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Abstract

The net foreign assets diverge since the early 2000s among the European Union (EU) countries: is this sustainable and what causes the divergence? This paper measures the persistence and the sources of shocks to the net foreign assets of twelve EU countries between 1972 and 2015. There is evidence of external adjustment to changes in external wealth but countries with the highest persistence of shocks see their net foreign assets diverging. The expansion of gross flows leads to this divergence of net foreign assets within the eurozone, implying whilst financial integration diversifies risk, it may lead to external imbalances.

Keywords: net foreign assets, financial integration, persistence

JEL codes: F31, F32

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1 Introduction

The net foreign assets diverge since the early 2000s among the European Union (EU) countries (see Figure 1): is this sustainable and what causes the divergence? This divergence underlies the causes of the European sovereign debt crisis (Baldwin and Giavazzi, 2015; Brunnermeier and Reis, 2019): differences in wealth and liabilities highlight competitiveness problems, in economies with current account deficits and high external debt, accumulated liabilities raise the possibility of sudden stop in capital flows and the risk of macroeconomic crisis (Blanchard and Milesi-Ferretti, 2012). The flow imbalances peak prior to the global financial crisis of 2008 and have narrowed since but considerable stock imbalances remain.

This paper measures the persistence and the sources of shocks to the net foreign assets in twelve EU countries (EU12) between 1972 and 2015. We use the persistence measures developed by Lee, Pesaran and Pierse (1992, 1993) and trace their evolution over time via the persistence profiles (Lee and Pesaran, 1993). The persistence measure captures the infinite-horizon effects of shocks to a nonstationary process and is scaled to the impact effects of the shocks. Using this measure, we could infer the presence of external adjustment, highlight countries that have high persistence of shocks therefore more susceptible to external imbalances. Although nonstationarity or large persistent measures are consistent with sustainability (Bohn, 2007; Antonini, Lee and Pires, 2013), rising net foreign liabilities could raise political pressure and financial stress during crisis. Large persistence measures also risk hurting its competitiveness against the rest of the world during normal times, as shown by Chen et. al (2013). With the estimated persistence measures, we could estimate the steady states at each time with the Beveridge-Nelson (1981) trends. Finally, we decompose the persistence measures by shocks to cross-border financial flows, common fluctuations in output and the dollar exchange rate, where significant persistence measures would identify the long-run driver of the net foreign assets.

This paper contributes to the literature by complementing the trend view of the net foreign assets. Lane and Milesi-Ferretti (2001) characterize the net foreign assets as a nonstationary process driven by demographics, stage of development and public debt, all of which are trended or slow-moving. Consistent with the literature, we also model the net foreign assets as a nonstationary process but elaborate on this non-stationarity as the persistence measure could range between zero and infinity. We also add to the trend view with financial integration as a long-run driver of the net foreign assets amongst the eurozone countries. This finding supports Hale and Obstfeld (2016) who analyze international debt flows within and outside the eurozone, finding that after the euro's introduction, euro core countries borrow from outside of the eurozone and lend to the euro periphery countries, leading to external imbalances within and beyond the eurozone. Our findings also confirm European Economic Advisory Group (2012) who argue that the imbalances in the euro area originate in the capital market.

We use the updated External Wealth of Nations (EWN) dataset (Lane and Milesi-Ferretti, 2018), including as many EU countries as possible and the longest time series. We end up with the EU12 economies between 1972 and 2015: the UK, Austria, Denmark, France, Germany, Italy, the Netherlands, Sweden, Switzerland, Greece, Portugal and Spain[2]. We focus on the EU economies because of the role of external balances in the European sovereign debt crisis and its subsequent inclusion in the macroeconomic surveillance framework (European Commission, 2012); furthermore, gravity factors (distance, language), trade and common institutional regime (the EU, the euro)

[2] We exclude Ireland and Finland due to large fluctuations of their net foreign assets that would affect the estimates of the multi-country system.

drive bilateral holdings that make the net foreign assets (Lane and Milesi-Ferretti, 2008a; Galstyan, Mehigan and Mercado, 2020). These interdependencies between countries are taken into account with a multi-country vector autoregression.

We find the expansion of gross flows, measured by the financial integration leads to divergence of net foreign assets of several euro-area economies: France, Germany, Greece, Portugal and Spain. These countries have the highest persistence of shocks to their net foreign assets. In other countries: Austria, Italy, the Netherlands and Switzerland, there is evidence of external adjustment where the persistence measures are less than one implying the long-run cumulative effects of shocks are less than their impact effects. Countries take between 4 and 10 years to adjust to new steady states following a shock to the net foreign assets. When we compare the net foreign assets with their steady states based on historical and cross-country dynamics, Denmark, Germany, the Netherlands, Greece, Portugal and Spain have deviated from their steady states persistently since 2000s.

The paper proceeds as follows. Section 2 describes how we characterize the dynamics of net foreign assets following Antonini, Lee and Pires (2013) and Lee and Pesaran (1993). Section 3 describes the data, the multi-country model and the results. Section 4 concludes.

2 Characterizing Net Foreign Assets Dynamics

We characterize the time series properties of the net foreign assets, like a stock variable, as a nonstationary process. This is consistent with both the cyclical and the trend views of the net foreign assets that complement each other in explaining the global imbalances. In the cyclical view (Obstfeld and Rogoff, 1995), the net foreign assets is modelled as a state variable: a shock that could be money shock, government spending shock or productivity shocks changes the current account and the net foreign assets; the net foreign assets would stay at the new level, known as the hysteresis property and treated as given in the optimization problems of the next periods. In the trend view, the net foreign assets are driven by persistent factors such as the demographic factors, the government debt and the economy's stage of development[3].

The dynamics of net foreign assets:GDP ratios in EU12 countries can be modelled through a simple vector autoregression (VAR) explaining the change in the ratio of each country in terms of its own recent past and the past values of the change in the ratios in related countries. Denoting the net foreign assets:GDP ratio in each country i at time t by nfa_{it} and modelling nfa_{it} as integrated of order 1 (I(1)) consistent with the description earlier, we can characterize the time series of the countries' ratios with the Wold representation:

$$\Delta nfa_t = \mu + C(L)\varepsilon_t \tag{1}$$

where $nfa_t = (nfa_{1t}, nfa_{2t}, \dots, nfa_{mt})'$ is the $m \times 1$ vector containing the net foreign assets ratio for the m countries of interest, μ is a vector of constants, $C(L) = I + C_1 L + \cdots + C_p L^p$ is a p-order matrix polynomial in the lag operator L, C_j are $m \times m$ matrices of parameters, and ε_t is the $m \times 1$ one-step-ahead forecast errors in Δnfa_t given information on lagged values of Δnfa_t. The ε_t are serially uncorrelated with mean zero and covariance Ω. The representation in (1) can capture cross-country interdependencies, including the effect of innovations to countries' net foreign assets that are correlated contemporaneously (through Ω) and the feedbacks across the countries' net

[3] Public debt is empirically found to be integrated of order one (Antonini, Lee and Pires, 2013); output per capita is I(1) because in the Cobb Douglas production function, the technology is the cumulation of productivity shocks (Garatt, Lee, Pesaran and Shin, 2012). Demography is a slow-moving variable.

foreign assets ratios over time (through the C_i), and so provides a useful vehicle to describe net foreign assets dynamics.

Following Lee, Pesaran and Pierse (1992, 1993), the long-run properties of the net foreign assets dynamics is captured by the $m \times m$ matrix **P** whose (i, j)th element is given by

$$\rho_{ij} = \frac{e_i' C(1) \Omega C(1)' e_j}{\sqrt{(e_i' C(0) \Omega C(0)' e_i)(e_j' C(0) \Omega C(0)' e_j)}}, i, j = 1, \dots, m \quad (2)$$

where e_i is the $m \times 1$ selection vector with unity in its ith element and zeroes elsewhere. The "persistence matrix" P provides a variance-based measure of the infinite-horizon effect of shocks to the system. It is easily interpreted by considering the measures $P_i = \sqrt{\rho_{ii}}$ based on its diagonal elements. These measures show the size of the permanent effect of a shock to the system that causes net foreign assets in that country i to rise by 1% on impact. In the univariate case, the measure coincides with the "impulse-based" measure of persistence, describing the infinite horizon effect of a 1% shock to the variable, therefore the two concepts are related. However, the variance-based measure has the advantage that it does not require, and indeed is invariant to, the identifying assumptions necessary to provide structural meaning to the shocks in an impulse response analysis conducted in a multivariate setting. The moving average representation at (1) accommodates the possibility that the instantaneous effect of shocks are gradually eroded over time so that the persistence measure can be close to or equal to zero (as it would be if the net foreign assets ratio series was actually stationary). The P_i therefore provides a continuous measure of the extent of the permanent effect of shocks to country i's net foreign assets, elaborating in a useful way on the usual dichotomous characterisation between I(0) and I(1) series.

We can trace the time profile of the effect of shocks measured by P_i at the infinite horizon, defining **P**(n) as the matrix whose (i, j)th element is given by

$$\rho_{ij}(n) = \frac{e_i' H(n) e_j}{\sqrt{(e_i' C(0)\Omega C(0)' e_i)(e_j' C(0)\Omega C(0)' e_j)}}$$

(3)

where $H(n) = (\sum_{i=0}^{n} C_i)\Omega(\sum_{i=0}^{n} C_i)'$ for $n = 0,1, \ldots$. Here the $H(n)$ capture the size of the permanent effects of the shocks as they accumulate over time up to period n. Clearly, the $P(n)$ converge to the persistence matrix P as $n \to \infty$ and the "persistence profiles," defined by the individual country-specific measures $P_i(n) = \sqrt{\rho_{ii}(n)}$, also converge to P_i as $n \to \infty$. These profiles will provide a useful characterization of net foreign assets dynamics, that again avoids the need for any structural assumption.

We could decompose the shocks to net foreign assets in the Wold representation of (1) so we can describe the way in which different types of system-wide shocks impact on countries' net foreign assets:GDP ratios and how their effects are propagated over time. Specifically, suppose x_t is a vector of EU-wide aggregates that will impact, in different ways and over different time scales, on net foreign assets of the EU economies; the vector might include EU12 aggregate output, say, so that we can consider the effect of a slowdown in growth on the individual economies' net foreign assets. Assume that the innovations in these aggregates are given by

$$v_t = x_t - \Gamma z_t$$

(4)

with mean zero and variance Ψ and where the Γ are fixed parameters and the z_t are a set of predetermined variables. Then we can generalize (1) to write

$$\Delta nfa_t = \mu + D(L)v_t + C(L)\varepsilon_t$$

(5)

where $D(L) = I + D_1 L + \cdots + D_q L^q$ is a matrix of lag polynomials capturing the effects of the identified system-wide shocks and the ε_t are now interpreted as "other, unidentified" innovations to net foreign assets assumed to be uncorrelated with the v_t. In this case, the matrix $P(n)$ is defined by its (i,j)th element in a way that can be decomposed:

$$\rho_{ij}(n) = \rho_{Sij}(n) + \rho_{Oij}(n)$$

(6)

where

$$\rho_{Sij}(n) = \frac{e_i' F(n) e_j}{\sqrt{(e_i' H(0) e_i)(e_j' H(0)' e_j)}}, \rho_{Oij}(n) = \frac{e_i' G(n) e_j}{\sqrt{(e_i' H(0) e_i)(e_j' H(0)' e_j)}}$$

$F(n) = (\sum_{i=0}^{n} D_i)\Psi(\sum_{i=0}^{n} D_i)'$, $G(n) = (\sum_{i=0}^{n} C_i)\Omega(\sum_{i=0}^{n} C_i)'$, and $H(n) = (\sum_{i=0}^{n} D_i)\Psi(\sum_{i=0}^{n} D_i)' + (\sum_{i=0}^{n} C_i)\Omega(\sum_{i=0}^{n} C_i)'$ for $n = 0,1, \ldots$ The profiles described by $P_{Si}(n) = \sqrt{\rho_{Sii}(n)}$ and $P_{Oi}(n) = \sqrt{\rho_{Oii}(n)}$ summarize the effects of the identified EU-wide shocks and the unidentified shocks on each countries' net foreign assets, and the scaling reflect the size of the identified and unidentified shocks on impact.

3 Net Foreign Assets in EU12 Countries

We first inspect the data and test if there is a unit root in the data. Having established the net foreign assets as a unit root process, we measure the persistence of shocks to the net foreign assets. Finally, we decompose the persistence measures by shocks to the cross-border financial flows, common fluctuations in output and the dollar exchange rate.

3.1 Data Overview

With the exception of Switzerland, the net foreign assets-to-GDP range between -60% and 20% of GDP from 1972 to the late 1990s but the range has grown to between –140% and 60% of GDP in 2015 (see Figure 1). The debtor countries: Greece, Portugal and Spain have built in excess of 100% of GDP of net foreign liabilities whilst the creditor countries: Germany, Denmark and the Netherlands have accumulated to nearly 50% of GDP. Switzerland has always had high net foreign assets throughout the sample but like other countries, its net foreign assets trends upward since 1990s before returning to 80% in 2015.

We test for unit roots in the net foreign assets data based on unit root tests with and without cross-section dependence: we do not reject the unit root null hypothesis for the net foreign assets but reject the null for the net foreign assets in first difference. Tables 1 and 2 report the augmented Dickey Fuller (ADF) test statistics for the levels and the first differences respectively for the individual countries and the panel unit root test statistics (Im, Pesaran and Shin, 2003) across different lag lengths. Tables 3 and 4 report the cross-sectional ADF (CADF) test statistics for the levels and the first differences for the individual countries and the panel unit root test statistics (Pesaran, 2007). We see evidence of the unit root null hypothesis not rejected for the levels but rejected for the first differences, most convincingly based on the panel unit root test statistics that is more powerful than individual countries' unit root statistics. Having established the net foreign assets as a unit root process, we estimate the persistence effects of shocks to the net foreign assets.

3.2 The Multi-country Model

We measure the long-run effect of a shock based on a multi-country VAR that models feedbacks over time and across countries. An unrestricted VAR (M_1) is one in which Δnfa_{it} is regressed on its own lags and lags of other countries individually but is impractical due to the length of our data. The most general model is therefore model M_2 that is a VAR of order r that regresses Δnfa_{it} on its own lags and lags of the rest of EU12, denoted as $\Delta nfa_{-i,t} = \sum_{j=1,j\neq i}^{m} \Delta nfa_{j,t}$. We conduct a search on models from M_2 to a random walk:

$$M_2: \Delta nfa_{it} = \alpha_i + \sum_{s=1}^{r} \beta_{s,i} \Delta nfa_{i,t-s} + \sum_{s=1}^{r} \gamma_{s,i} \Delta nfa_{-i,t-s} + \varepsilon_{it}, i = 1, \dots, m \tag{7}$$

M_3: the specific model of M_2, where coefficients with *t*-ratio below unity (in absolute value) are excluded

(8)

$$M_4: \Delta nfa_{it} = \alpha_i + \sum_{s=1}^{r} \beta_{s,i} \Delta nfa_{i,t-s} + \varepsilon_{it}, i = 1, \dots, m \tag{9}$$

$$M_4: \Delta nfa_{it} = \alpha_i + \varepsilon_{it}, i = 1, \dots, m \tag{10}$$

We specify a search on M_2 where we drop coefficients whose *t*-ratios are less than one in absolute value to obtain M_3. This improves the parsimony of the model and the precision of the persistence measures. M_4 is an autoregressive model that captures the feedbacks across time; M_5 is a random walk. We estimate the four models for the EU12 countries between 1972 and 2015 with the Full Information Maximum Likelihood (FIML) to take into account simultaneous cross-country correlations of residuals[4]. We compare the models with likelihood ratio test statistics against the critical values of χ^2 distribution given the restrictions of one model against another. Table 5 reports the log-likelihood values and the likelihood ratio tests.

[4] In the case of the unrestricted VAR model, M_1, the FIML and the OLS estimates coincide. In the case of restricted VAR models, M_2 and M_3, the FIML estimates are computed by iterating on the Seemingly Unrelated Regression Equations (SURE) estimates.

The specific multi-country model M_3 is the preferred model from Table 5. We do not reject model M_3 against model M_2 where the likelihood ratio test statistic is 27.36 against the χ^2_{20} critical value. In contrast, we reject the autoregressive model M_4 against the multi-country models M_2 and M_3, implying the relevance of cross-country influences in the data. We reject the random walk M_5 against all other models, implying the relevance of the short-run dynamics and the cross-country influences. Therefore, we compute the persistence measures (2) from the Wold representation of the multi-country models M_2 and M_3.

Taking the EU12 as a whole, the long-run effect of a percent shock to the net foreign assets is 0.74 percent, but the permanent effects range between 0.60 and 1.23 across countries. As expected, the persistence measures based on model M_3 are more precise than those obtained from model M_2 for all countries on Table 6. The aggregate persistence measure of less than one implies the presence of external adjustment i.e. counteracting effects to the impact effects of the shocks to the net foreign assets: long-run budget constraint means that creditors would run trade deficits and debtors would run trade surpluses. Countries with the highest persistence measures are Denmark, Germany, Sweden, Greece, Portugal and Spain, whose net foreign assets diverge on Figure 1.

Economies take between four and ten years to adjust to a new equilibrium following a shock to the net foreign assets. Figure 2 plots the persistence profiles from its impact effect to 15 years after the shock occurs. Subsequent to a percent shock, there are cases where the short-run exceed the long-run effect e.g. Germany and cases where the short-run effects oscillate e.g. the UK, Austria, France, reflecting the complexity and delays in macroeconomic or policy responses. Furthermore, it takes nearly 10 years for Austria and France to adjust to its long-run value but less than 5 years for other countries.

We could compute the steady states or the long-run values of the net foreign assets at each period with both the persistence measures and the shocks. The persistence measures of Table 6 and the associated profiles in Figure 2 are scaled to show the effect of a shock that causes the net foreign assets:GDP ratio to rise in that country by 1% on impact; they characterize the dynamic effects of shocks, but do not provide information on the shocks that have impacted on countries. The Beveridge and Nelson (1981) (BN) trends in the net foreign assets:GDP ratio provide information on this based on the estimated model M_3. The BN trend associated with the model in (1) is defined by $\widetilde{nfa}_t = \widetilde{nfa}_{t-1} + \mu + C(1)\varepsilon_t$ so that it evolves through time accumulating the infinite-horizon effect of the innovations to the series. It is effectively the infinite-horizon forecast of the series obtained once the effects of past shocks have worked their way through the system and in the absence of any subsequent innovations. The BN trends are therefore readily interpreted as the "steady-state" net foreign assets:GDP ratio at each point in time.

Denmark, Germany, the Netherlands, Greece, Portugal and Spain have deviated persistently from their steady states since the 2000s based on the historical dynamics of net foreign assets. We locate the BN trends in level by assuming that the net foreign assets:GDP ratios were all at steady state in the year 2000[5]. Figure 3 plot the net foreign assets and their steady states by distinguishing two groups of countries: one with and without a persistent gap between the net foreign assets and their steady states since the 2000s. The

[5] One could argue that most countries were close to their steady state in the run up to, or shortly after the adoption of the Stability and Growth Pact in 1997. We check the robustness of the results by varying the year to a few years before and after 2000.

latter group includes the UK, Austria, France, Italy, Sweden and Switzerland whose net foreign assets have fluctuated around their steady states.

3.3 The Source of Shocks

We turn to the decomposition of shocks and their contribution to persistence following the discussion around (4) and (5). The analysis takes its starting point model M2 where the shock in (7) has been decomposed into p different types of shocks, $\nu_{j,t}, j = 1, \dots, p$ and innovations, $\tilde{\varepsilon}_{it}$ orthogonal to $\nu_{j,t}$ as follows:

$$\widetilde{M}_2: \Delta nfa_{it} = \alpha_i + \sum_{s=1}^{r} \beta_{s,ii} \Delta nfa_{i,t-s} + \sum_{s=1}^{r} \gamma_{s,i} \Delta nfa_{-i,t-s}$$
$$+ \sum_{j=1}^{p} \sum_{s=0}^{r} \delta_{i,j}\, \nu_{j,t-s} + \tilde{\varepsilon}_{it}$$

(11)

where m = 12, r = 2, and p is the number of shocks. We consider three shocks that affect the net foreign assets ratios: namely, shocks to EU12 financial integration (FI_t), shocks to EU12 output (Y_t) and shocks to the dollar effective exchange rate (EX_t), which we define later. We compute the shocks from regressing each variable on its own lags as follows:

$$x_{j,t} = \lambda_{0j} + \sum_{k=1}^{q} \lambda_{kj} x_{j,t-k} + \nu_{j,t}, \qquad j = 1, 2, 3$$

(12)

where $x_{j,t}$ is the FI_t, the logarithm of Y_t and the logarithm of EX_t in turn, q denotes the lags. Enough lags are included so there is no serial correlation in the residuals. Model $\widetilde{M}_2$ consists of (11) and (12), which can be estimated jointly using FIML. Model $\widetilde{M}_3$ is where specification search is conducted on model $\widetilde{M}_2$ to improve the parsimony of the estimated model. Information criteria (AIC and BIC) are used to compare the general model $\widetilde{M}_2$ and the specific model $\widetilde{M}_3$. The estimated model can be inverted to obtain the estimate of the moving average form of (5) and the estimates of the associated persistence profiles described in (6).

In an environment of greater elasticity of capital flows, financial integration lowers interest rates that encourages borrowing and lending across countries: we define the EU12 financial integration as the cross-country average of international financial integration[6]. We further probe if common fluctuations in output drive the net foreign assets in the long run, defining the EU12 output as the sum of Gross Domestic Product (GDP) across the EU12. Current account imbalances might reflect the convergence mechanism between the EU core economies and the EU peripheral economies (Blanchard and Giavazzi, 2002). Finally, we probe if the exchange rate fluctuations are important long-run determinants of the net foreign assets in the EU, using the dollar effective exchange rate i.e. trade weighted bilateral nominal exchange rates as we have legacy European currencies, British pound, Swiss franc, Danish krone and Swedish krona. The dollar is the world reserve currency; exchange rate can affect the net foreign assets via two channels---first, via the net valuation changes directly (to the extent there is a currency mismatch); second, via the current account balance indirectly. Gourinchas and Rey (2014) discuss the external adjustment and the valuation effects extensively. We obtain the EU12 financial integration and the EU12 output from the EWN dataset; the dollar effective exchange rate from the Bank of International Settlements.

[6] Lane and Milesi-Ferretti (2003) define the measure of international financial integration as $IFIGDP_{it} = \frac{FA_{it}+FL_{it}}{GDP_{it}}$ where FA(FL) denotes the stock of external assets (liabilities).

The model in (11) and (12) can be viewed as the reduced form of a structural model explaining countries' net foreign assets ratios, financial integration, outputs and dollar exchange rates. The structural model would embody the relevant autonomous economic relationships, specifying contemporaneous relationships between variables, and the associated innovations would have a behavioural interpretation in terms of financial integration, or output or exchange rate shocks, say. The $\tilde{\varepsilon}_{it}$ and $v_{j,t}$ obtained from the autoregressions of (11) and (12) represent the corresponding reduced-form errors and do not have a straightforward behavioural interpretation. Identification of the effects of the behavioural structural shocks requires theory-based restrictions on the contemporaneous relationships between variables so that these errors can be recovered.

Despite the absence of a compelling theory of the short run, we consider the effects of the reduced-form shocks to the financial integration, outputs and dollar exchange rates equations, recognizing that these represent an amalgam of the underlying behavioural shocks. The persistence measures of (6) describe the effects of a typical shock to the system, taking into account the fact that an unexpected change in financial integration, captured here by a shock to the reduced-form financial integration equation, typically coincides with an unexpected change in output and indeed in all the other variables of the system. The persistence measures therefore accommodate the complicated contemporaneous interrelationships that exist in practice between the financial integration, the output and the dollar exchange rate. The measures do not rely on short-run identifying assumption, unlike a Cholesky decomposition for example, and are invariant to the ordering of the variables in the VAR. The effect of the shocks captured by the persistence measures should not be interpreted as the effect of a particular policy undertaken in isolation, then, but rather as showing the effects of the policy taking into account also the contemporaneous responses of all the other variables expected to occur on the basis of what has been observed historically.

Table 7 shows the results of the decomposition of the countries' and aggregate persistence measures by type of shock obtained on the basis of estimated version of model $\widetilde{M}_3$. The total persistence measures in the last column of Table 7 are similar to the persistence measures on Table 6 with a larger standard error: for the EU12 as a whole, the measure is 0.99 and the countries with the highest total persistence measures on Table 7 are similar to Table 6: Denmark, France, Germany, Sweden, Greece, Portugal and Spain.

In terms of the sources of shocks, unexpected changes in the financial integration has the largest persistence on the EU12, 1.03 via the eurozone countries: France, Germany, Greece, Portugal and Spain that have large and significant persistence measures. There is evidence that both common output and exchange rate fluctuations are long-run determinants in a few countries (Denmark, Germany and Sweden for the EU12 output; the UK, Germany and Sweden for the dollar effective exchange rate) but not on the EU12, where the aggregate persistence measures are insignificant, 0.02 and 0.15 with standard errors of 0.38 and 0.34 respectively.

The EU12 financial integration, measured by the cross-country average size of individual countries' international balance sheet to GDP, has risen from less than one in 1972 to more than seven in 2015, representing the most prominent surge of cross-border financial flows in the world since the 1990s (Lane and Milesi-Ferretti, 2008b). Figure 4 plots the financial integration and the forecast errors: we fit a constant, a deterministic trend and five lags of the financial integration. The financial flows accelerate since 1990s and tapers off after the financial crisis and the euro crisis of 2008 and 2010; the forecast errors also reflect these adverse events. The spikes of forecast errors between

2003 and 2007 are interpreted as ‘credit supply shocks’ (Lane, 2013) reflecting financial innovation and cross-border banking in Europe (Shin, 2012; Hale and Obstfeld, 2016).

The sudden expansion of gross flows affects the eurozone more than other countries in EU12, seen via the significant persistence measures in France, Germany, Greece, Portugal and Spain. One explanation is the elimination of currency risk within the eurozone accelerates cross-border financial flows. In addition, the absence of exchange rate does not help external adjustment and the transfer from debtor countries to creditor countries (Bleaney and Tian, 2014). During the global financial crisis, Lane and Milesi-Ferretti (2012) find that the euro has not facilitated the external adjustment of the economies.

4. Concluding Comments

The expansion of gross flows, measured by the financial integration, widens the external imbalances within the eurozone: France, Germany, Greece, Portugal and Spain. Prior to the European Sovereign Debt crisis, most of the flow imbalances have been financed by debt flows (Lane, 2013); the sudden drying up of the credit markets trigger the crisis as debt is riskier with its repayment obligations and therefore subjected to sustainability reassessment. Our analysis further shows the same economies except France have deviated persistently from their steady state since the 2000s based on historical dynamics of the net foreign assets.

Whilst there are advantages to financial integration, notably risk-sharing, it also carries the cost of exacerbating external imbalances when putting countries at the risk of debt crises as our study find within a monetary union. Devereux and Yu (2019) has pointed a related but different point i.e. financial integration spreads crises as it increases global leverage. There is a case for policy makers to monitor the gross financial flows, particularly debt flows, the debt-equity composition of a country's balance sheet as well as facilitating external adjustment within a monetary union.

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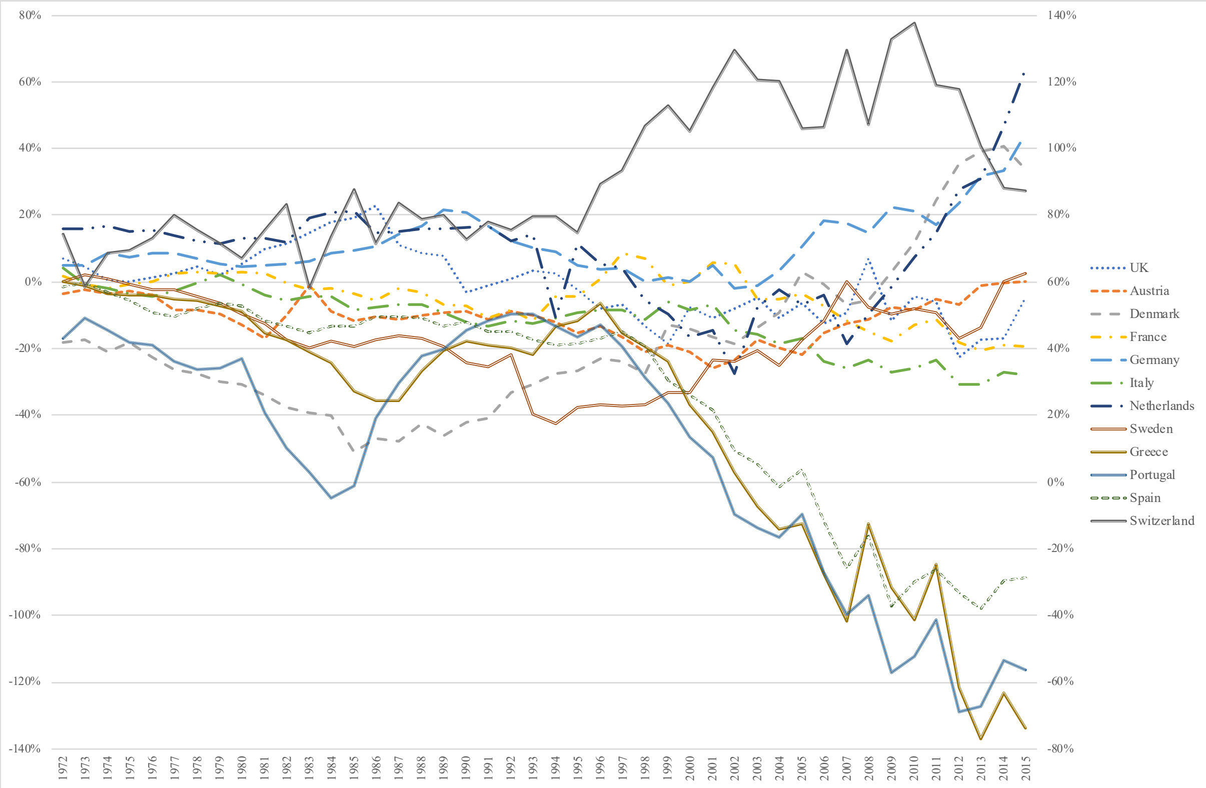
Figure 1. Countries' Net Foreign Assets:GDP Ratios



Notes: Right axis: Switzerland; left axis: other countries.

Figure 2. Persistence Profiles Measures

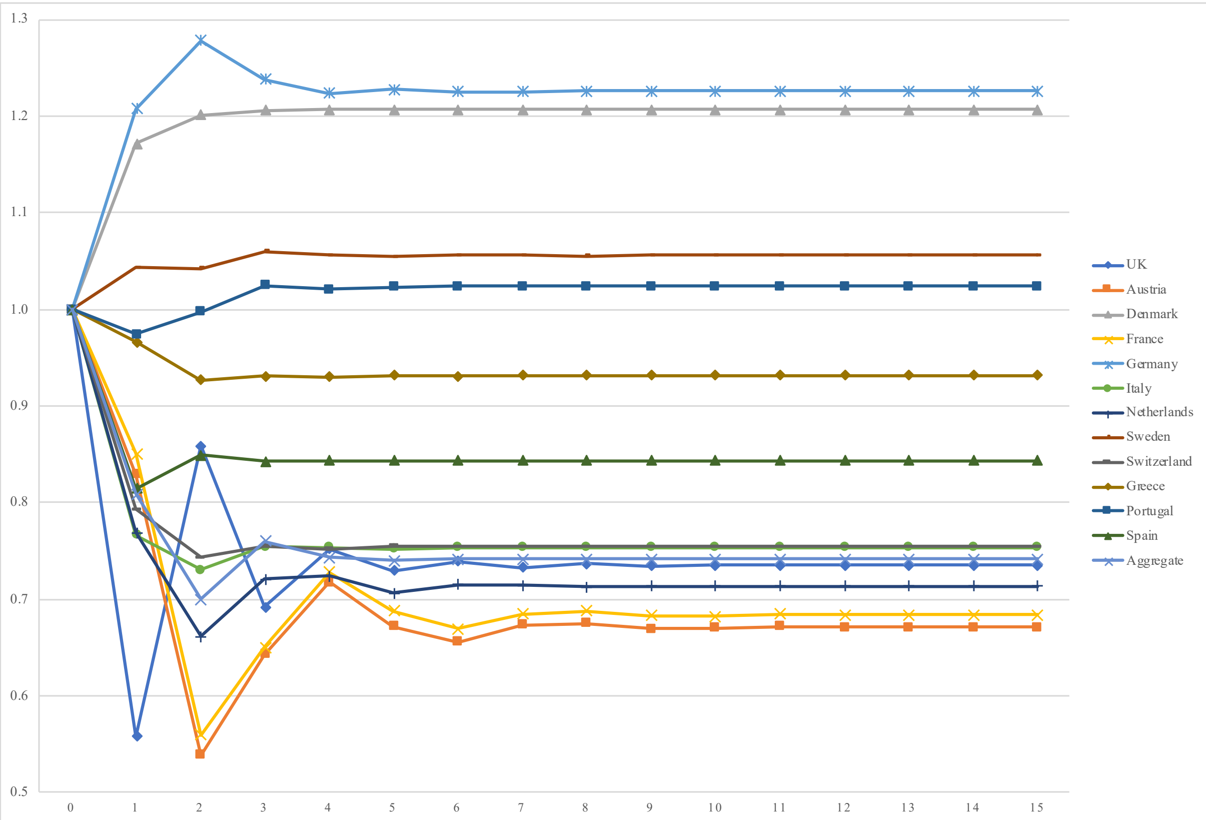
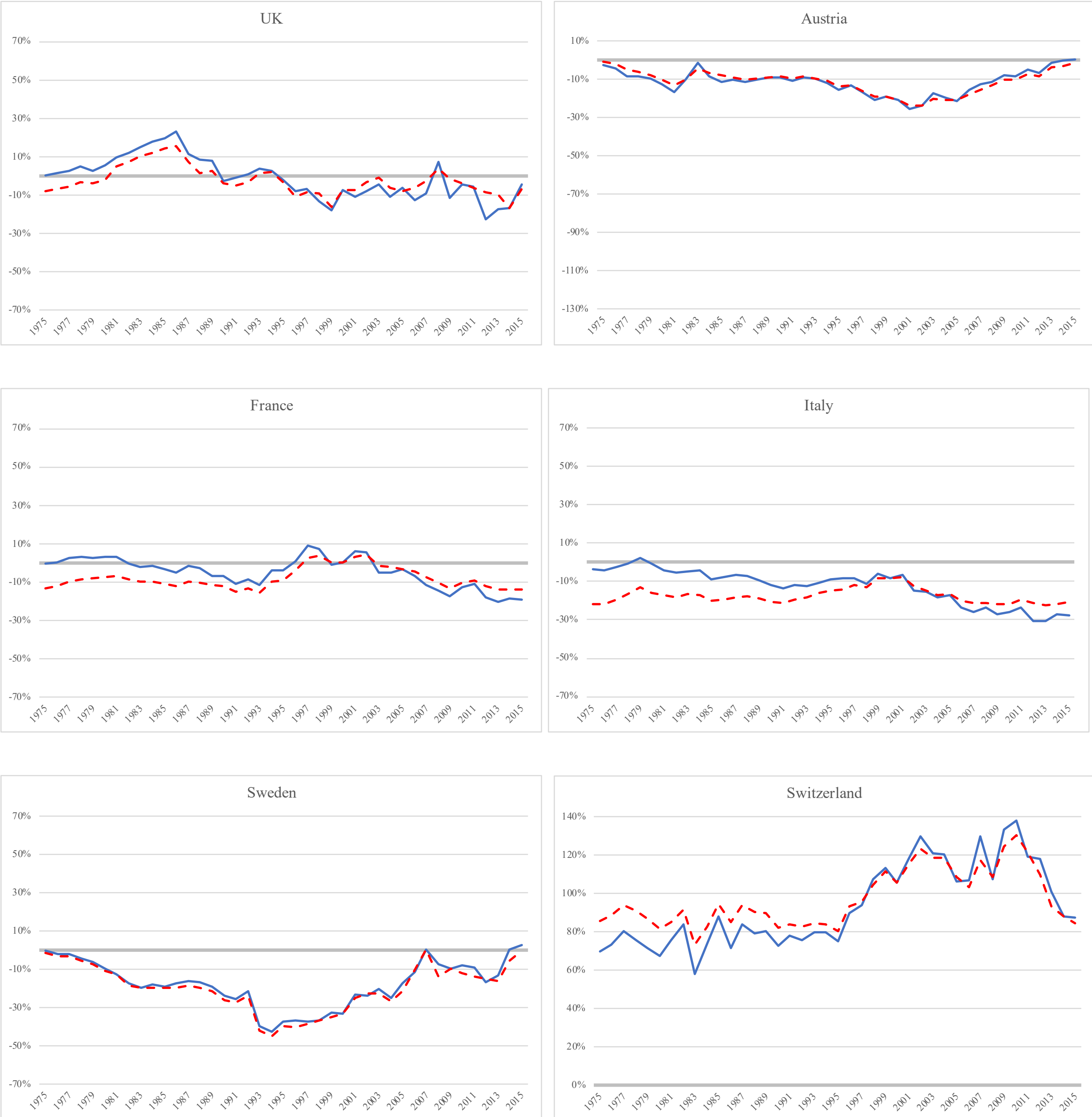
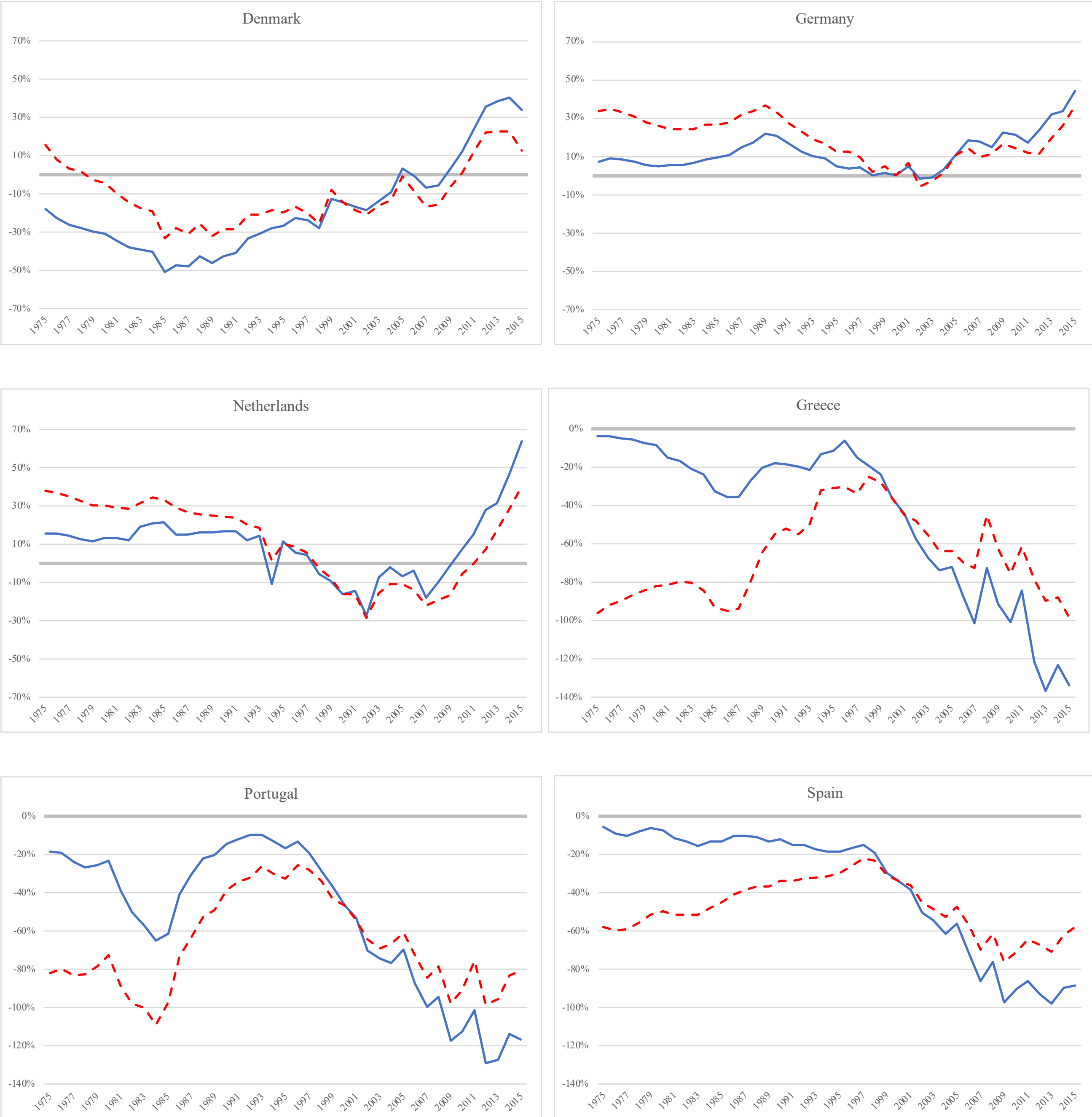


Figure 3. Net Foreign Assets and Beveridge-Nelson (1981) Trends: Gap less than 10% of GDP between the net foreign assets and their steady states



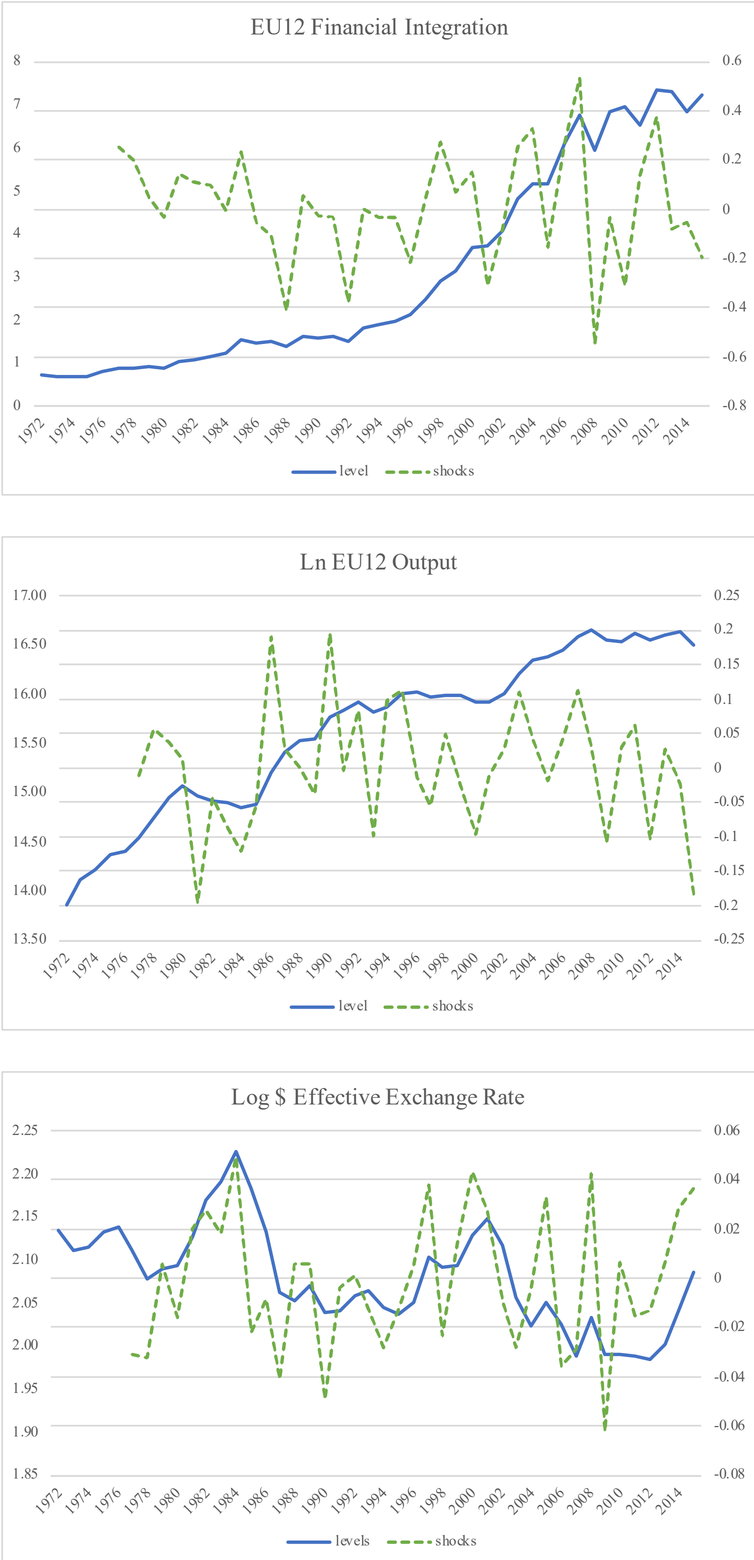
Notes: blue solid: net foreign assets/gdp; red dashed: Beveridge-Nelson (1981) trends.

Figure 3. Net Foreign Assets and Beveridge-Nelson (1981) Trends: Gap more than 10% of GDP between the net foreign assets and their steady states



Notes: blue solid: net foreign assets/gdp; red dashed: Beveridge-Nelson (1981) trends.

Figure 4. EU12 Financial Integration, EU12 GDP and The Dollar Effective Exchange Rate



Notes: The EU12 financial integration is the cross-section average of the ratio $IFIGDP_it = (FA_it + FL_it)/(GDP_it)$ where FA(FL) denotes the stock of external assets (liabilities), the EU12 is the sum of GDP across the twelve countries and the dollar effective exchange rate is the trade-weighted effective exchange rate from the Bank of International Settlements.

TABLE 1

AUGMENTED DICKEY-FULLER TESTS FOR UNIT ROOTS ON NET FOREIGN ASSETS:GDP RATIOS, 1972-2015

	ADF(1)	ADF(2)	ADF(3)	ADF(4)
UK	-2.53**	-2.31	-3.10***	-2.24
Austria	-1.26	-0.19	-0.47	-0.78
Denmark	-2.09	-2.02	-1.44	-1.38
France	-2.14	-1.31	-1.39	-1.88
Germany	-0.08	-0.07	-0.49	-0.54
Italy	-2.25	-2.02	-1.91	-2.02
Netherlands	1.36	0.86	0.78	0.78
Sweden	-1.12	-0.94	-0.85	-1.19
Switzerland	-1.43	-0.96	-1.84	-1.81
Greece	-1.00	-0.25	-1.50	-1.19
Portugal	-1.34	-1.22	-2.17	-1.77
Spain	-1.45	-1.36	-1.77	-1.94
Mean	-1.28	-0.98	-1.35	-1.33
(IPS test stat)	3.62	4.43	2.87	2.56

Notes: ADF(p) statistics are computed using ADF regressions with an intercept, a linear trend, and p lagged differences of the dependent variable. The 1%, 5% and 10% critical values are -2.63, -2.50 and -2.42. The IPS test statistic is the normalized value of the mean of the ADF statistics and is compared to the standard normal distribution. * denotes significance at the 10% level, ** denotes significance at the 5% level, and ***denotes significance at the 1% level.

TABLE 2

AUGMENTED DICKEY-FULLER TESTS FOR UNIT ROOTS IN THE CHANGE OF NET FOREIGN ASSETS:GDP RATIOS, 1972-2015

	ADF(0)	ADF(1)	ADF(2)	ADF(3)
UK	-8.35***	-5.50***	-2.87*	-3.93***
Austria	-6.26***	-6.10***	-3.24**	-2.26
Denmark	-4.79***	-3.32**	-3.32**	-2.61*
France	-5.90***	-6.04***	-4.08***	-2.62*
Germany	-4.48***	-3.26**	-1.84	-1.55
Italy	-7.56***	-5.29***	-4.25***	-3.32**
Netherlands	-6.79***	-2.89*	-2.05	-1.66
Sweden	-5.83***	-4.37***	-3.36**	-2.09
Switzerland	-8.38***	-5.76***	-2.73*	-2.50
Greece	-7.54***	-6.02***	-2.32	-2.63*
Portugal	-5.65***	-4.31***	-2.22	-2.58
Spain	-7.59***	-4.65***	-2.42	-1.98
Mean	-6.59***	-4.79***	-2.89**	-2.48
(IPS test stat)	-21.13***	-13.24***	-5.70***	-3.95***

Notes: ADF(p) statistics are computed using ADF regressions with an intercept and p lagged differences of the dependent variable. The 1%, 5% and 10% critical values are -3.60, -2.93 and -2.60. The IPS test statistic is the normalized value of the mean of the ADF statistics and is compared to the standard normal distribution. * denotes significance at the 10% level, ** denotes significance at the 5% level, and ***denotes significance at the 1% level.

TABLE 3

CROSS-SECTIONALLY AUGMENTED DICKEY-FULLER TESTS FOR UNIT ROOTS ON NET FOREIGN ASSETS:GDP RATIOS, 1972-2015

	CADF(1)	CADF(2)	CADF(3)	CADF(4)
UK	-3.88**	-3.27	-2.22	-1.46
Austria	-1.21	-0.17	-0.30	-0.60
Denmark	-1.95	-1.64	-0.51	-0.77
France	-1.20	-0.69	-0.62	-2.30
Germany	-0.33	-0.85	-0.24	-0.81
Italy	-2.26	-2.45	-1.61	-2.41
Netherlands	0.88	0.72	0.74	0.80
Sweden	-1.57	-1.50	-1.15	-1.49
Switzerland	-1.78	-1.12	-1.93	-2.17
Greece	0.13	-0.22	0.69	0.32
Portugal	-1.07	-0.82	-0.41	-0.61
Spain	-2.00	-1.87	-1.73	-2.32
Mean (CIPS test stat)	-1.35	-1.16	-0.77	-1.15

Notes: CADF(p) statistics are computed using ADF regressions with an intercept, a linear trend, and p lagged differences of the dependent variable, plus the lagged level and contemporaneous and p lagged differences of the cross-sectional average. The 1%, 5% and 10% critical values are -4.58, -3.82 and -3.46, respectively. The CIPS test statistic is the cross-sectional mean, compared to the distribution described in Pesaran (2007) where the 1%, 5% and 10% critical values are -3.08, -2.85 and -2.7, respectively. * denotes significance at the 10% level, ** denotes significance at the 5% level, and ***denotes significance at the 1% level.

TABLE 4

CROSS-SECTIONALLY AUGMENTED DICKEY-FULLER TESTS FOR UNIT ROOTS IN THE CHANGE OF NET FOREIGN ASSETS:GDP RATIOS, 1972-2015

	CADF(0)	CADF(1)	CADF(2)	CADF(3)
UK	-7.72***	-4.86***	-4.52***	-5.41***
Austria	-6.08***	-5.79***	-2.89	-1.86
Denmark	-4.33***	-3.23*	-3.14*	-2.59
France	-6.13***	-5.15***	-3.38**	-1.84
Germany	-4.22***	-2.97*	-2.03	-1.66
Italy	-5.06***	-3.75**	-4.06***	-2.49
Netherlands	-7.18***	-3.00*	-2.06	-1.72
Sweden	-5.44***	-3.77**	-3.35**	-2.24
Switzerland	-7.71***	-5.60***	-2.82	-2.51
Greece	-5.58***	-3.48**	-2.41	-1.45
Portugal	-4.14***	-3.28*	-3.08*	-2.75
Spain	-6.70***	-3.43**	-2.66	-1.94
Mean (CIPS test stat)	-5.86***	-4.03***	-3.03***	-2.37**

Notes: CADF(p) statistics are computed using ADF regressions with an intercept, p lagged differences of the dependent variable, plus the lagged level and contemporaneous and p lagged differences of the cross-sectional average. The 1%, 5% and 10% critical values are -4.02, -3.32 and -2.95. The CIPS test statistic is the cross-sectional mean, compared to the distribution described in Pesaran (2007) where the 1%, 5% and 10% critical values are -2.56, -2.33 and -2.21, respectively. * denotes significance at the 10% level, ** denotes significance at the 5% level, and ***denotes significance at the 1% level.

TABLE 5

MAXIMIZED LOG-LIKELIHOOD VALUES

Model	LLF	*N*	$\chi2(r)$
M_2	815.55	60	-
M_3	801.87	40	M_3 vs. M_2: 27.36 (20)
M_4	792.59	36	M_4 vs. M_2: 45.92*** (24) M_4 vs. M_3: 18.56*** (4)
M_5	765.10	12	M_5 vs. M_4: 54.98*** (24) M_5 vs. M_3: 73.54*** (28) M_5 vs. M_2: 100.90*** (48)

Notes: LLF is the maximized log-likelihood value, N is the number of estimated coefficients, and $\chi2(r)$ is the likelihood ratio test statistic relating to the r restrictions imposed on model M_i to get to model M_j. ***denotes significance at the 1% level.

TABLE 6

INDIVIDUAL COUNTRIES' AND AGGREGATE PERSISTENCE MEASURES

	Models	
Country	M_2	M_3
UK	0.72	0.74
	(0.09)	(0.10)
Austria	0.66	0.67
	(0.07)	(0.08)
Denmark	1.39	1.21
	(0.30)	(0.18)
France	0.64	0.68
	(0.07)	(0.07)
Germany	0.70	1.23
	(0.09)	(0.22)
Italy	0.90	0.75
	(0.18)	(0.04)
Netherlands	0.70	0.71
	(0.10)	(0.10)
Sweden	0.93	1.06
	(0.14)	(0.04)
Switzerland	0.69	0.75
	(0.10)	(0.08)
Greece	0.73	0.93
	(0.10)	(0.11)
Portugal	0.94	1.02
	(0.16)	(0.13)
Spain	0.98	0.84
	(0.16)	(0.06)
Aggregate	0.63	0.74
	(0.12)	(0.08)

Notes: Results relate to Models M_2 and M_3 defined in the text and estimated over 1972-2015. Individual countries' persistence measures are estimated using equation (2) and the aggregate persistence measures is obtained using vector **w**, a vector of ones, in place of e_i and e_j. Figures in parathenses are asymptotic standard errors calculated using analytic derivates. The formulae used are given in Appendix B of Lee, Pesaran and Pierse (1992, 1993).

TABLE 7

DECOMPOSITION OF INDIVIDUAL COUNTRIES' AND AGGREGATE PERSISTENCE MEASURES BY TYPE OF SHOCK

	Macro shocks					
Country	Ifi	Ly	Lex	Total macro	Other shocks	Total
UK	0.33	0.09	0.84	0.91	1.10	1.01
	(0.40)	(0.33)	(0.28)	(0.25)	(0.14)	(0.13)
Austria	0.50	0.23	0.16	0.47	0.74	0.71
	(0.34)	(0.79)	(0.81)	(0.35)	(0.10)	(0.10)
Denmark	0.60	1.42	1.48	2.67	1.19	1.28
	(1.25)	(0.77)	(3.10)	(2.64)	(0.24)	(0.27)
France	1.31	0.39	0.63	1.57	1.09	1.26
	(0.42)	(0.46)	(0.44)	(0.37)	(0.18)	(0.24)
Germany	1.78	2.70	1.61	3.26	2.14	2.58
	(1.42)	(1.14)	(0.89)	(1.40)	(0.73)	(0.94)
Italy	0.43	0.16	0.32	0.57	1.09	0.93
	(0.31)	(0.68)	(0.65)	(0.44)	(0.23)	(0.21)
Netherlands	1.24	0.47	0.01	1.25	0.77	0.87
	(0.78)	(0.80)	(0.73)	(0.77)	(0.13)	(0.18)
Sweden	0.73	1.23	2.42	1.84	1.00	1.14
	(1.34)	(0.28)	(1.02)	(0.89)	(0.00)	(0.12)
Switzerland	0.31	1.01	0.87	1.02	0.90	0.92
	(0.67)	(1.19)	(1.13)	(1.19)	(0.09)	(0.23)
Greece	0.86	0.58	0.12	1.15	0.95	1.06
	(0.36)	(0.44)	(0.50)	(0.34)	(0.15)	(0.22)
Portugal	1.06	0.68	0.66	0.99	1.42	1.21
	(0.28)	(0.78)	(0.75)	(0.30)	(0.24)	(0.23)
Spain	1.38	0.48	0.10	1.34	1.03	1.20
	(0.36)	(0.57)	(0.52)	(0.34)	(0.17)	(0.25)
Aggregate	1.03	0.02	0.15	1.06	0.87	0.99
	(0.19)	(0.38)	(0.34)	(0.19)	(0.12)	(0.14)

Notes: Results relate to Models Mtilde3 defined in the text and estimated over 1972-2015. Individual countries' persistence measures are estimated using equation (6) and the aggregate persistence measures is obtained using vector **w**, a vector of ones, in place of e_i and e_j. Values in parathenses are asymptotic standard errors calculated using analytic derivates. The formulae used are given in Appendix B of Lee, Pesaran and Pierse (1992, 1993).