit-root. T-bar test statistics are provided for CADF panel unit-root. The CIPS test statistics are given in fourth column and the critical values are -2.08 (10%), -2.16 (5%), and -2.3 (1%). In PANIC unit-root testing, MQ_c and

MQ_f show the test statistics for multiple factors, and P_a, P_b, and PSMB indicate the test statistics for an idiosyncratic term. The p-values are located in parenthesis.

Therefore, the rejection of the null hypothesis confirming that there may be long-run co-trending movements among the series. In addition, the results of cross-sectional dependence and homogeneity tests are represented in Table 4.

Table 4. Diagnostic Tests Results

Cross-Sectional Dependence Tests			
	Frees (1995, 2004)	Pesaran (2004)	Friedman (1937)
Statistics (*p*-value)	3.260 (0.000)	6.065 (0.000)	98.233 (0.000)
Homogeneity Test			
	Delta	*p*-value	
Nominal	29.425	0.000	
Adjusted	32.898	0.000	

Note: The p-values are located in parenthesis.

Therefore, the next issue is to test the cointegrating relationship among the series through various panel cointegration tests for long-run estimations. On the one hand, the first group of cointegration tests is based on the assumption that there is no cross-sectional dependence in the panel data by way of using the methods of Kao (1999) and Pedroni (1999, 2004). On the other hand, we also apply another technique of Westerlund (2007) which allows for detecting long-run relationships among the series in the presence of cross-sectional dependence. The main rationale for using both first- and second-generation panel cointegration tests is to show that the results do not significantly change for heterogeneous panel data. The results are summarized in Table 5, and thus, they indicate that there is a long-run relationship among the series. We also estimate the cointegration model for the given series by using the method of panel Augmented Mean Group which is based on the heterogeneous parameters and all these heterogeneous parameters are estimated for each unit. The results are thus given in Table 6.

Table 5. Panel Cointegration Tests

	Kao			Pedroni			Westerlund		
	Stat.	*p*-value		Stat.	*p*-value		Value	*z*-value	*p*-value
Modified DF-t	-5.17	0.000	v	-4.86	0.000	Gt	-4.02	-8.39	0.000
DF-t	-3.79	0.000	rho	3.29	0.000	Ga	-17.04	-2.06	0.020
ADF-t	-4.51	0.000	PP-t	-1.49	0.067	Pt	-25.44	-11.72	0.000
Unadjusted Modified DF-t	-5.41	0.000	ADF-t	-2.14	0.016	Pa	-23.83	-8.50	0.000
Unadjusted DF-t	-3.88	0.000							

Note: In testing Pedroni's cointegration method, v is the modified variance ratio, rho is the modified Phillips-Perron t, PP-t is the Phillips-Perron t, and the ADF-t is the Augmented Dickey-Fuller t. In testing Westerlund's cointegration method, Gt and Ga are group mean tests, while Pt and Pa are panel mean tests. 'a' refers to the estimation of the error correction estimate, while 't' refers to the estimation for the standard error of 'a'. For more information, please see Persyn and Westerlund (2008: 233-235).

Table 6. Panel Augmented Mean Group Estimation Result

	Coefficient	Std. Error	z	P>|z|
SAV	0.233	0.076	3.08	0.002***
COMMON	0.796	0.154	5.14	0.000***
TREND	-0.000	0.000	-0.35	0.725
CONS	0.198	0.019	9.96	0.000***
No. of observations	1160			
No. of groups	29			
Wald X^2	9.49			
Prob > X^2	0.0021			

*Note: The dependent variable is INV. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively. Root Mean Squared Error (sigma) is 0.0189. COMMON refers to the common dynamic process, which is included as an additional regressor. TREND refers to a group-specific linear trend. The share of group-specific trends significant at 5% level is 0.379 (= 11 trends). All coefficients present represent averages across groups. Coefficient averages are computed as outlier-robust means.*

Finally, Table 7 reports the long-run estimates based on the Dynamic Common-Correlated Effects method. Model 1 shows that there exists the F-H puzzle with a low-level effect of the saving-retention coefficient, that is, 0.303. This implies that approximately 31 percent of the domestic investment is financed by domestic savings and the rest of the 69 percent is financed by international capital mobility. This is a partial result thus it is expected that the dynamics of the socio-economic and political framework of the given sample may change the saving-retention coefficient in the long-run. This magnitude is confirmed for Models 2-6. For instance, having more unequal distribution income intensifies the domestic investment-saving nexus in Model 2. Therefore, international capital mobility can be increased by way of providing an enhancement in specific indicators over time.

Model 2 and the others show that the inclusion of additional variables into the estimation provides a piece of information that the saving-retention coefficient can be increased over time in comparison with Model 1. It implies that the magnitude of each variable has a significant impact on the change of the relationship between domestic investment and domestic savings. However, their magnitude on that nexus can slightly differ in models. For instance, the increase in the share of labor income accrued in total GDP can further stimulate the process of capital mobility by 0.40 percent (*see* Model 2). In particular, the measure of welfare-relevant technological progress enters significantly positive in the baseline regression which implies that domestic magnitude of given nexus may increase with a higher level of technology using in the production system over time, whereas the significance of interaction terms is not valid in the context of the statistical procedure (*see* Model 3).

All in all, Table 7 provides a robustness check for the initial findings in Model 7 to point out the general framework for the validity of the F-H puzzle in the long-run. In that vein, we include all the variables into the regression to control misspecification bias. The estimation results of Model 7 show that the saving-retention coefficient is significantly high in all samples by contrast with the baseline results and the coefficient of the interaction term for government expenditures becomes statistically significant in the case of robustness check. However, the same conclusion cannot be done for the coefficient of financial development and political globalization. Therefore, the interaction term for government expenditures remarks that providing a sound social and economic system in the presence of government regulations will lead to an increase in risk-sharing in time. These findings are consistent with Bibi and

Jalil (2016: 246). Further, both baseline findings and robustness checks lead us to confirm *H*1 presented in Section 3, which implies that there is a high correlation between domestic saving and domestic investment in the presence of a high degree of capital mobility for 29 high-income countries over the 1980-2019 period.

Table 7. Dynamic Common-Correlated Effects Results

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
SAV	0.303*** (0.075)	0.401*** (0.076)	0.287*** (0.073)	0.253** (0.115)	0.451*** (0.150)	0.516*** (0.178)	0.583*** (0.194)
LABSH		0.004*** (0.001)					0.003*** (0.001)
TECH			0.340*** (13.24)				0.288*** (0.033)
Interaction Terms							
SAV*FD				-0.001 (0.001)			-0.000 (0.001)
SAV*GOV					-0.008 (0.012)		-0.012* (0.006)
SAV*POL						-0.001 (0.002)	-0.000 (0.001)
Constant Term							
CONS	0.073 (0.301)	0.135 (0.332)	-0.414 (0.272)	0.066 (0.305)	0.047 (0.354)	0.073 (0.288)	-0.092 (0.316)
R-squared	0.57	0.35	0.34	0.48	0.49	0.49	0.14
R-squared (MG)	0.72	0.82	0.83	0.75	0.75	0.75	0.91
CD Statistic	-3.01	-2.27	0.52	-2.25	-3.06	-1.90	0.28
p-value	0.0026	0.0229	0.6045	0.0244	0.0022	0.0580	0.7795
No. of obs.	1073	1073	1073	1073	1073	1073	1073
No. of groups	29	29	29	29	29	29	29
Obs. per group (T)	37	37	37	37	37	37	37

*Note: The standard errors are shown in parentheses. *** 1% level of significance, ** 5% level of significance, * 10% level of significance.*

In the light of these empirical findings, more concern can be imposed on the reasons for the presence of the Feldstein-Horioka puzzle. According to that puzzle, the country's real interest rate should be engaged to the world real interest rate by real interest parity condition. Therefore, instead of the country's dependence on the nominal interest rate, the real interest rate is the major determinant of the link between saving and investment, in theory. However, for Feldstein-Horioka condition to hold, ''...any and all determinants of a country's rate of investment other than its real interest rate be uncorrelated with its rate of national saving.'' (Frankel, 1992: 197-198). In that vein, the empirical findings of Feldstein and Horioka also showed that the value of beta is closer to 1 than to 0 for case of the sample countries, which indirectly meant that financial markets are not highly integrated. Therefore, this extraordinary argument, according to mainstream wisdom, has been criticized by two major contexts. First, one consensus argued that national saving is endogenous or is correlated with all other factors that determine the rate of investment. This indirectly produced the idea that the aforementioned condition is prevailing if national saving and investment are both procyclical or if they are both affected by population of productivity growth rates (Obstfeld, 1986; Summers, 1988). Second, the other consensus focused on the case that this may come

theoretically significant if governments respond endogenously to incoming imbalances in current account with policies to alter public or private saving in such a way as to mitigate the current imbalances, which is called as ''policy reaction'' in the existing literature (Fieleke, 1982; Tobin, 1983; Summers, 1988; Bayoumi, 1990). In case of the econometric discussions, the other argument is that the shortfall in domestic savings leads to an increase in the world interest rate, and thereby, crowds out investment in domestic countries and as the same in foreign countries (Tobin, 1983; Murphy, 1984). However, this argument has also caused another dilemma since it cannot explain why the countries having high saving rates tend to come across with the countries that are high investment rates. Moreover, if the saving-investment regressions were accepted as a benchmark to test the effectiveness of barriers to financial market integration, the beta coefficient would be decreased over time (Frankel, 1992). For further explanations of that finding can be attached to the real interest parity condition. If the domestic real interest rate is not matched with the foreign real interest rate, then there is no way of expecting to be a zero coefficient in saving-investment regression, even though the other additional variables were integrated into the analysis. All in all, this is what that paper tried to show the Feldstein-Horioka puzzle is still significant, at least for the high-income economies and therefore it directly leads to produce an argument that there is evidence for limited capital mobility through the reasons with less integrated financial markets.

6. Concluding Remarks

This paper reexamined the Feldstein-Horioka puzzle in line with the magnitude of international capital mobility in a sample of 29 high-income countries from 1980 to 2019. Indeed, the topic is not a new approach in which it is assumed as one of the most challenging puzzles in international economics. Therefore, there exist different types of inconclusive and controversial findings in the existing literature which thus further leads researchers to focus on it along with a bulk of studies. In consideration of these findings, some of the major reasons for the mixed empirical outputs can be ranged as follows: sample selection and size problem, simultaneity bias, misspecification error, mutually linked financial shocks, omitted variable bias, and non-linearity problem.

In this regard, this study contributes to the existing literature by employing the Dynamic Common-Correlated Effects method on panel data of 29 high-income countries from the period 1980 to 2019 to control cross-sectional dependence and heterogeneity problems. The major advantage of the DCCE method is that the problems arising from the heterogeneous characteristics of the units and cross-sectional dependence among the countries are incorporated in the empirical analysis. Since the time horizon is based on longer time-series data, the methodology of DCCE may provide significant, consistent, and unbiased findings in comparison to the traditional estimation techniques. Furthermore, the paper also investigated the long-run cointegration between domestic investment and domestic savings by employing the panel Augmented Mean Group estimator for heterogeneous panels. In particular, the DCCE method comprised the role of several macroeconomic and social factors that are almost ignored in the literature such as financial development, labor share of income, welfare-relevant technological progress, government expenditure, and political globalization. The empirical results are based on three main headings. First, the empirical findings confirmed the Feldstein-Horioka puzzle that there is a high correlation between domestic savings and domestic investment in the presence of a high degree of capital mobility. Second, in consideration of the interaction terms, the international capital could be transferred into sample countries through the implication of a higher rate of government

expenditure. In other words, foreign capital could be freely and comfortably invested in selected high-income countries with a well-endowed governmental process in line with improved institutions. Finally, the empirical results showed that having more unequal distribution income among capital and labor intensifies the domestic investment-saving nexus for an aggregate economy. Therefore, this finding leads us to argue that policymakers should consider the rising level of income inequality if they want to attract foreign capital and savings from abroad for their countries.

All in all, the significance of the Feldstein-Horioka puzzle can also be tied to the discussions on the relevance of economic globalization and the latest Great Recession. In particular, the repercussion effect of the recent global crisis is directly linked to the international economic flows in the relevant literature (Narlikar, 2010; Roubini and Mihm, 2010; Bremmer and Roubini, 2011; Mahbubani, 2013; IMF, 2016). Apart from this, the growing scale of heterogeneity among the members within the international system has also elaborated the economic relations and thereby the link between saving and investment across the globe (Kupchan, 2012). However, the stagnation of the global agendas had led to limited short-term effects on the process of insertion of the advanced countries within the international system (Nye, 2017). In addition, the onset of the Global Recession induced a new economic cycle, which reflected negatively on three major indicators, especially market by a deceleration with developed countries: (i) the expansion of international trade, (ii) the long-term investments, and (iii) the international trade. This deceleration in the international economic flows is also followed by the slowdown in growth rates and deepening exhaustion of national governments along with the breaking down of global economic cooperation and the stagnation of the process of internationalization of national economies (Helleiner, 2010; Drezner, 2014).

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