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**NET FOREIGN ASSETS IN THE EURO AREA:
A COINTEGRATION ANALYSIS**

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Abstract

This paper discusses the macroeconomics of NFA at the Euro Area level, making use of the cointegrated VAR methodology. The wish to contribute to the literature on EMU motivates the choice of the topic; the non-stationarity of the data explains the choice of the methodology. The main conclusion of the paper is that, as far as Net Foreign Assets are concerned, the use of synthetic Euro area aggregate data yields a series of results consistent with economic theory. Real growth and exchange rate appreciation are both consistent with NFA accumulation. Portfolio adjustment considerations appear also to be important.

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NET FOREIGN ASSETS IN THE EURO AREA: A COINTEGRATION ANALYSIS*

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1. Introduction

The European Monetary Union (EMU), launched on January 1st 1999, can be compared to a complex machine made up of two “new” pieces, the Euro and the European Central Bank (ECB), and many “used” ones (the single countries, the national central banks). Any empirical investigation of the functioning of this machine, either limits itself to post-1999 data, which is unfeasible in a standard quarterly time series framework, or uses pre-1999 data too, collecting them on a country-by-country basis and aggregating them, *as if* EMU had existed before 1999.

The use of synthetic aggregate data is open to many questions, ranging from the validity of the *as if* idea to various methodological aspects. Recent contributions to the monetary policy literature, however, (e.g. Agresti - Mojon [1], Peersman - Smets [25], Mojon - Peersman [22]) recognize the validity of this expedient to investigate the macroeconomics of EMU. We take the same stand, focusing on Net Foreign Assets (NFA).

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NFA are defined as the difference between the stock of foreign assets (bonds, equity, direct foreign investment, foreign exchange reserves) held by domestic residents and the stock of domestic liabilities held by foreign residents. Lane - Milesi-Ferretti [19] suggest three reasons which make the study NFA worthwhile. First, the level of NFA is a key state variable in many open-economy models of growth and the business cycle. Second, many of the benefits of international financial integration are tied to the gross holdings of foreign assets and liabilities, rather than to capital flows. Third, the level and composition of international investment positions may be important in understanding vulnerability to external shocks, the degree of international risk sharing and the dynamics of current account adjustment.¹

The NFA literature identifies six stylized facts, valid for industrialized economies. First, the accumulation of NFA tends to be associated with real exchange rate appreciation, which compensated the country's positive (negative) international investment position by inducing a current account deficit (surplus) (Gagnon [11], Lane - Milesi-Ferretti [18]).

Second, relative output per-capita can affect NFA accumulation through several channels (Lane - Milesi-Ferretti [20] p.82). If the domestic marginal product of capital decreases, as the domestic stock of capital increases, home investors will seek out overseas investment opportunities, adding to their NFA. An increase in domestic income may lead to a higher savings rate which, even if temporary, could bring about a permanent improvement in terms of NFA. A positive correlation between relative GDP per-capita and NFA accumulation is also found by the traditional stages-of-

¹ See also KRAY - VENTURA [17] and BUSSIÈRE - CHOARTAREAS - DRIVER [5].

the-balance-of-payments-hypothesis literature (e.g. Fisher - Frenkel [9]).

Third, NFA accumulation in a country appears to be related with a shrinking differential between the long-term interest rates of that country and those of the rest of the world, *via* falling risk-premia (Lane - Milesi-Ferretti [20]). Fourth, Selaive - Tuesta [27], [28] claim that NFA affects both cross-country risk-sharing, *via* the cost of bond holding, and the uncovered interest parity, *via* the contribution of NFA to explaining nominal exchange rate movements. Fifth, in a world where Ricardian equivalence does not hold, higher levels of public debt may be associated with falling NFA (Faruquee - Laxton [8]).

Finally, a positive correlation is suggested, between NFA accumulation and aging population. However, the impact of demographic factors on NFA position is not just a function of the youth and old-age dependency ratio but also of other factors, e.g. the age structure of the working age population (Mundell [23]).

The contribution of this paper to the EMU literature is threefold. First, we update Euro area NFA using the same methodology as developed by Lane - Milesi-Ferretti [19]. Second, we analyze the linkages between NFA and a subset of the variables indicated as relevant by the literature (real exchange rates, output per-capita and real interest rates) in a theoretically consistent way. Third, we model NFA linkages in a multivariate time-series framework, the cointegrated VAR model, whereas previous contributions prefer panel or single-equation models.

The structure paper is as follows. In section 2, we discuss the theoretical and methodological framework of the analysis. Estimates are

discussed in section 3. Section 4 concludes. Appendix 1 contains a detailed description of the data and of the aggregating methodology.

2. The methodology

This paper investigates the macroeconomics of NFA at the Euro area level within the statistical framework provided by the Vector Error Correction (VEC) model (Johansen [14]). This class of models offers a way of describing the variation of the data, which associates the economic concept of *long-run* to the statistical concept of *stationarity*.

The VEC model is especially conceived to analyze integrated time series, taking into account the possibility of linearly combining them to form stationary (cointegration) vectors. Ideally, these vectors describe steady-state configurations, which the data tend to revert to in the long run. Their number and structure are identified on the basis of appropriate statistical tests. Usually, considerable emphasis is placed on the idea that the identification of the cointegration vectors should be theoretically consistent. As Pagan [24] points out, close adherence between statistical procedure and economic theory makes a good compromise between the theoretically-biased DSGE approach (e.g. Smets - Wouters [29]) and the empirically-biased approached based on large scale macroeconomic models (e.g. Fagan - Henry - Mestre [7]).

A theoretical framework for long-run macro-modelling

We consider an open economy consisting of two sectors, domestic and

foreign, and four markets: output, domestic money, domestic bonds and foreign bonds. The properties of this model have been studied, among others, by Godley [13] and Garratt - Lee - Pesaran - Shin [12]. Private wealth accumulation depends on public finance and balance of payments stock/flow identities and on the relative yields of the different financial instruments (portfolio selection mechanism).

The model contains three blocks. The first block identifies a global technological trend linking domestic (y) and world (y^w) real GDP per-capita (Binder - Pesaran [3]), sharing the same neoclassical technology. Adding an error term μ_{GDP} , this equilibrium condition reads as

$$y - y^w = \mu_{GDP} \quad (1)$$

The second block contains the interest and exchange rate parities. These are the Uncovered Interest Parity (parity between domestic and foreign interest rate, UIP), the Fisher Interest Parity (parity between domestic interest rate and inflation, FIP), the Purchasing Power Parity (parity between domestic and foreign price level expressed in the same currency, PPP) and the Term Structure parity (parity between domestic short and long-term interest rate, TERM). The empirical literature recognizes that these parities may not hold in their strong form because of market sluggishness and imperfections (see Juselius - MacDonald [16]).

We take the same stand-point, assuming the existence of two “mixed” parities: an internal parity and external one. The “internal” parity mixes up TERM, FIP and PPP linking the short-term real interest rate (rs), the long-term real interest rate (rl) and the real exchange rate (q). This condition may be written as

$$(rl - rs) + \beta_1 \cdot q + \beta_2 \cdot rs = \mu_{YC} \quad (2)$$

where $\beta_1 \leq 0$, $\beta_2 \geq 0$ and μ_{GDP} indicates the deviation from the equilibrium condition.

The “external” parity condition mixes FIP and UIP and links the domestic (rl) and foreign (rlw) real interest rate. Including the deviation term μ_{UIP} , it can be written as

$$rl - rlw = \mu_{UIP} \quad (3)$$

The last block describes how agents allocate their wealth among domestic money and domestic and foreign securities. As a result of this choice, the net external position of the private sector (nfa) emerges as a function of domestic GDP-per capita, real interest rates and the real exchange rate. Domestic determinants of nfa are linked to foreign variables through the two conditions 1 and 3.

$$nfa + \beta_3 \cdot q + \beta_4 \cdot rl + \beta_5 \cdot rs + \beta_6 \cdot y = \mu_{NFA} \quad (4)$$

where $\beta_3 \geq 0$, $\beta_4 \geq 0$, $\beta_5 \leq 0$, $\beta_6 \leq 0$, reflect some of the stylized facts mentioned above, and μ_{NFA} indicates the deviation from the equilibrium condition.

Econometric framework

Adopting the same notation as introduced above, the VEC model, forming the basis of our investigation, may be written as follows

$$\begin{bmatrix} \Delta q_t \\ \Delta y w_t \\ \Delta r l w_t \\ \Delta r l_t \\ \Delta r s_t \\ \Delta y_t \\ \Delta n f a_t \end{bmatrix} = \mathbf{a} + \sum_{j=1}^{m-1} \mathbf{\Gamma}_j \cdot \begin{bmatrix} \Delta q_{t-j} \\ \Delta y w_{t-j} \\ \Delta r l w_{t-j} \\ \Delta r l_{t-j} \\ \Delta r s_{t-j} \\ \Delta y_{t-j} \\ \Delta n f a_{t-j} \end{bmatrix} + \mathbf{\Pi} \cdot \begin{bmatrix} q_{t-1} \\ y w_{t-1} \\ r l w_{t-1} \\ r l_{t-1} \\ r s_{t-1} \\ y_{t-1} \\ n f a_{t-1} \end{bmatrix} + \mathbf{\Phi} \cdot \mathbf{d}_t + \mathbf{u}_t \quad (5)$$

with $\mathbf{u}_t \sim N(\mathbf{0}, \mathbf{\Sigma}_u)$.

Estimating (5) requires taking three steps. First, the lag length m and the deterministic component $\mathbf{d}_t$ are chosen so that estimated residuals match the multi-normal distribution as closely as possible, this being an essential requirement for a correct statistical inference.

Second, the long-term component of the model is identified, evaluating the degree of consistency between the data and the theoretical framework discussed above. The number of cointegrating vectors is equal to the (reduced) rank of the matrix $\mathbf{\Pi}$ and is determined on the basis of two tests: the trace test and the maximum eigenvalue test (Johansen [15]). Being of reduced rank, $\mathbf{\Pi}$ can be expressed as the product of two matrices of rank $r < k$, i.e. as $\mathbf{\Pi} = \mathbf{A} \cdot \mathbf{B}'$. Matrix $\mathbf{B}$ contains the $r < k$ cointegration vectors. Matrix $\mathbf{A}$ contains the feedback coefficients (loadings).

Checking the theoretical consistency of the data implies testing the following cointegration structure is

$$\begin{bmatrix} 0 & -1 & 0 & 0 & 0 & 1 & 0 \\ \beta_1 & 0 & 0 & 1 & \beta_2 & 0 & 0 \\ 0 & 0 & -1 & 1 & 0 & 0 & 0 \\ \beta_3 & 0 & 0 & \beta_4 & \beta_5 & \beta_6 & 1 \end{bmatrix} \cdot \begin{bmatrix} q_t \\ yw_t \\ rlw_t \\ rl_t \\ rs_t \\ y_t \\ nfa_t \end{bmatrix} = \begin{bmatrix} \mu_{GDP,t} \\ \mu_{YC,t} \\ \mu_{UIP,t} \\ \mu_{NFA,t} \end{bmatrix} \quad (6)$$

Finally, the structural dynamics of the system are identified on the basis of the statistical significance of the parameters collected in the matrices $\mathbf{A}$, $\mathbf{\Gamma}_j$ and $\mathbf{\Phi}$. Given that impulse response functions may be influenced by the presence of statistically insignificant coefficients, we estimate a parsimonious VECM (Subset VECM), deleting those parameters with t -values lower than 2.00. This follows the Sequential Elimination of the Regressors Testing Procedure (SER/TP) proposed by Brüggemann - Lütkepohl [4]. The possibility of simultaneous relationships between the variables is taken account of by checking for the statistical significance of the corresponding parameters.

3. Empirical analysis

Model specification

Our data sets consists of 92 quarterly observation ranging from 1980: $q1$ to 2002: $q4$ and covering the whole post-oil shock EMS-EMU period. Appendix 1 contains a full description of the data and the aggregating

methodology.

The lag-length is chosen on the basis of the usual optimal lag-length criteria. Akaike information criterion (AIC) suggests choosing lag 3, while Hannan and Quinn (HQ) and Bayesian (BIC) criteria suggest lag 1. Likelihood-based system reduction tests [$LR(p/p-1)$ and $LR(pmax/p)$] support our choice of lag 3 (indicated in the upper section of table 1).

The deterministic component includes constant, seasonal dummies, and four impulse dummies (...0, 0, 1, 0, 0, ...), all unrestricted with respect to the cointegration space. The impulse dummies refer to the following quarters: 1985:q3 (Plaza agreements), 1990:q1 (German unification), 1992:q3 (EMS crisis), 1999:q1 (launching of third phase of EMU).

Misspecification tests indicate an adequate fit of the chosen specification to the data. Estimated residuals match the multi-normal distribution (lower section of table 1) in a satisfactory way. Chow tests for parameter stability (available on request) do not indicate the presence of significant instability at the system level.²

² Details on both kinds of tests may be found in DOORNIK - HENDRY [6].

Lag Determination							
	LR($p/p-1$)	LR($p_{\max}/p$)	AIC	HQ	BIC		
$p=1$	-	$\chi^2(147)$ [0.00]	-78.142	-77.053	-75.439		
$p=2$	$\chi^2(49)$ [0.00]	$\chi^2(98)$ [0.00]	-78.543	-76.898	-74.461		
$p=3$	$\chi^2(49)$ [0.00]	$\chi^2(49)$ [0.57]	-78.922	-76.722	-73.461		
$p=4$	$\chi^2(49)$ [0.57]	-	-78.685	-75.929	-71.844		
Univariate misspecification Tests							
	q	yw	rlw	rl	rs	y	nfa
AR ₍₁₋₅₎ F(5,55)	[0.11]	[0.09]	[0.10]	[0.03]	[0.07]	[0.68]	[0.81]
Normality $\chi^2(2)$	[0.29]	[0.40]	[0.54]	[0.49]	[0.16]	[0.01]	[0.35]
ARCH ₍₁₋₄₎ F(4,52)	[0.26]	[0.42]	[0.55]	[0.70]	[0.81]	[0.73]	[0.38]
Hetero F(42,17)	[0.91]	[0.94]	[1.00]	[0.85]	[0.89]	[1.00]	[0.57]
Multivariate misspecification Tests							
Vector AR ₍₁₋₅₎ F(245,143) [0.16]							
Vector Normality $\chi^2(14)$ [0.11]							
Vector Hetero $\chi^2(1176)$ [0.21]							

Table 1. Upper part: lag determination. Lower part: model specification tests. p-values in square brackets.

Long-run analysis

Both the trace and the maximum eigenvalue test suggest choosing rank 4 for the Π matrix (table 2, upper part). This conclusion is robust to the inclusion of impulse dummies.³

The lower part of table 2 reports the main statistical properties of each time-series within the cointegration space. Stationarity tests are consistent with the assumption that all the variables are not $I(0)$. Excludability tests indicate that none of the variables can be excluded from the cointegration space if not at the loss of useful information. The real exchange rate and

³ Moreover, the number of cointegration relationships is coherent with the economic priors suggested by the theoretical model of reference. Even if this piece of information does not come from statistical procedures, it can turn out useful to determine the dimension of the cointegration space, as suggested by Juselius and Hendry (2001).

world GDP per capita appear to be weakly exogenous with respect to the long-run parameters of the model. This means it would be possible to specify a subset model conditioning on these two variables.

Rank Determination							
Eigenvalues	Rank	Max Eigenvalue Test		Trace Test			
0.46	0	54.16	[0.004]	190.82	[0.000]		
0.40	1	45.98	[0.007]	136.66	[0.000]		
0.37	2	40.45	[0.005]	90.68	[0.000]		
0.29	3	30.46	[0.018]	50.23	[0.028]		
0.14	4	13.67	[0.407]	19.76	[0.450]		
0.06	5	5.67	[0.660]	6.09	[0.689]		
0.00	6	0.42	[0.518]	0.42	[0.518]		
Preliminary Analyses on Cointegration Space							
	<i>q</i>	<i>yw</i>	<i>rlw</i>	<i>rl</i>	<i>Rs</i>	<i>y</i>	<i>nfa</i>
Stationarity $\chi^2(3)$	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Weak Ex. $\chi^2(4)$	[0.39]	[0.12]	[0.00]	[0.00]	[0.00]	[0.04]	[0.03]
Exclusion $\chi^2(4)$	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.03]

Table 2. Determination of the cointegration rank. p-values in square brackets.

Table 3 contains the specification of the cointegration space. This is fully consistent with the theoretical model outlined above. Such specification is not rejected by the data with a p-value of 0.05 (asymptotic LR test) and of 0.43 (parametric bootstrap LR test).⁴

⁴ We have performed the bootstrap exercise using 4.999 replications. For each replication an artificial dataset, of the same length as the original one (89 observation), is generated, using the observed pre-sample values (over the quarters 1980:1-1980:3) of each variable, the estimated model and a set of random innovations (drawn from a multivariate normal distribution).

	q	yw	rlw	rl	Rs	y	nfa
First vector	.	-1	.	.	.	1	.
Second vector	0.0317 (0.0043)	.	.	1	-0.2714 (0.0991)	.	.
Third vector	.	.	-1	1	.	.	.
Fourth vector	0.5460 (0.0791)	.	.	19.341	-19.341 (3.3048)	-0.3368 (0.0537)	1
$\chi^2(7)=13.92$		Asymptotic C.V.			Bootstrap C.V.		
		5%=14.07 10%=12.02			5%=32.97 10%=29.29		

Table 3. Long-run structure. Standard errors in round brackets.

The first vector links the domestic and world GDP per-capita in a way consistent with the presence of a global technological trend driving both series. The second vector is coherent with the internal parity story. Rewriting it as $(rl - rs) + 0.73 \cdot rs + 0.0317 \cdot q$, the spread between the two interest rates tends to fall when the short-term interest rate increases and/or when the real exchange rate appreciates. The third vector conforms with the external parity. The fourth vector links NFA, domestic GDP per-capita, the real exchange rate and the differential between the two interest rates. NFA accumulation matches higher GDP-per capita and real exchange appreciation. A relatively higher long-term interest rate with respect to its short-term counterpart appears to be correlated with lower NFA. This might reflect funds flowing back the Euro Area, when domestic long-term lending conditions become more severe.⁵

⁵ Testing each vector singularly we obtain the following results: first vector (p-value=0.38), second vector (p-value=0.26), third vector (p-value=0.05), fourth vector (p-value=0.21).

Short-run structural analysis

Table 4 reports the correlation matrix of the reduced-form residuals calculated on the basis of model estimated above. The contemporaneous correlation between rl and rs is very high (0.90) and might reflect the presence of low barriers to capital movements between the money and bond market of the euro area.

	q	yw	rlw	rl	rs	y	nfa
q	1.0000	.	.	.	.	.	.
yw	0.3459	1.0000	.	.	.	.	.
rlw	-0.2064	-0.0349	1.0000	.	.	.	.
rl	-0.2807	-0.0400	0.4465	1.0000	.	.	.
rs	-0.2230	-0.0959	0.2075	0.8967	1.0000	.	.
y	0.2837	0.4682	0.0203	0.0299	0.0132	1.0000	.
nfa	-0.0834	-0.0538	0.1126	-0.0350	-0.0834	0.1014	1.0000

Table 4. Residuals correlation, reduced form model

The possibility of a non diagonal Σ_u matrix calls the problem of structural identification into question. We address it by re-estimating a parsimonious VECM by 3SLS, allowing the two domestic interest rates to contemporaneously adjust to one another.⁶ Diagnostic tests on the structural model show no evidence of autocorrelation or non-normality of estimated residuals. The p-value associated to the Portmanteau autocorrelation test is equal to 0.33. The p-value associated to the multivariate normality test is equal to 0.24. Table 5 reports the coefficients measuring the speed to which the data tend to revert to the long-run equilibrium.

⁶ All other contemporaneous effects are tested to be borderline statistically not significant. The impact of Δrl on Δrs is equal to 0.66 (t-value 6.2) while that of Δrs on Δrl is equal to 0.56 (t-value 3.5).

	Δq	Δyw	Δrlw	Δrl	Δrs	Δy	Δnfa
$\mu_{GDP}(-1)$	.	0.061 (0.024)	.	.	.	-0.205 (0.050)	0.036 (0.016)
$\mu_{YC}(-1)$	-3.479 (0.904)	.	-0.495 (0.107)	-0.203 (0.067)	.	.	0.392 (0.097)
$\mu_{UIP}(-1)$	.	.	0.185 (0.066)	-0.128 (0.030)	.	-0.501 (0.149)	.
$\mu_{NFA}(-1)$	.	.	0.018 (0.005)	.	0.013 (0.004)	.	.

Table 5. Feedback coefficients. Standard errors in round brackets.

Domestic, world GDP per capita and the NFA/GDP ratio significantly adjust to the first cointegration vector. This is consistent with the common technological trend story and with real growth leading to NFA accumulation. The adjustment to the second cointegration vector (labelled internal parity) affects all the variables of the system with the exception of two GDP series. Adjustment to the external parity affects the two long-term interest rates, consistently with the error correction mechanism, and domestic GDP (IS effect). Finally adjustment to the fourth vector involves the domestic short-term interest rate and the foreign interest rate. The coefficient measuring the adjustment of Δnfa (-0.006), is consistent with the error correction mechanism but statistically not significant. This might reflect the fact that deviations from the fourth cointegrating vectors are not strong enough to modify the accumulated stock of NFA.⁷

Finding an exhaustive explanation for all effects of lagged variable

⁷ Weak exogeneity test and the specification of the adjustment matrix for the estimated Subset VEC model produce non-concordant results with respect to the statistical significant of the adjustment to the cointegration space in the real exchange rate equation and in the world output equation. This may be due to the automatic-sequential procedure we have adopted. We have preferred to leave these two feedback coefficients in the model (instead of deleting them) to preserve the consistency of our modelling approach.

and deterministic components, reported in table 6 and 7 is both difficult and unnecessary for the purposes of the present study.

As a general consideration, all the lagged and deterministic variables play a statistically significant role in at least one of the equations of the structural model. This corroborates the chosen specification. Lagged interest rates are closely related to one another and affect all the other variables of the system. The real exchange rate reacts to lagged values of the two long-term interest rates and GDP. NFA tend to decrease with real exchange rate depreciation, consistently with the stylized facts discussed above, and react in a non trivial way to the lagged values of the other variables of the model.

	Δq	Δyw	Δrlw	Δrl	Δrs	Δy	Δnfa
constant	0.033 (0.011)	0.002 (0.000)	0.031 (0.008)	.	0.021 (0.007)	.	-0.003 (0.001)
<i>sd1</i>	.	.	0.004 (0.001)	.	-0.001 (0.000)	.	-0.003 (0.001)
<i>sd2</i>	0.027 (0.007)	.	-0.005 (0.001)	.	-0.001 (0.000)	.	.
<i>sd3</i>	.	.	0.007 (0.002)	0.003 (0.000)	.	.	.
<i>di853</i>	.	.	0.007 (0.002)	0.004 (0.001)	.	.	.
<i>di901</i>	.	0.008 (0.003)	-0.006 (0.002)	.	.	0.014 (0.007)	.
<i>di923</i>	-0.063 (0.022)	.	.	.	0.005 (0.002)	.	-0.008 (0.002)
<i>di991</i>	.	.	.	.	.	.	0.009 (0.002)

Table 6. Deterministic component. Standard errors in round brackets.

	Δq	Δyw	Δrlw	Δrl	Δrs	Δy	Δnfa
$\Delta q(-1)$	0.306 (0.080)	.	.	.	.	.	-0.016 (0.008)
$\Delta yw(-1)$	.	0.518 (0.072)	-0.239 (0.049)	.	.	.	.
$\Delta rlw(-1)$	.	.	-0.287 (0.080)	.	.	.	0.125 (0.038)
$\Delta rl(-1)$	3.213 (0.958)	.	.	.	-0.165 (0.074)	0.458 (0.211)	-0.306 (0.080)
$\Delta rs(-1)$	.	.	0.369 (0.086)	.	.	.	.
$\Delta y(-1)$	.	.	.	.	.	0.237 (0.076)	.
$\Delta nfa(-1)$	.	.	.	.	.	.	0.328 (0.076)
$\Delta q(-2)$	.	.	.	.	.	.	.
$\Delta yw(-2)$	.	.	.	0.045 (0.022)	0.079 (0.038)	.	0.134 (0.058)
$\Delta rlw(-2)$	1.138 (0.424)	.	-0.158 (0.077)	.	.	-0.269 (0.111)	.
$\Delta rl(-2)$	.	.	.	.	-0.211 (0.071)	.	.
$\Delta rs(-2)$	.	-0.199 (0.089)	0.210 (0.079)	.	.	-0.640 (0.182)	.
$\Delta y(-2)$	0.743 (0.322)	.	.	.	.	0.398 (0.074)	-0.138 (0.032)
$\Delta nfa(-2)$	.	0.283 (0.097)	.	0.123 (0.027)	.	.	.

Table 7. Lagged endogenous terms. Standard errors in round brackets.

Impulse response analysis

Structural impulse responses provide further information on the linkages among the variables. Dynamic simulation exercises are performed, controlling for possible contemporaneous correlations among the variables, by means a short-run modeling approach based on the statistical significance of the feedback coefficient and the autoregressive parameters of the model. The reduction process gives a parsimonious model with a diagonal dispersion matrix. In this special case, the recursive scheme is not

influenced by the ordering of the variables.

The left (right) column of Figure 1 shows the impulse response functions of *nfa* to unitary shocks hitting all the variables of the system. The right column, instead, shows the impulse response functions of all the variables of the system to a unit shock hitting *nfa*. The graphs also include confidence intervals (at the 95% significance level), computed following the recommendations in Benkwitz - Lütkepohl - Neumann [2] and using the bootstrap methodology proposed in Hall [10], with 1000 replications. The simulation horizon is set equal to 20 quarters.

The responses exhibit trajectories consistent with the theoretical model and the stylized facts discussed in the previous sections. The response of *nfa* to shocks hitting domestic and world GDP and the short-term interest rate is not statistically significant.⁸ A shock to the foreign long-term interest rate and to *nfa* itself leads to NFA accumulation, conforming with portfolio stock adjustment considerations. The responses of *nfa* to shocks hitting the domestic long-term interest rate and the real exchange rate are very weak and borderline statistically significant.⁹ As to the effect of shocks originating from *nfa*, the only statistically significant impulse response is that on the real exchange rate which is consistent with a permanent increase in *nfa* leading to real exchange rate appreciation.

⁸ The responses of domestic and world output to shocks hitting *nfa* seem to be related to the theoretical long-run relationship linking the two variables.

⁹ Even if the response of *nfa* to a real exchange rate shock is significant at any horizon of the simulation, the deviation from the baseline path can be considered as negligible (around 0.5% in the long-run).

Figure 1. Impulse response analysis, structural form model. Percentage values.

4. Conclusions

This paper has discussed the macroeconomics of NFA at the Euro Area level, making use of the cointegrated VAR methodology.

Our measure of NFA is broadly consistent with currently available estimates over the whole sample period. We take this as indicating that we have been using an adequate aggregative and updating procedure. The main conclusion of the paper is that, as far as Net Foreign Assets are concerned, the use of synthetic Euro area aggregate data yields a series of results consistent with economic theory. Real growth and exchange rate appreciation are both consistent with NFA accumulation. Portfolio adjustment considerations are also important.

Both these conclusions must be qualified as preliminary and subject to revision, due the lack of other empirical works on this issue. The possibility of improving upon the aggregating procedure, which we have been using, tackling the observed discrepancy between our series and those most recently calculated at the Euro area level, constitutes a first possible extension of the current research. A further extension consists in including more variables in the analysis, improving upon our preferred theoretical structure and econometric structure.

Appendix

Elaborations have been performed using the following econometric packages: J-Multi 3.03 (SVECM model reducing process and diagnostic tests), Malcolm 2.90 (preliminary analyses), Pc-Fiml 10.3 (preliminary analyses and estimation) and SVAR 0.26 (bootstrap exercises). All seasonally unadjusted quarterly data are taken from OECD (Main Economic Indicators, CD-ROM release 2003/2) and IMF (IFS CD-Rom, March 2004) databases. Table A.1 contains further details.

Series	Definition	Source	Code
<i>RY</i>	Real GDP (1995=100)	IFS March 04	99BVP/R...ZF
<i>Y</i>	Nominal GDP	IFS March 04	99B/C...ZF
<i>RY</i> _{OECD}	OECD Real GDP (1995=100)	OECD MEI 03/2	000139KSA
<i>POP</i>	Population	OECD MEI 03/2	99Z...ZF
<i>S</i>	Short-term interest rate	IFS March 04	60B...ZF
<i>L</i>	Long-term interest rate	IFS March 04	61...ZF
<i>P</i>	Consumer price index	IFS March 04	64...ZF
<i>E</i>	NC-US dollar nominal exchange rate	IFS March 04	RF...ZF
<i>DIA</i>	Direct investment abroad	IFS March 04	78...BDDZF
<i>PIA</i>	Portfolio investment assets	IFS March 04	78...BFDZF
<i>OIA</i>	Other investment assets	IFS March 04	78...BHDZF
<i>DIL</i>	Direct investment in rep. economy	IFS March 04	78...BEDZF
<i>PIL</i>	Portfolio investment liabilities	IFS March 04	78...BGDZF
<i>OIL</i>	Other investment liabilities	IFS March 04	78...BIDZF
<i>NFA</i> ₇₁	Stock of NFA in 1971	Lane and Milesi-Ferretti (2001a)	ACUMCA

Table A.1. Data sources.

Synthetic aggregate data for the Euro area are calculated as weighted averages of EMU countries data. The variables are: the real effective exchange rate (q), foreign real GDP per-capita (yw), foreign real long-term interest rate (rlw), domestic real long-term interest rate (rl), domestic real short-term interest rate (rs), domestic real GDP per-capita (y), and the NFA/GDP ratio (nfa). Their construction is illustrated in Table A.2.

Variables	Definition																				
q	$\sum_{j=1}^{10} w_j \cdot \ln(E_j / E_{j,1995}) - \sum_{i=1}^8 w_i \cdot \ln(E_i / E_{i,1995}) + \sum_{i=1}^8 w_i \cdot \ln(P_i) - \sum_{j=1}^{10} w_j \cdot \ln(P_j)$																				
yw	$\ln \left[RY_{OECD} / \left(POP_{OECD} / POP_{OECD,1995} \right) \right]$																				
rlw	$0.25 \cdot \sum_{i=1}^8 w_i \cdot \ln \left[1 + \left(L_i / 100 \right) \right] - \sum_{i=1}^8 w_i \cdot \ln \left(P_i / P_{i,-1} \right)$																				
rl	$0.25 \cdot \sum_{j=1}^{10} w_j \cdot \ln \left[1 + \left(L_j / 100 \right) \right] - \sum_{j=1}^{10} w_j \cdot \ln \left(P_j / P_{j,-1} \right)$																				
rs	$0.25 \cdot \sum_{j=1}^{10} w_j \cdot \ln \left[1 + \left(S_j / 100 \right) \right] - \sum_{j=1}^{10} w_j \cdot \ln \left(P_j / P_{j,-1} \right)$																				
y	$\sum_{j=1}^{10} w_j \cdot \ln \left[RY_j / \left(POP_j / POP_{j,1995} \right) \right]$																				
nfa	$\sum_{j=1}^{10} w_j \cdot \ln \left\{ \left[1 + \left(NFA_{71,j} + \left(\sum DIA_j + PLA_j + OIA_j - DIL_j - PIL_j - OIL_j \right) \right) / Y_j \right] \right\}$																				
Weights for aggregations																					
Regional aggregation of the Euro area countries																					
w_j	<table><tr><td>AUT</td><td>BEL</td><td>FIN</td><td>FRA</td><td>GER</td><td>IRE</td><td>ITA</td><td>NET</td><td>POR</td><td>SPA</td></tr><tr><td>0.0303</td><td>0.0338</td><td>0.0170</td><td>0.2101</td><td>0.3064</td><td>0.0114</td><td>0.2001</td><td>0.0576</td><td>0.0238</td><td>0.1045</td></tr></table>	AUT	BEL	FIN	FRA	GER	IRE	ITA	NET	POR	SPA	0.0303	0.0338	0.0170	0.2101	0.3064	0.0114	0.2001	0.0576	0.0238	0.1045
AUT	BEL	FIN	FRA	GER	IRE	ITA	NET	POR	SPA												
0.0303	0.0338	0.0170	0.2101	0.3064	0.0114	0.2001	0.0576	0.0238	0.1045												
Euro Area bilateral trade flow matrix																					
w_i	<table><tr><td>CAN</td><td>DEN</td><td>JAP</td><td>NOR</td><td>SWE</td><td>SWI</td><td>UK</td><td>USA</td></tr><tr><td>0.0242</td><td>0.0542</td><td>0.1094</td><td>0.0386</td><td>0.0787</td><td>0.1227</td><td>0.3348</td><td>0.2374</td></tr></table>	CAN	DEN	JAP	NOR	SWE	SWI	UK	USA	0.0242	0.0542	0.1094	0.0386	0.0787	0.1227	0.3348	0.2374				
CAN	DEN	JAP	NOR	SWE	SWI	UK	USA														
0.0242	0.0542	0.1094	0.0386	0.0787	0.1227	0.3348	0.2374														

Table A.2. Construction of variables.

Weights w_j represent the share of national real GDP (in PPP) on the Area Euro one in the base-year (1995), whereas w_i 's are constructed as quotas of country i on total trade, defined as the sum of imports and exports, computed as an average over the period 1994-1996 (see Lewbel [21] and Pesaran - Schuermann - Weiner [26]).

As Lane - Milesi-Ferretti [19] point out, the evaluation of NFA is a difficult task involving several problems such as missing stock data (to be substituted by cumulating flows), valuation adjustments (debt reduction and forgiveness, price and exchange rate changes, mis-measurement of gross capital flows), lack of official statistics on bilateral current accounts (and their main components). In Figure A.1. we plot nfa as well as the NFA/GDP ratio calculated using the same methodology as employed by Lane - Milesi-Ferretti [19] and Fagan - Henry - Mestre [7]. The correlation between our measure of nfa and the other two is satisfactory (0.86 and 0.76, respectively), even though some differences emerge in their evolution over time.

Figure A.1. NFA/GDP ratio (1980-2002).

The behaviour of *nfa* over the period 1980-2002 suggests that the Euro area switches from debtor to creditor status after the Plaza agreements of 1985. The NFA/GDP ratio reaches its peak (equal to 2%) in 1990. This is followed by a progressive deterioration of the international investment position of the Euro area which, only recently, has turned back to positive. This pattern is not fully reflected in the measure of Fagan - Henry - Mestre [7], mainly due to a different amount of the historical stock of reference. Nevertheless, such difference should not matter, because it would just reflect into a shift in the estimated intercept.

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