Does Accounting for Foreign Capital Flows help to solve the Feldstein and Horioka Puzzle? The Case of Norway

Eleftherios Makedonas and Stavros Tsopoglou[1]

ABSTRACT

A new proxy variable for the investment part of the initial Feldstein and Horioka model is proposed. We denominate it 'modified gross fixed capital formation'. It is derived by subtracting the imports of fixed assets included in an economy's gross fixed capital formation from the gross fixed capital formation itself. This way, the exclusively domestic part of an economy's investment is isolated. Applying it in the case of Norway, the aforementioned approach significantly reduces or even eliminates the high autocorrelation inherent in the initial Feldstein and Horioka model specification. Norway appears to be characterized by a high degree of international capital mobility.

1. INTRODUCTION

A PARTICULARLY POLEMICAL DEBATE has been triggered since Feldstein and Horioka (1980) (FH) obtained high estimated values for the slope coefficient (β) of their regression of 'gross domestic investment' on 'gross domestic saving' for a group of 16 economically developed OECD countries. They interpreted their finding — later termed 'the FH paradox' — as an indication of a low degree of international capital mobility among the countries of their sample.

According to their syllogism, β stands for the 'saving retention coefficient' of the economy under examination, in the sense that it captures any incremental changes in its domestic saving subsequently converted to domestic investment. Under this interpretation, they argued that β could constitute an alternative measure for the existent degree of international capital mobility of the economy: close to one estimated values for β would remit to self-sufficiency with regard to the investment capital needs of the economy, discouraging any foreign capital inflows. One could think of such an economy as a 'closed' one. On the contrary, close to zero estimated values for β would imply the existence of a high degree of international capital mobility.

In this paper, instead of trying to come to terms with the 'FH paradox' from a purely econometric perspective, a strategy amply adopted by the majority of researchers during the last thirty years, we have rather opted for a National Accounts point of view, focusing on the very accounting definition of the variables included in the classical FH model.

The basic question to which we have subjected the FH syllogism is the following one: does the initial FH model specification actually measure the relationship between the genuinely *domestic*[2] part of an economy's total investment and the equally *domestic* part of its saving, as the initial FH logic demands?[3] The answer we give to this question is that probably not, since in what Feldstein and Horioka (1980) called 'gross domestic investment' it is strongly likely that foreign capital resources might be included as well. In our effort to somehow 'cleanse' the investment part of the FH model from such foreign capital constituents we introduce a new variable denominated 'modified gross fixed capital formation' (MGFCF) which, in general terms, is derived by subtracting from an economy's investment any *imports of fixed assets* embedded in it. Such a process can be effectuated using the so-called 'supply-use' and 'input-output' tables maintained in the broader context of the System of National Accounts (SNA).

Working this way, and using data for the economy of Norway, we finally obtain what seems to be a better-performing model specification for the initial FH model, basically due to the elimination of the autocorrelation apparently inherent in it. Furthermore, the results obtained from this modified version we propose, as well as from the alternative methodologies implemented in the empirical analysis section of the paper, all point towards a high degree of international capital mobility for Norway as opposed to the significantly lower one predicted by the FH model in its initial formulation.

The remainder of the paper is organized as follows: Section 2 reviews the relevant literature with an emphasis to those strands which are related to our own empirical methodology. Section 3 explains a little more the alternative approach to the FH paradox which we propose as well as the various accounting magnitudes involved. The various econometric methodologies used in our empirical analysis, derived from respective theoretical considerations regarding the FH paradox are explained in Section 4. In Section 5 the variables and data used are introduced. Section 6 outlines the empirical results. Finally, Section 7 concludes the paper.

2. Literature review

Feldstein and Horioka (1980) proposed that the degree to which the gross domestic investment of an economy responds to changes in its gross domestic saving constitutes a measure for its underlying degree of international capital mobility. Under conditions of high international capital mobility one would expect its investment needs to perfectly be met by a kind of global 'pool' of capitals formed by the excessive savings of foreign economies, which are freely moving on an international scale in search of increased rates of return. In the contrary case, any incremental saving produced domestically within an economy would entirely be absorbed by its own investment capital needs and not permitted to freely pursue better rates of return outside its national borders. That is, a close to unity saving-investment relationship for the economy (β) would be produced, and thus, a low degree of international capital mobility should be assumed.

What was actually paradoxical with the empirical part of the Feldstein and Horioka (1980) paper, was their finding of generally high saving-investment correlations for a group of developed OECD countries during the 1960-1974 period, implying that, contrary to the common intuition, low international capital mobility was actually the underlying characteristic of these economies. This finding of theirs has ever since been repeatedly corroborated (Feldstein, 1983; Feldstein and Bacchetta, 1991; Blanchard and Giavazzi, 2002).

Many attempts have been made, however, to reconcile what has come to be deemed a 'stylized fact' in international economics with what common sense or direct observation would rather dictate, i.e., an ever bigger degree of international capital mobility prevailing internationally in a supposedly 'globalized' and thus, highly integrated, world economy. One of them approaches the FH puzzle via the so-called 'intertemporal budget constraint' assumption, according to which saving and investment must ultimately equalize in the long run, or else, that the current account balance (CAB) is a stationary magnitude in the long run. Gundlach and Sinn (1992) and Mastroyiannis (2007) have convincingly explained that the necessary condition for the existence of international capital mobility for an economy is that its CAB be nonstationary or integrated of first order. Jansen (1997) and Corbin (2004) have also approached the FH paradox in terms of the theoretical premise of the 'intertemporal budget constraint'. Plenty of other authors have focused on CAB's stationarity as an alternative approach to the FH puzzle, capable of revealing the true saving-investment relationship (Miller, 1988; De Haan and Siermann, 1994; Argimón and Roldán, 1994; Schneider, 1999; Sinha and Sinha, 2004; Kalyoncu, 2007).

Implicit in the assumption of a stationary CAB lies the existence of a 'one-to-one' saving-investment relationship in the long run, which according to the FH logic, is translated to a low degree of international capital mobility. On the contrary, CAB's nonstationarity remits to a high degree of international capital mobility, since saving and investment do not somehow seem to be related in the long run. A high volatility in CAB's behavior can be observed through time in this case, and by extension, a high degree of international capital mobility can be deduced (Sinn, 1992). Thus, under the prism of the 'intertemporal budget constraint', high β values in the FH sense could perfectly coexist with high degrees of international capital mobility (Krol, 1996; Jansen, 1996; Coiteux and Olivier, 2000; Corbin, 2004). We also adopt the strategy of conducting CAB stationarity tests as a means for revealing the true saving-investment relationship in our empirical analysis as we further explain in Section 4.

On the other hand, expressions like 'there is a one-to-one saving-investment relationship' and 'CAB is stationary in the long run', which according to the FH terminology imply high β values and thus a low degree of international capital mobility, are also equivalent, within the context of cointegration theory, to the expression 'saving and investment are cointegrated'. Cointegration theory has received increasing attention in relation to the FH paradox (Miller, 1988; Leachman, 1991; Gulley, 1992; De Haan and Siermann, 1994), basically because the concept of two variables being linearly linked in the long run, intuitively alludes to the very essence of the 'FH paradox' of a generally strong saving-investment relationship. However, even sophisticated cointegration studies (e.g. Özmen, 2003; Hussein, 1998) have generated inconclusive and, at times, contradictory results. In the empirical analysis part of this paper we also carry out stationarity and cointegration tests for the variables of saving and investment in their various definitions, as we further explain in Section 4.

Belonging to the broader field of cointegration theory, the Autoregressive Distributed Lag (ARDL) method offers the advantage of not requiring prior knowledge as to the order of integration of the variables involved for a cointegration analysis to be carried out. Applied to the 'FH paradox', an ARDL specification has the merit of simultaneously incorporating terms corresponding to both the short and the long run responsiveness of investment to potential changes in saving. De Vita and Abbott (2002) especially adapted the ARDL model for the needs of the 'FH paradox'. Vikøren (1994), Corbin (2004), Özmen (2007), Kollias, Mylonidis and Paleologou (2008), and Singh (2008) are also inscribed in this strand. In our own empirical analysis, we also have recourse to the ARDL method whenever our stationarity tests produce inconclusive results as to the order of integration of the variables involved, or in case that the Engle-Granger (EG) test for cointegration cannot conclusively decide as to the existence of cointegration between them.

Another critique against the FH finding pertains to what Apergis and Tsoumas (2009) have called 'Criticisms on Variables' measurements'. Within this current, the most interesting approach seems to be that of Rossini and Zanghieri (2002, 2003). It addresses the main question we are also posing in this paper, as already stated in the Introduction: whether the investment variable of the initial FH model actually corresponds to the gross *domestic* investment of the economy, so that when regressed on its *domestic* saving, a measure for its underlying degree of international capital mobility can be obtained as the FH initial syllogism demanded. The answer Rossini and Zanghieri (2002, 2003) give to this fundamental question is that FH's investment variable might in fact deviate significantly from what it supposedly depicts, probably due to the inevitable intertwinement between the financial and the real side of an ever more globalized international economy. They subtracted foreign direct investment (FDI) from investment,[4] obtaining lower β coefficient values than the ones produced by the FH model in its initial version, a finding which they interpreted as an indication of a higher degree of capital mobility than the one the FH paradox would have predicted. In the line of Rossini and Zanghieri (2002, 2003), Adey (2003) also adopted this method, nevertheless obtaining results which confirm the 'FH paradox' (high degrees of saving-investment relationship). We have also adopted this approach in our empirical analysis as an alternative means of assessing the actual degree of Norway's international capital mobility. Our MGFCF approach, however, seeks to give an even more satisfactory answer to the same question. More about both the Rossini and Zanghieri (2002, 2003) and our own MGFCF methodology is explained in Section 3.

There have also been studies in the relevant literature focusing exclusively on the Norwegian paradigm. Using data for Norway, for the time span 1970-1985, Sinn (1992) observed that, in average terms, the saving-investment gap of Norway only reached a meager 2.2 per cent at most, which according to the FH criterion would point towards a limited degree of international capital mobility. At the same time, however, the respective pattern of change of Norway's CAB revealed a remarkable dynamism and volatility, especially during the sub period of 1973-1981. This way, Sinn (1992) formulated his famous argument against the use of averaged data on saving and investment[5] when testing for the validity of the 'FH paradox', claiming that a strong saving-investment relationship can in fact be compatible with a high degree of international capital mobility if averaged data are used.

Vikøren (1994) used an ARDL model specification, finding a simultaneously high degree of short run and a low degree of long run international capital mobility for Norway between 1954 and 1988. He interpreted this contradiction in terms of the intertemporal budget constraint.

Jansen and Schulze (1996) used an Error Correction Mechanism (ECM)[6] specification particularly adjusted to the needs of the 'FH paradox'. Using data for the Norwegian economy comprising the period 1954-1989, they also found a simultaneous existence of some degree of international capital mobility in the short run and a respective lack of international capital mobility in the long run. When they searched for structural breaks in their data, they finally reached a satisfactory match between their empirical findings and some of the most easily identifiable historical milestones of the recent Norwegian economy.

3 A NECESSARY ACCOUNTING MODIFICATION

As already stated, in this paper we have sought a more accurate definition for the investment variable of the basic FH equation as an alternative way of tackling the 'FH paradox', rather than further trying to exploit the apparently long ago exhausted terrain of the implementation of ever more sophisticated econometric approaches.

The main challenge is to avoid that foreign capital resources also surreptitiously enter into the investment variable of the FH equation, since in this case, what one would actually be measuring would be the relationship between the economy's *domestic* saving on one hand, and something which would only approximate its total (and not its solely *domestic*) investment, on the other. In this case, we should, by no means, deem the obtained estimated value of β an appropriate benchmark for the economy's actual degree of international capital mobility in the original FH sense. Investment should somehow be 'cleansed' from the foreign capital ingredients possibly embedded in it, so that a better performing overall FH model specification would be achieved.

Looking thus for the ideal accounting magnitude for *domestic* investment one can easily enough find out that FH's variable 'gross domestic investment' is actually a former name for the SNA magnitude that was posteriorly named 'gross capital formation' (GCF). According to the SNA definition, GCF is ' … measured by the total value of the gross fixed capital formation (GFCF),[7] changes in inventories and acquisitions less disposals of valuables' (2008 SNA, 2010). Following our electronic correspondence with International Monetary Fund's (IMF) specialist on National Accounts and Balance of Payments issues, Ms S. Matei,[8] and given that actually several recent papers within the FH literature have used GFCF as a proxy for FH's 'gross domestic investment' (Jounas, 2007; Payne and Mohammadi, 2006; Payne, 2005; Kollias, Mylonidis and Paleologou, 2008), we have also opted for GFCF in our empirical analysis.

Nevertheless, neither GFCF exactly corresponds to the purely *domestic* part of investment: if one really delves into its constituents from an accounting point of view, we will realize that numerous foreign capital elements are also included in it. Still, a more refined investment variable is needed.

Rossini and Zanghieri's (2002, 2003) approach has been such an attempt. However, one should be aware of the drawbacks which this approach might also suffer from. According to Ms S. Matei,[9] the basic problem with it lies in that the magnitude of FDI might also contain capital inflows from abroad, especially in the form of services imported by resident institutional units of the economy from their respective foreign parent companies.

Generally speaking, any similar effort of fully 'cleansing' out investment from its various foreign capital components is bound to collide with the obstacle of the continuous flows of capital on an international scale, utterly interconnected and in most cases impossible to track, as is happening in our globalized economy. The two basic economic spheres (material and financial) are constantly converted one into the other, rendering the whole attempt of clearly isolating one from another practically impossible. This is why we use the Rossini and Zanghieri (2002, 2003) method only as an alternative approach to the 'FH paradox', out of many others, and not in an absolute manner. All in all, a 'holistic' treatment to the 'FH paradox', consisting in the simultaneous implementation of many different approaches is certainly superior to a one-sided or targeted one, and this is exactly the strategy we have adopted in our empirical analysis.

The alternative method we propose in this paper consists in subtracting the *imports of fixed assets* which are destined to an economy's GFCF from the GFCF itself, hoping to thus obtain the desired purely *domestic* part of the economy's investment. We first extract the *imports of fixed assets* destined to the GFCF from the respective supply-use tables,[10] and then subtract them from its GFCF, to obtain our MGFCF magnitude. MGFCF presents the additional merit of being no more subject to the aforementioned drawback of the 'GFCF minus FDI' method of mixing up material and nonmaterial elements. In this sense, it corresponds to the purely productive part of *domestic* investment and thus it can be expected to reveal the actual degree of 'closeness' of the economy or else, its underlying degree of international capital mobility, when regressed on domestic saving.

4 Methodological framework

We have already briefly explained the basic premises behind the 'FH paradox' in Section 2. We offer here its general mathematical formulation:

$$(I/Y)_i = \alpha + \beta(S/Y)_i \tag{1}$$

where:
Y stands for GDP, S for saving and I for investment, $(I/Y)_i$ is the gross domestic investment to GDP ratio, and $(S/Y)_i$ is the gross domestic saving to GDP ratio.

Based on equation 1, in the purely empirical part of this paper we use four different approaches to it, derived from respective theoretical considerations met in the relevant literature presented in Section 2:

i. The classical Feldstein and Horioka (1980) approach of equation 1 which uses the magnitude GFCF as a proxy for investment (I), and gross domestic saving (GDS)[11] as a proxy for saving (S), both expressed as ratios to GDP. Thus, equation 1 is rewritten as:

$$(GFCF/GDP)_i = \alpha + \beta(GDS/GDP)_i \tag{2}$$

ii. The 'FDI subtracted from GFCF' approach of Rossini and Zanghieri (2002, 2003). In this case, the initial FH model of equation 1 becomes:

$$[(GFCF/FDI)/GDP]_i = \alpha + \beta(GDS/GDP)_i \tag{3}$$

iii. CAB/GDP stationarity tests, as a means for revealing the true long-run saving-investment relationship, and hence, the underlying degree of international capital mobility of the economy.

CAB's stationarity tests' relevance for the 'FH paradox' has been explained in Section 2. Regarding their interpretation from a purely empirical point of view, Coakley, Kulasi and Smith (1998) have warned about the two diametrically opposed ways in which a stationary CAB might be interpreted: first, as pointing towards a lack of significant international capital mobility, since it implies a 'one to one' saving-investment relationship or else, cointegration of saving and investment; second, as indicative of a high degree of international capital mobility since it remits to an open economy, for which the 'solvency constraint' holds. Out of these interpretations we have adopted the first one for our empirical analysis, which is also the most frequently met in the relevant literature.

iv. Our MGFCF approach as an improved proxy for Feldstein and Horioka's (1980) 'gross domestic investment' variable. The mathematical formulation of the FH model would in this case be:

$$(MGFCF/GDP)_i = \alpha + \beta(GDS/GDP)_i$$

Regarding the specific steps of our overall econometric analysis, we first run an Ordinary Least Squares (OLS) regression under each one of the different model specifications corresponding to equations 2, 3, and 4. We then test for the validity of the stochastic assumptions of a typical OLS regression analysis: first, the residuals' normality assumption via the Jarque-Bera (JB) test; then the residuals' autocorrelation tests follow: Breusch-Godfrey (BG) and Ljung-Box (LB). Finally, we test for correct model specification, using the Ramsey's RESET test.

Whenever we detect autocorrelation, as a first step we try to eliminate it by adding extra auto regressive terms (AR terms) to the model, and then we reestimate. In parallel, we also proceed to the aforementioned formal autocorrelation tests.

Alongside the already mentioned CAB's stationarity tests, we also carry out stationarity tests for the variables included in equations 2 and 3, i.e., *GDS/GDP* and *GFCF/GDP*, and *GDS/GDP* and (*GFCF-FDI*)/*GDP*, respectively. If they prove to be integrated of the same order, then we proceed with an EG test for cointegration. As a general rule, validity of the 'FH paradox', or equivalently, a low degree of international capital mobility could be deduced in the event of obtaining saving-investment cointegration. In the opposite case (saving and investment are non-cointegrated) a high degree of capital mobility should be inferred.

In case of contradictory or inconclusive results from our stationarity tests or the EG test the ARDL method is implemented. An ARDL model especially adapted for the needs of the 'FH paradox' is found in De Vita and Abbott (2002):

$$\Delta\left(I/Y\right)_t = c_0 + \pi_1\left(I/Y\right)_{t-1} + \pi_2\left(S/Y\right)_{t-1} + \sum_{i=1}^{p}\gamma_i\Delta\left(I/Y\right)_{t-i} + \sum_{j=0}^{q}\delta_j\Delta\left(S/Y\right)_{t-j} + \varepsilon_t \qquad (5)$$

where I/Y and S/Y correspond to the saving and investment shares in output, while the sum $\pi_1(I/Y)_{(t-1)} + \pi_2(S/Y)_{(t-1)}$ constitutes an ECM specification.

5. Variables and data used

We have gathered data for Norway's gross domestic product (GDP), gross domestic saving (GDS), gross fixed capital formation (GFCF), imports of fixed capital assets destined to GFCF, current account balance (CAB), and foreign direct investment (FDI). The data is available on request from the authors.

Regarding the sources and time spans of the aforementioned data, GDP, GDS and GFCF were kindly offered by Statistics Norway via electronic correspondence,[12] and refer to the period 1978-2008; regarding CAB and FDI, the former is referring to the period 1983-2008, the latter to the period 1981-2008, and the respective time series for both magnitudes were downloaded from Statistics Norway — Balance Of Payments Tables. Subsequently, we formed the respective variables: gross domestic saving to GDP (*GDS/GDP*), gross fixed capital formation to GDP (*GFCF/GDP*), and current account balance to GDP (*CAB/GDP*). Using the available data on the imports of (4) fixed capital assets destined to the GFCF of Norway, we were able to form our variable *MGFCF/GDP*. Whereas, subtracting FDI from GFCF and then dividing by GDP, we obtained the variable (*GFCF-FDI*)/*GDP*, which corresponds to the Rossini and Zanghieri (2002, 2003) approach.

All variables are expressed in current prices, and in millions of Norwegian kroner (mill. NOK).

6. Empirical results

Table 1 recapitulates the empirical results for Norway. The basic empirical finding of this paper is that of the existence of significant autocorrelation in the classical FH specification of equation 2, which actually renders it invalid for further inference from an econometric point of view.

As to the JB normality test results, we invariably find normality for the residuals produced by each one of the regression equations 2, 3, and 4. With regard to the autocorrelation tests, though, more discussion is needed. Autocorrelation of the disturbance terms may appear in a regression due to factors related to a wrong model specification such as omitted variables, a wrong functional form for the regression equation or measurement errors in the variables used (Asteriou, 1986). In this case, the results of the OLS regression analysis must be discarded and a more appropriate model specification sought.

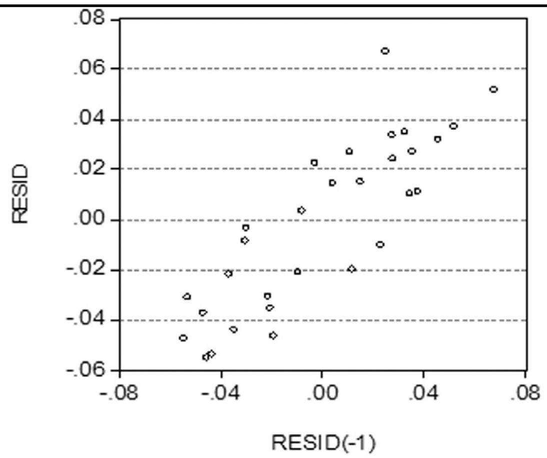
Table 1: Empirical results for Norway

Model	*β coefficient*	*Durbin-Watson*	*BG test for autocorrelation: p-value of the LM statistic (p = 2)*	*AIC*	*SBC*
Equation 2. Dependent variable: GFCF	-0.21452	0.29636	0.00002	-3.80626	-3.71375
Equation 2 with an additional AR(1) term	-0.22447	1.49487	-	-5.03064	-4.89052
Equation 3. Dependent variable: GFCF-FDI	-0.22675	0.29575	0.00004	-3.65881	-3.56366
Equation 3 with an additional AR(1) term	-0.26498	1.74776	-	-4.85630	-4.71232
Equation 4. Dependent variable: MGFCF	0.104883	0.96649	0.055931	-5.32604	-5.22946

Notes: 1. Eviews runs on data as described in Section 6.

In the case of Norway, we detected autocorrelation in the disturbance terms of equation 2 at an early stage of our analysis, when we just scatter plotted the current period's residuals against those of the respective previous period (i.e. lagged once residuals), as shown in Figure 1.

Figure 1: Eqn 2 Scatter plot of current period (RESID) against previous period residuals [RESID(-1)]



The positive relationship connecting the current period's residuals against the previous period's ones, signifies the existence of (positive) serial correlation in the disturbance terms of equation 2. Additionally, the Durbin-Watson (DW) statistic value of 0.29636 produced by running equation 2 offers further evidence as to the existence of autocorrelation in the disturbance terms, being significantly lower than the rule of thumb value of 2 which corresponds to the no-autocorrelation state. We further corroborate this first intuition from the results of our formal BG and LB autocorrelation tests. The respective p-value of the Lagrange Multiplier (LM) statistic of the BG test is equal to 0.00002, leading to an indubitable rejection of the implied null hypothesis of the lack of autocorrelation in the specification of equation 2.

Table 2: Breusch-Godfrey Serial Correlation LM Test for equation 2

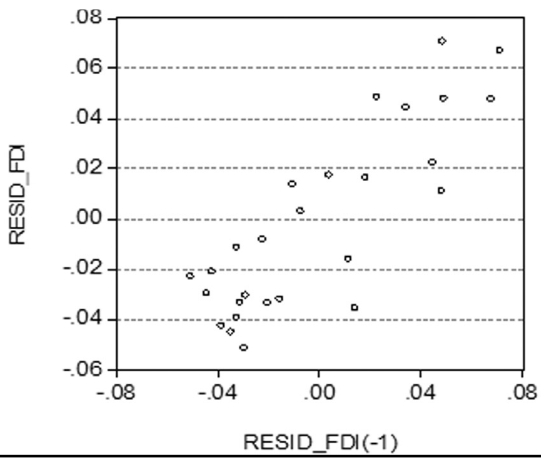
F-statistic	30.78722	Probability	0.00000
Obs*R-squared	21.55032	Probability	0.00002

Notes: 1. Eviews runs on data as described in Section 6.

In order to account for the aforementioned autocorrelation of the disturbance terms found in equation 2, we add an autoregressive term AR (1) to it. We now obtain a DW value of 1.49487, conspicuously higher than the respective obtained with the specification of equation 2, implying that the addition of AR terms significantly reduces autocorrelation compared to the initial FH specification, although still not eliminating it at all. Besides, according to the Akaike Information Criterion (AIC) and the Schwartz Baysean Criterion (SBC), the model specification with the additional AR term must be preferred to that of the classical FH specification of equation 2.[13]

When we adopt the specification of equation 3, i.e., the FDI subtraction from the GFCF method, autocorrelation still does not completely cease to exist as is evident from the respective RESID_FDI against [RESID_FDI(-1)] graph below.

Figure 2: Eq3 Scatter plot of current period (RESID_FDI) against previous period residuals [RESID_FDI(-1)]



We still obtain a low DW value (0.29575) in the OLS regression of equation 3, and the p-value of the LM statistic of the BG test is still low enough (0.00004) for the null hypothesis of no autocorrelation to be accepted at a 95% level of significance. Nevertheless, it has moved slightly towards the 'region' of the acceptance of the aforementioned null hypothesis (0.00004>0.00002), which we are tempted to interpret as an indication that the model of equation 3 suffers to a lesser extent from the autocorrelation problem diagnosed in the initial FH specification of equation 2.

Table 3: Breusch-Godfrey Serial Correlation LM Test for equation 3

F-statistic	31.07663	Probability	0.00000
Obs*R-squared	20.19995	Probability	0.00004

Equation 3 seems to perform slightly better as a proper 'FH paradox' specification than equation 2 does, especially regarding the problem of the disturbance terms' autocorrelation flaw, and this is further confirmed by the fact that when an AR term is added in the former, the respective DW value becomes somewhat closer to the rule of thumb value of 2.[14]

Finally, and most importantly, autocorrelation seems to be significantly reduced or even eliminated, when the MGFCF approach which we propose is used. We now obtain a DW value of 0.96649, which still signifies the existence of autocorrelation in our own specification, but clearly outperforms the respective values produced by equations 2 and 3.

Even more important though, is the fact that using MGFCF, the BG test produces a p-value of 0.05593 for the respective LM statistic, which is this time high enough for the null hypothesis of the lack of autocorrelation to be accepted at a 5% significance level. This finding strongly points towards the elimination of autocorrelation under the new specification. By focusing on a better accounting definition of the variables involved, more specifically the one referring to the investment part of the initial FH equation, we have been able to reach a better performing model specification, which furthermore, seems to more accurately correspond to the basic FH logic itself.

The AIC and SBC values produced are now 5.32604 and -5.22946, confirming that the MGFCF specification outperforms the other ones we have used in our empirical analysis, namely, the classical FH model of equation 2, and the model of equation 3. They are even lower than the ones obtained when additional AR terms are incorporated in equations 2 and 3.

As a final, but no less important observation in relation to the regression analyses' results of Table 1, we should particularly emphasize the fact that under almost any one of the various regression equations used the estimated value of the 'savings retention coefficient' β persistently oscillates around a value of -2. Only under the model specification of equation 4, does β acquire for the first time a positive but close to zero value. Temporarily overlooking the violation of the basic stochastic assumption of no autocorrelation detected, the very fact that the negative β estimated values are converted to a small positive one as soon as a more precise variable definition for investment takes place, points towards the non-validity of the 'FH paradox' in the case of Norway. The estimated value of 0.10488 for β obtained from equation 4 is realistic enough, especially if compared to the negative values around -2 produced by the other specifications: one would logically enough argue that negative estimated values for β seem rather difficult to interpret from an economic point of view. The value of 0.10488 on the other hand is economically interpretable, and clearly points towards an exceptionally low saving-investment relationship for Norway, or else, towards a high degree of international capital mobility characterizing this country, contrary to what the 'FH paradox' would have predicted.

Alongside the regression analyses' results presented in Table 1, we have also carried out stationarity tests for *CAB/GDP*. We have used three distinct tests, namely the Augmented Dickey-Fuller test (ADF), the Phillips-Perron test (PP), and the Kwiatkowski, Phillips and Shin test (KPSS). Two (out of the three in total) Dickey-Fuller (DF) specifications have been used: i) with solely a constant included, and ii) with a constant, as well as a trend included. Various, empirically decided upon, numbers of lagged terms have been used.

As to the results obtained, both the ADF and PP tests leave no doubt about the non-stationarity of the *CAB/GDP* in levels for Norway, especially under the first DF version, which in passing, according to Vogelvang (2005), is the most important one for economic applications in general. The KPSS test produces inconclusive results, but overall it also points towards the non-stationarity of the *CAB/GDP*, especially for more 'conservative' statistical significance levels, irrespectively of the DF version used.[15]

But, as we have already pointed out elsewhere, a non-stationary *CAB/GDP* should be interpreted as an indication that the 'FH paradox' does not hold, or else, as evidence for a high degree of international capital mobility. Thus, the *CAB/GDP* stationarity tests offer a further confirmation to our regression analyses' results, pointing towards a high degree of international capital mobility for Norway.

Finally, we have also carried out stationarity and cointegration tests in pairs for the variables involved in equations 2 and 3, i.e., *GDS/GDP* and *GFCF/GDP*, and *GDS/GDP* and (*GFCF-FDI*)/*GDP* respectively. Generally, a lack of cointegration between both pairs is deduced from these tests.

Unfortunately, due to the general lack of data for a sufficient group of countries and a satisfactory time span our MGFCF approach suffers from, we have been prevented from conducting stationarity and cointegration tests for the respective variables involved in equation 4 (*GDS/GDP*) and (*MGFCF/GDP*). Only a few economically developed countries do maintain the necessary 'supply-use' and 'input-output tables' data for the MGFCF magnitude to properly be formed, and only for the last few years.

We further tested the hypothesis of the lack of cointegration between *GDS/GDP* and *GFCF/GDP*, using the ARDL method, for the reasons already exposed in Sections 2 and 4. Interestingly enough, the ARDL also pointed towards the lack of cointegration between the variables producing a value of 0.11082 for the respective F-statistic, which lies well below the lower bound of the pair of critical values provided by Pesaran and Pesaran (1997).[16] Thus, we were obliged to accept the lack of a long-run relationship between *GDS/GDP* and *GFCF/GDP*, and by extension, deduce that the FH paradox does not hold for Norway when the magnitude GFCF is used as a proxy for investment.

The same conclusion was reached when we tested the other pair of variables for stationarity: *GDS/GDP* and (*GFCF-FDI*)/*GDP* appear to be of a different order of integration in their levels, and thus, no cointegration between them can be inferred. The ARDL method again decides in favor of the null hypothesis of the lack of cointegration between the two variables, producing a value of 0.40924 for the respective F-statistic, which also lies below the lower bound of the pair of critical values provided by Pesaran and Pesaran (1997).[17] Thus, we also obtain evidence pointing towards the lack of a long-run relationship between saving and investment in the case of Norway when the magnitude (*GFCF-FDI*) is used as a proxy for investment. In the context of the 'FH paradox' terminology, this finding again points towards a high degree of international capital mobility for Norway, in sharp contradiction to what the 'FH paradox' would dictate.

7 Conclusions

In an attempt to approach the 'FH paradox' from an accounting point of view, we have tried to 'cleanse' the investment variable of the initial FH model from any foreign capital components included in it, so that it better corresponds to the purely *domestic* investment magnitude initially sought after by Feldstein and Horioka (1980).

Towards this direction, we have subtracted Norway's imports of fixed capital assets from its GFCF, obtaining what we have termed the 'modified gross fixed capital formation' (MGFCF). Using MGFCF in place of the FH investment variable we have eliminated autocorrelation as well as obtained a β value significantly lower than the respective one produced by the classical FH model. The former means an improved FH model specification, while the latter implies a higher degree of international capital mobility for Norway than the one the classical FH specification would have predicted.

A promising field for further research on the FH paradox is opened up to the extent that, gradually, more countries are able to provide data on their imports of fixed capital assets for broader time spans.

Accepted for publication: 20 January 2013

ENDNOTES

1. Informatics Department, University of Macedonia, Thessaloniki, Greece. Corresponding author: Eleftherios Makedonas, 24, Iasonidou st., 552 36 Panorama, Thessaloniki, Greece. E-mail: lefmak@gmail.com. The authors gratefully acknowledge two anonymous referees and Bruce Philp for their useful comments.

2. '*Domestic*' in italic denoting the cleansed-from-foreign-capital-constituents investment of an economy, as opposed to 'domestic' as initially used by FH (1980), which might still be including foreign capital constituents.

3. In the words of Feldstein and Horioka (1980): 'This paper uses data on the major industrial countries to measure the extent to which a higher domestic saving rate in a country is associated with a higher rate of domestic investment' (p. 317).

4. What they (rather vaguely) called 'domestic investment', without unfortunately further analyzing its exact accounting constituents.

5. A tactic firstly introduced by Feldstein and Horioka (1980), who divided the total 15-year span of their data into three 5-year sub periods, claiming that this way any cyclicality inherent in their annual saving and investment observations was eliminated (p. 318).

6. Like ARDL, an ECM also encompasses both a term referring to the short and one referring to the long run responsiveness of investment to potential saving changes. For the ECM models as a special derivation from the ARDL ones see for example Baddeley and Barrowclough (2009). A methodical and comprehensive way of working with ECMs within the context of the 'FH paradox' can be found in Van Rensselaer & Copeland (2000).

7. According to the 2008 SNA, GFCF constitutes a subtotal of GCF, which ' ... is measured by the total value of a producer's acquisitions, less disposals, of fixed assets during the accounting period plus certain specified expenditure on services that adds to the value of nonproduced assets' (2008 SNA, 2010).

8 Personal communication Matei, S. (December 24, 2009), and Matei, S. (December 28, 2009).

9 Personal communication Matei, S. (December, 24, 2009).

10. For the various concepts and definitions regarding the supply-use and input-output tables, we have basically drawn upon the 2008 SNA (2010) and the Eurostat Manual of Supply, Use and Input-Output Tables (2008), to which we remit.

11. From an accounting point of view, FH's 'gross domestic saving' magnitude would nowadays correspond to the balancing item of the 'Use of disposable income account' of the SNA. Hence, we use this latter magnitude in our own empirical analysis.

12 Personal communication Jakobsen, O. M. (September, 16, 2009). Imports of fixed capital assets destined to GFCF were downloaded from Statistics Norway - National Accounts/Input Output Tables 1992-2007.

13 Using the model with the additional AR (1) term, we obtain -5.03064 and -4.89052 respectively for the AIC and SBC criteria, compared to the values of -3.80627 and -3.71375 respectively when we use the classical FH specification of equation 2.

14. With the addition of an AR(1) term in equation 3, the DW statistic obtains a value of 1.74776, compared to the value of 1.49487 obtained when an AR(1) term is added to equation 2.

15. While the KPSS test decides in favor of the CAB/GDP non-stationarity at both the 5% and 10% significance levels under the first DF version, it does so only at the 10% significance level under the second DF version.

16. According to Pesaran and Pesaran (1997), for one independent variable as in our case (k=1), and a 5% significance level, the lower and upper bounds for the F-statistic are 4.934 and 5.764, respectively. Within the context of the ARDL method, a value of 0.11082 for the F-statistic, lying below the lower bound of the respective critical values (0.11082 < 4.934), means that the null hypothesis of no cointegration cannot be rejected, leading to the conclusion of a high degree of international capital mobility for Norway.

17. In this case, again, for the same number of independent variables as before (k-1), and at the same significance level (5%), the respective lower and upper bounds are 4.934 and 5.764. Since 0.40924<4.934, we cannot reject the null hypothesis of no cointegration implied by the ARDL method, and a high degree of international capital mobility is again deduced when the variable (*GFCF-FDI*) is used as a proxy for Norway's investment.

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