What Drives US Foreign Borrowing? Evidence on External Adjustment to Transitory and Permanent Shocks*

Giancarlo Corsetti†
European University Institute, University of Rome III, and CEPR

Panagiotis Th. Konstantinou‡
University of Macedonia

*We thank Harald Uhlig, and Helmut Lütkepohl for comments on earlier drafts of the paper, and Roberto Cardarelli for his help with the data. For useful comments and discussions we also thank Mike Artis, Paul Bergin, Roberto Cardarelli, Luca Dedola, Charles Engel, Mathias Hoffmann, Søren Johansen, Jaewoo Lee, Francesco Lippi, Bartosz Mackowiak, Gian Maria Milesi-Ferretti, Dimitris Moschos, Theo Panagiotidis, Asaf Razin, Helene Rey, Costas Roumanias, Jens Søndergard, Jaume Ventura, conference participants in the conference "Dollars, Debt, and Deficits – 60 Years After Bretton Woods", organized by the Banco de Espana and the International Monetary Fund in Madrid, June 14 and 15 2004, in the 6th CEPR-RTN Workshop on "The Analysis of International Capital Markets", and in the CESifo Area Conference, and seminar participants at the Banca d' Italia, European University Institute/RSCAS, Humboldt University, the University of Athens, the University of Macedonia and the University of Piraeus. We thank Francesca Viani for excellent research assistance. This paper is part of the research network on 'The Analysis of International Capital Markets: Understanding Europe's Role in the Global Economy,' funded by the European Commission under the Research Training Network Programme (Contract No. HPRN-CT-1999-00067), and the Pierre Werner Chair Programme on Monetary Union at the Robert Schuman Centre of the EUI. Previous versions of this paper circulated with titles: 'The Dynamics of U.S. Net Foreign Liabilities: an Empirical Characterization.'

†Correspondence to: European University Institute, Department of Economics, Villa San Paolo, Via della Piazzuola 43, I-50133 Florence, Italy. Email: giancarlo.corsetti@eui.eu. Tel: +39-055-4685760, Fax: +39-055-4685770.

‡Correspondence to: University of Macedonia, Economic and Social Sciences, Department of Economics, Egnatia 156, GR – 540 06, Thessaloniki, Greece. Email: pkonstant@uom.gr. Tel. +30-2310-891.724, Fax: +30-2310-891.292

What drives US Foreign Borrowing? Evidence on External Adjustment to Transitory and Permanent Shocks

Abstract

The joint dynamics of US net output, consumption, and (valuation-adjusted) foreign assets and liabilities, characterized empirically following Lettau and Ludvigson [2004], is shown to be strikingly consistent with current account theory. While US consumption is virtually insulated from transitory shocks, these contribute considerably to the variation in net output and, even more so, in gross foreign positions, arguably smoothing temporary variations in returns. A single permanent shock – naturally interpreted as a productivity shock – raises consumption swiftly while causing net output to adjust only gradually. This leads to persistent, procyclical external deficits but, interestingly, moves gross assets and liabilities in the same direction.

JEL Classification: C32, E21, F32, F41

Keywords: Current Account; Net Foreign Wealth; Consumption Smoothing; Intertemporal Approach to the Current Account; International Adjustment Mechanism; Permanent-Transitory Decomposition.

Current Version: January 9, 2009

1 Introduction

What drives the dynamic evolution of foreign borrowing and lending by a country? Modern international economics has provided fundamental insights into this issue essentially by articulating the permanent income hypothesis and later development of consumption theory (with emphasis on precautionary savings) into models of equilibrium dynamics of foreign wealth — see e.g. Obstfeld and Rogoff [1995, 1996]. According to the baseline intertemporal-trade model of the current account, countries should run external deficits when idiosyncratic shocks lower the current level of their output net of government spending and investment (usually referred to as 'net output'), below its permanent level, or vice-versa.[1] By way of example, deficits are desirable during temporary contractions of output, in periods of abnormally high government spending, during investment booms (arguably driven by anticipation of higher productivity in the future), and *vis-à-vis* temporary fluctuations in the real rate of return around its long run level. In the policy debate, these theoretical considerations have provided crucial arguments in favor of capital account liberalization, mostly by softening traditional concerns rooted in views of external deficits as by-products of competitiveness losses. At the same time, they have offered a consistent framework to assess intertemporal trade-offs between trade imbalances in the short run, and adjustment in the medium and long-run.

Despite the relevance of the intertemporal-trade approach to the current account in theory and policy, the empirical evidence has long remained quite controversial. Inconclusive results are reached by early contributions which have built testing frameworks on enough restrictions to derive a present value relation equating, in expectations, the current account balance to the present discounted value of changes in net output. According to small-open-economy variants of the model originally conceived by Campbell [1987] and Campbell and Shiller [1987], the present-value restrictions are not rejected for some countries, while they are strongly rejected for others.[2] The empirical limits of this early approach, however, may well be due to the auxiliary assumptions commonly adopted to make the model testable e.g. preferences are quadratic and the return to net foreign wealth is constant. Indeed, results become more clear-cut when the return to net foreign wealth is not restricted to be constant, but is allowed to vary stochastically according to some stationary process (see Bergin and Sheffrin [2000], Nason and Rogers [2006]). Note that in this case foreign markets are seen not only as an opportunity to trade intertemporally, but also as a source of shocks external to the domestic economy. More recently, Gourinchas and Rey [2007a] underscore capital gains and losses (and therefore stochastic returns) on foreign assets driven by expected movements

[1] Precisely, following a country-specific, permanent positive shock, if net output growth is positively autocorrelated, consumption should respond more than net output in the short run, generating an external deficit; if growth is not autocorrelated, consumption should adjust one-to-one with net output, leaving the external account unaffected; if instead shocks are transitory, consumption should rise by less than net output, generating a current account surplus — see e.g. Obstfeld and Rogoff [1996] p. 82–84.

[2] See e.g. Ghosh [1995] and Sheffrin and Woo [1990] among others. Obstfeld and Rogoff [1995] provide a summary of these findings.

in exchange rates as a distinct, financial adjustment channel, complementing the traditional trade channel. These frameworks emphasize both permanent and transitory shocks to net output and returns as essential elements to bring the theory to the data.

But what is the evidence on the relative weight of different shocks — returns versus output, transitory versus permanent — in explaining external imbalances? Moreover, does the macroeconomic response to these different types of shocks match the main predictions of current account theory? In this paper, we sharply focus on these two questions, by characterizing empirically the joint dynamics of consumption, net output, and the market value of foreign assets and liabilities for the United States, for the post-Bretton Woods period. Drawing on Campbell and Mankiw [1989] and Lettau and Ludvigson [2001, 2004], we adopt a methodology that allows us to decompose shocks moving these variables according to their transitory and permanent nature.[3]

Our analysis yields three notable sets of results. A first set of findings fully support the notion that transitory shocks are key drivers of the dynamics of foreign borrowing. Consistently with key implications of current account theory, we find that virtually all variation in aggregate consumption is dominated by permanent innovations. In contrast, transitory shocks explain most of the variation in net output over short and medium horizons, and most of the variability in gross asset and liabilities positions — and the implied current account — over all horizons. Specifically, while the share of consumption variance explained by the permanent shock in our sample is between 97 and 99 percent at all horizons, at an horizon up to 4 quarters temporary shocks account for 75 percent of the variance of net output, and for more than 90 percent of the variance of assets and liabilities. Transitory innovations to net output are less important over longer horizons: the fraction of variance in net output explained by temporary shocks gradually falls from 50 percent over 12 quarters, and to less than 20 percent over 40 quarters. For the stocks of foreign assets and liabilities, instead, transitory innovations remain important also over these longer horizons — explaining more than 70 percent of their fluctuations over the 40 quarters horizon. Combining assets and liabilities as to proxy for the change in net foreign assets, i.e. the current account, transitory shocks explain 95 percent of its fluctuations at virtually all horizons.

A second result is noteworthy in light of the large body of literature documenting that consumption is excessively smooth *vis-à-vis* persistent shocks to income (see e.g. Campbell and Deaton [1989]). According to theory, in response to permanent shocks to net output domestic consumption should jump on impact, and reach its new permanent level either immediately (if the interest rate is constant) or along the optimal path dictated by short-run variations in its intertemporal price. Our impulse-response analysis shows that US consumption indeed responds to permanent shocks to the system quite swiftly, reaching its new permanent level in less than four quarters. Instead, output

[3] Specifically, as in Campbell and Mankiw [1989] and Lettau and Ludvigson [2001, 2004], we do not build present value models resting on specific assumptions about preferences; instead, we appeal to agents' non-satiation, transversality conditions and assumptions ensuring the existence of a stationary limiting equilibrium, to provide an empirical characterization of the joint dynamics of the four variables in our system.

net of investment and government spending jumps on impact, but then grows at a contained rate for many quarters, raising to its new long-run level only gradually. Moreover, in response to positive shocks that raise net output gradually towards its new long-run level, consumption smoothing implies that the economy runs a current account deficit. We indeed find a deterioration in the US external accounts in the medium run, although its dynamics is non linear. After an improvement on impact — corresponding to the initial peak in net output — the current account deteriorates persistently for about 16 quarters.[4]

Finally, while the net external effect of disturbances that raise US output in the long run is a deficit, we find that national residents simultaneously increase both their positive and negative external financial positions — in other words, the stocks of US Foreign assets and liabilities move in the same direction. This novel result — also confirmed in structural VAR analyses of shocks to US manufacturing (see Corsetti et al. [2008b]) — provides an interesting benchmark for models of international portfolio diversification.

Key to our analysis is that, in our study, assets and liabilities are all valuation-adjusted, i.e. our time series record the estimated market values of bonds, equities and other assets in the US foreign wealth. As the process of financial globalization has translated into the accumulation of very large stocks of foreign assets and liabilities, capital gains and losses affecting asset market valuation are arguably playing an increasing role in agents' intertemporal and portfolio decisions, a point stressed by Lane and Milesi-Ferretti [2001, 2007], Tille [2003, 2005] and Gourinchas and Rey [2007a, 2007b]. Our study documents that transitory fluctuations in these stocks are highly correlated with transitory fluctuations in the returns on the underlying assets, both variables displaying swings that are quantitatively large and persistent.

Our empirical methodology is structured as follows. As a preliminary step, we test a (weak) implication of the intertemporal budget constraint for the US, that a balanced growth path exists in the limit. This implies that consumption, the stock of gross assets and liabilities are cointegrated with net output. Then we make use of the long-run restrictions implied by cointegration to identify empirically the permanent and transitory shocks,[5] and relate these to aggregate consumption, net output, gross assets and liabilities. The shocks that move the variables in our systems in either a permanent or a temporary fashion correspond to a variety of structural disturbances hitting the economy at either national or international level — the methodology employed in our paper does not allow identification of structural disturbances. But in a sense this strengthens a central message

[4]This non-linearity is not specific to our methodology — similar dynamics has been documented by Ventura [2003] and Kraay and Ventura [2000, 2003]. These authors rationalize this evidence by stressing the incidence of investment costs in the short run as a reason why investment plans are delayed in response to shocks. By the same token, in structural studies, such as Corsetti et al. [2008a, 2008b], analyzing the response of an identified shock to productivity, external deficits emerge only with a lag of a few quarters.

[5]There are several studies that employ the restrictions implied by cointegration to identify specific innovations in a range of structural models (e.g. King et al. [1991] and Mellander et al. [1992] for early applications; Breitung et al. [2004] and Lütkepohl [2006] Ch. 9 for a general treatment).

of our paper: innovations that raise net output in the long-run (by more than in the short run) are associated with current account deficits, and cause large adjustment in consumption in the short run. However, similar to present-value models, our study does not distinguish between US-specific and global shocks. This distinction would be crucial in the analysis of small open economies. In the case of the US, we claim that such limitation of our analysis is not too consequential for our results. Because of the economic size of this country, most domestic shocks have global repercussions, but still have a clear asymmetric component relative to the rest of the world.[6]

The methodology we adopt in this paper proves useful in many promising areas of research in international finance. Notably, our analysis complements Gourinchas and Rey [2007a], who also build on Campbell and Mankiw [1989] and Lettau and Ludvigson [2001, 2004]. Whereas these authors analyze the external adjustment through movements in asset prices, we analyze it through the response of consumption, net output and foreign aggregate portfolio positions to temporary and permanent disturbances. Their study focuses on the financial account, emphasizing the role of predictable exchange rate and return movements in correcting external imbalances through valuation effects in the assets markets. Our study instead encompasses both quantity and valuation adjustment, showing that transitory disturbances are much more important drivers of US foreign wealth, than typically estimated using variants of the present value tests of the current account. Our main conclusion is that in many dimensions — variance decomposition and impulse response analysis — current account theory does a remarkably good job in accounting for the dynamics of the external deficit.

The rest of the paper is organized as follows. Section 2 provides a theoretical motivation for our work. Section 3 lays out our empirical methodology. Section 4 presents our empirical results. Section 5 examines the robustness of our results. The last section concludes.

2 Analytical Framework

The current account of a country is defined as the change in the value of net foreign assets between two dates. Using simple national accounting, this change must correspond to the flow of national saving net of investment over the period between these two dates, namely:

$$\mathcal{CA}_t \equiv [\mathcal{A}_{t+1} - \mathcal{L}_{t+1}] - [\mathcal{A}_t - \mathcal{L}_t] = \mathcal{Y}_t - \mathcal{C}_t - \mathcal{G}_t - \mathcal{I}_t + r_t [\mathcal{A}_t - \mathcal{L}_t] \tag{1}$$

where $\mathcal{A}_t$ is the (value of the) stock of gross assets and $\mathcal{L}_t$ the (value of the) stock of gross liabilities at the beginning of period t, $\mathcal{Y}_t$ denotes output, $\mathcal{C}_t$ denotes private consumption, $\mathcal{G}_t$ is government spending on final goods and services, $\mathcal{I}_t$ investment — all these variables are expressed in units of

[6] For an analysis of global vs. country-specific shocks see Glick and Rogoff [1995], Gregory and Head [1999], and Iscan [2000]. Hoffmann [2001, 2003] exploits cointegration and the stationarity of the current account, in order to identify permanent and transitory global and country-specific shocks. An interesting reformulation of current account theory in terms of a country's shares of world output has been recently proposed by Engel and Rogers [2006].

domestic consumption[7] — and r_t is the realized real rate of return earned by the country on its net foreign assets. Note that this rate of return varies over time as a function not only of fluctuations in the short-run interest rate, but also of capital gains and losses on bonds and equities in the foreign portfolio. Following a common convention in the literature, define output net of both investment and government spending as a new (flow) variable $\mathcal{Z} = \mathcal{Y} - \mathcal{G} - \mathcal{I}$. This 'cash flow' variable captures the stream of resources ultimately available to agents for consumption in the current as well as in all future periods. Using this variable, the above definition becomes

$$\mathcal{CA}_{t+i} \equiv [\mathcal{A}_{t+i+1} - \mathcal{L}_{t+i+1}] - [\mathcal{A}_{t+i} - \mathcal{L}_{t+i}] = \mathcal{Z}_{t+i} - \mathcal{C}_{t+i} + r_{t+i}[\mathcal{A}_{t+i} - \mathcal{L}_{t+i}] \quad (2)$$

The most basic notion underlying current account theory is that international financial markets enable national residents to smooth consumption in the face of country-specific temporary fluctuations in private output, and firms to carry out their efficient investment plans without being constrained by the size of current national saving. This notion is nicely summarized by the so-called fundamental equation of the current account, derived abstracting from uncertainty and under the maintain assumption that residents of a country have identical infinite-horizon, isoelastic separable preferences (see Obstfeld and Rogoff [1995, 1996]). Define the discount factor $R_{t,s}$ as $R_{t,s} = \left[\prod_{j=t+1}^{s}(1+r_j)\right]^{-1}$, with $R_{t,t} = 1$, so that, for any variable $\mathcal{X}$, its 'permanent level' is

$$\widetilde{\mathrm{X}}_t = \frac{\sum_{s=t}^{\infty} R_{t,s}\mathcal{X}_s}{\sum_{s=t}^{\infty} R_{t,s}}$$

With little algebra, one can manipulate the above identity and the first order conditions for the representative national consumer as to derive:

$$\begin{aligned} CA_t &= (\mathcal{Y}_t - \widetilde{\mathcal{Y}}_t) - (\mathcal{I}_t - \widetilde{\mathcal{I}}_t) - (\mathcal{G}_t - \widetilde{\mathcal{G}}_t) + (r_t - \widetilde{r}_t)[\mathcal{A}_t - \mathcal{L}_t] + \Xi_t \\ &= (\mathcal{Z}_t - \widetilde{\mathcal{Z}}_t) + (r_t - \widetilde{r}_t)[\mathcal{A}_t - \mathcal{L}_t] + \Xi_t \end{aligned}$$

The first few terms on the right hand side capture the smoothing components of the external deficit. Namely, a country optimally runs a current account deficit when net output is temporarily below its permanent level: this stems from temporary fluctuations of output, investment or government spending. Furthermore, a debtor country ($\mathcal{A}_t - \mathcal{L}_t < 0$) will increase its deficit in periods where the rate of return on foreign wealth is temporarily high — we should however stress that in general the sign of the interest rate term is ambiguous, depending on specific assumptions about preferences. The term Ξ_t is a function of a country's discount rate and the international rate of return, and accounts for external deficits motivated by discrepancies between the two (see Obstfeld and Rogoff [1995, 1996] and Nason and Rogers [2006] for details). The last two terms disappear when the real rate of return is constant, and equal to the country's rate of time preferences — in which case the

[7] The domestic consumption as the numeraire is a natural choice in our analysis. Yet we should note that it addresses the concerns by Palumbo, Rudd and Whelan [2006] in the context of analyses similar to ours. These authors stress the need to proceed by deflating nominal series with the same deflator.

fundamental equation of the current account can be derived without specifying any functional form for the utility function of the representative consumer.

From the above textbook rendition of current account theory, one can easily derive a small set of general implications, which hold across a large class of model specifications. Namely, first, if borrowing and lending allow households to smooth consumption vis-a-vis temporary shocks to net output and asset income, the current account should respond strongly to transitory fluctuations in these variables. However, because of smoothing, consumption should have a large permanent component. Second, domestic agents should adjust their consumption rapidly to the new long-run level. The shape of the response of net output to shocks is key to the sign of the current account response. Specifically, in response to positive shocks that raise net output gradually towards a higher long-run level, consumption smoothing implies that the economy should run a current account deficit. Much of our empirical work below will be focused on these two empirical dimensions of current account theory.

As a final observation, note that current account theory is not specific about the dynamics of *gross* foreign positions. Yet, one may expect that these respond to both permanent shocks, affecting the optimal long-run portfolio composition, and transitory shocks, reflecting consumption smoothing. An open issue, on which our study contributes novel and intriguing evidence, is the extent to which gross positions respond to either type of shocks.

2.1 From the Present Value Model of the Current Account to our Approach

As discussed in the introduction, an important strand of the empirical literature tests present value models (PVM) of the current account after Campbell [1987] and Campbell and Shiller [1987], reconsidered in a small open-economy setting (see e.g. Sheffrin and Woo [1990], Ghosh [1995], and Bergin and Sheffrin [2000]). Typically, the PVM model is derived from the permanent-income decision rule of a national representative household with quadratic preferences, facing a constant world interest rate.

Under quadratic preferences and a constant interest rate, it is well known that the current account can be written in the following present value form[8]

$$\mathcal{CA}_t = -\sum_{i=1}^{\infty} \left(\frac{1}{1+r} \right)^i \mathrm{E}_t \left\{ \Delta \mathcal{Z}_{t+i} \right\}, \tag{3}$$

where $\Delta \mathcal{Z}_{t+i} \equiv \mathcal{Z}_{t+i} - \mathcal{Z}_{t+i-1}$ denotes the first difference of net output and r denotes the world real interest rate, constant by assumption. Equation (3) clearly embeds the idea that agents optimally smooth consumption by borrowing and lending in international markets. If net output is high relative to what it is expected to be in the future, so that $\Delta \mathcal{Z}_{t+i}$ is expected to fall over time, national residents can raise their future consumption by running a current account surplus; conversely, when expected future net output is above trend — future net output levels are expected

[8] See e.g. Ghosh [1995] or Obstfeld and Rogoff [1995, 1996].

to be above current levels — agents optimally borrow against future resources, running a current account deficit.

The assumptions required to derive the above equation and run the test constitute obvious shortcomings of the approach. As a first important instance, the fact that net output can be characterized as an integrated process is usually coupled with the assumption that there is only one disturbance in the form of a unit root (permanent), country–specific shock to net output. Under this maintained hypothesis, the analysis cannot exploit the different implications of shocks with different degrees of persistence, which are key to the theory.[9] Second, the assumption that interest rates are constant rules out by construction a source of shocks which is potentially relevant on empirical grounds. This point is emphasized by Nason and Rogers [2006], who focus on transitory shocks to the world real interest rate as a key element to bring theoretical models in line with the evidence. In a similar vein, Bergin and Sheffrin [2000] allow for a stochastic interest rate, and demonstrate that their variant of the PVM fairs better for some small open economies, relative to standard PVM tests.

In what follows, we develop our approach starting from the same theoretical framework as the present value models, but proceed by imposing a weaker set of assumptions to derive our empirical framework. Specifically, we will not impose a specific functional form for the utility of the national representative consumer. Likewise, we will neither impose that all shocks to net output are permanent, nor that the rate of returns on foreign assets and liabilities are constant. Indeed, a key contribution of our paper consists in documenting in detail the empirical relevance of temporary shocks to these two variables.

2.2 Intertemporal Budget Constraint and the Common Trend in Consumption, Net Output and Gross External Positions

As in Campbell and Mankiw [1989] and Lettau and Ludvigson [2001, 2004] in a closed economy setting, and Bergin and Sheffrin [2000] in an open economy, the main building block of our analysis consists in deriving an approximate expression for the budget constraint of a country. This expression leads to a set of cointegrating relationships between net output, consumption, foreign assets and foreign liabilities which can be used to decompose shocks into permanent and temporary components, as in Lettau and Ludvigson [2004].

To derive our model, we follow the literature in taking a first-order Taylor approximation of the intertemporal budget constraint, and impose the appropriate transversality conditions around a long-run balanced-growth path. The analysis thus rests on enough maintained assumptions to ensure that a long-run balanced growth path exists — assumptions that in turn have testable implications in the data.

An issue in defining these assumptions is raised by the fact that our analysis applies to a sample including periods characterized by long processes of deregulation and liberalization of international

[9] One exception is Hoffmann [2003] but the focus is on the identification of global and country-specific shocks.

financial markets, as well as by the integration in the global economy of new, growing countries. Arguably, these phenomena are at the roots of the steady increase in the stock of cross-border foreign assets and liabilities observed over the last two decades. Gourinchas and Rey [2007a] argue that these trends do not belong to the analytical core of studies of current account adjustment, and advocate the need to abstract from them, as to insulate the main features of the 'financial transmission channel' which should be active at different degrees of capital market integration.

In the same vein, but pursuing a distinct approach, we tackle this issue by allowing from the start for both deterministic and stochastic trends in variables, to be estimated jointly by the data. We then proceed under the maintained assumption that deterministic trends are good within-sample approximations to the above phenomena. A key advantage of this approach is that, while being theoretically consistent with the model, it does not eliminate stochastic trends underpinning cointegration analysis.

Specifically, consider once again the flow budget constraint of a country (2). Consistently with our approach, we rewrite each variable $\mathcal{X}_t$ distinguishing between a deterministic trend $\exp(\gamma_{x,t})$, and a non-deterministic-trend component X_t, i.e. $\mathcal{X}_t = X_t \exp(\gamma_{x,t})$. Under this notational convention, the constraint reads:

$$
\begin{aligned}
A_{t+i+1}\exp\left(\gamma_{a,t+i+1}\right) - L_{t+i+1}\exp\left(\gamma_{l,t+i+1}\right) &= Z_{t+i}\exp\left(\gamma_{z,t+i}\right) - C_{t+i}\exp\left(\gamma_{c,t+i}\right) + \\
\left(1+r_{t+i}\right)\left[A_{t+i}\exp\left(\gamma_{a,t+i}\right) - L_{t+i}\exp\left(\gamma_{l,t+i}\right)\right], &\qquad i = 0, 1, ...;\ A_t, L_t : \text{given} \qquad (4)
\end{aligned}
$$

where A_{t+i} is the de-trended stock of gross assets, L_{t+i} the de-trended stock gross liabilities, both measured at the beginning of period $t+i$, Z_{t+i} denotes de-trended net output, C_{t+i} de-trended consumption and r_{t+i} is the real rate of return. The deterministic trend component of each variable is denoted by $\gamma_{w,t+i}$, for $w = A, L, Z, C$ in period $t+i$. Note that these trend components need not be constant, but may vary over finite horizons — a point further discussed below.

For the purpose of our analysis, it is crucial to allow for flexibility in the model as regards the trend-evolution of variables over the sample period. As mentioned above, one may expect a large increase in the stock of international assets and liabilities stemming from the process of liberalization in international financial markets. We envision this increase to occur as the global economy moves from a balanced growth path with barriers to capital movements, towards a balanced growth path with capital market integration. Introducing possibly time-varying deterministic trend components in variables $\gamma_{w,t+i}$ is a parsimonious and (most importantly) model–consistent way to capture this passage. Assuming that the system eventually reaches a new balanced growth path, we impose that these trends converge, for all variables, to the same long-run trend.

Assumption 2.1 *The deterministic trend components $\gamma_{w,t}$ converge asymptotically to the same value*

$$\lim_{k\to+\infty} \gamma_{w,t+k} = \gamma_{t+k}, \qquad (5)$$

for $w = c, z, a, l$.

While different variables can have different trends in the sample, this assumption imposes that all variables eventually grow at the same rate, γ_t, along a balanced-growth path. Assuming non-satiation, then, we know that the consumption plans by optimizing national consumers will obey the transversality condition. Hence we posit:

Assumption 2.2 *The transversality condition*

$$\lim_{k\to\infty} \mathrm{E}_t \left\{ R_{t,t+k} \left[A_{t+k+1} \exp\left(\gamma_{a,t+k+1}\right) - L_{t+i+1} \exp\left(\gamma_{l,t+k+1}\right) \right] \right\} = 0, \tag{6}$$

holds.

If $\lim_{k\to+\infty}\left(\gamma_{a,t+k+1} - \gamma_{l,t+k+1}\right) = 0$, as implied by Assumption 2.1, in the limit gross assets and liabilities grow at the same deterministic rate (γ_{t+k+1}). What condition (6) requires is that in the limit, the return on the NFA portfolio exceeds the growth rates of gross assets and liabilities — a familiar condition in growth models. Under these assumptions, by repeated substitutions, we may write the intertemporal budget constraint as:

$$\mathrm{E}_t \sum_{i=0}^{\infty} R_{t,t+i} Z_{t+i} \exp\left(\gamma_{z,t+i}\right) = L_t \exp\left(\gamma_{l,t}\right) - A_t \exp\left(\gamma_{a,t}\right) + \mathrm{E}_t \sum_{i=0}^{\infty} R_{t,t+i} C_{t+i} \exp\left(\gamma_{c,t+i}\right). \tag{7}$$

It is analytically convenient to define two new variables as follows: $\Phi_t \equiv \sum_{i=0}^{\infty} R_{t,t+i} C_{t+i} \exp\left(\gamma_{c,t+i}\right)$ and $\Psi_t \equiv \sum_{i=0}^{\infty} R_{t,t+i} Z_{t+i} \exp\left(\gamma_{z,t+i}\right)$, as to rewrite (7) more synthetically as

$$\mathrm{E}_t \Psi_t = L_t \exp\left(\gamma_{l,t}\right) - A_t \exp\left(\gamma_{a,t}\right) + \mathrm{E}_t \Phi_t \tag{8}$$

The following three assumptions are necessary for our linearization to be consistent with the underlying model economy:

Assumption 2.3 *(a) The expectation term* $\mathrm{E}\left(\Phi_t/\Psi_t\right)$ *exists and is finite.*

(b) The expectation terms $\mathrm{E}\left[A_t \exp\left(\gamma_{a,t}\right)/\Psi_t\right]$ *and* $\mathrm{E}\left[L_t \exp\left(\gamma_{l,t}\right)/\Psi_t\right]$ *exist and are finite.*

(c) The expectation terms $\mathrm{E}\left[Z_t \exp\left(\gamma_{z,t}\right)/\Psi_t\right]$ *and* $\mathrm{E}\left[C_t \exp\left(\gamma_{c,t}\right)/\Phi_t\right]$ *exist and are finite.*

Assumption 2.3 (a) states that the ratio of present value of consumption to the present value to net output is a stationary process, essentially implying that consumption and net output are tied together in the long-run. Assumption 2.3 (b) states that the ratio of gross assets (regardless of its trending behavior) to the present value of (trending) net output, and the ratio of gross liabilities (with its trend) to the present value of (trending) net output, exist and are finite. Finally, part (c) of Assumption 2.3 simply states that the ratio of net output to its present value, and the ratio of consumption to its present value are well defined processes.

In the transition from a regime of limited capital mobility to one in which capital markets are integrated and there is free capital mobility, it is possible that the trending behavior in gross assets and liabilities be different from that in consumption and net output.[10] Empirically, we therefore posit that, while deterministic trends in variables converge to the same constant in the long run, they may differ within the sample:

Assumption 2.4 ***(Empirical in–sample Approximation)*** *The deterministic trend components $\gamma_{w,t}$ may be expressed (in–sample) as linear functions of time*

$$\gamma_{w,t} = \gamma_w \times t, \tag{9}$$

for $w = c, z, a, l$.

Recall that Assumption 2.1 posits that all variables eventually grow at the same rate, γ_t, along a balanced-growth path (ruling out that the rate of growth of gross assets and liabilities permanently exceeds the rate of growth of consumption and output). Assumption 2.4 instead adds empirical flexibility to our framework, by allowing variables to grow at different deterministic rates *within our sample*. Clearly, in order for Assumption 2.1 to hold in the limit, it would be necessary that — at some point in time — all trend parameters change and converge, so that $\gamma_w = \gamma$, implicitly assuming the occurrence of a "structural break." Such a change however will not have an impact on our results, as it will only change the deterministic part of the variables, and not their stochastic structure.[11]

Although controlling for deterministic trend in-sample is consistent with the model, a linear time trend is admittedly a crude approximation to the effects of growing financial market integration and increasing capital market liberalization. Yet, for the purpose of our analysis, it is clearly preferable to alternative procedures, such as low-frequency filtering the data, which remove both deterministic and stochastic trend (permanent) components — i.e., essential building blocks of the exercise we pursue drawing on Campbell and Mankiw [1989] and Lettau and Ludvigson [2004]. We actually find that deterministic trends do help describing the equilibrium relationships among aggregate consumption, net output, gross assets and liabilities positions. As long as there exists an exogenous factor that is approximated by deterministic components, the omission of deterministic components from the empirical analysis would bias the results.

Leaving to an appendix details on the derivation, under Assumptions 2.1 to 2.4, below we write

[10] Consider for example $\gamma_{w,t} = \delta_w + (\gamma + \zeta_w)\, t$. This allows both for trend and level shifts depending on whether δ_w and ζ_w differ from 0 in one or more periods. For instance, trends in aggregate variables need not be identical in the presence of differences in the consumption and savings behavior among (possibly heterogeneous) agents facing changes in the regulation and liberalization of financial markets (affecting their overall degree of participation in such markets).

[11] In the spirit of Beveridge and Nelson [1981] we may decompose a time series x_t into a stochastic trend, a deterministic trend and a cyclical component: $x_t = \tau_t + d_t + \xi_t$. The 'break' will only change d_t, but not the stochastic part of the series $\tau_t + \xi_t$. Of course, our tests could potentially "confuse" such breaks with a permanent shock, if they are not explicitly accounted for (see Perron [1989]). In fact, we do perform a series of stability tests in our empirical work (available upon request). We do not find any evidence of structural breaks in the sample 1973-2004.

the approximation to (8):

$$\begin{aligned}&(c_t - z_t - (\gamma_z - \gamma_c)\,t) - \rho_l\,(l_t - z_t - (\gamma_z - \gamma_l)\,t) - \rho_a\,(a_t - z_t - (\gamma_z - \gamma_a)\,t)\\ \approx\;& -\mathrm{E}_t\left\{\sum_{i=1}^{\infty}\rho_{C\Phi}^i \Delta c_{t+i} + \frac{1}{\rho_d}\sum_{i=1}^{\infty}\rho_{Z\Psi}^i \Delta z_{t+i} + \sum_{i=1}^{\infty}\left(\rho_{C\Phi}^i - \varphi_z \rho_{Z\Psi}^i\right) r_{t+i} +\right.\\ &\left.\sum_{i=1}^{\infty}\rho_{C\Phi}^i\gamma_c + \frac{1}{\rho_d}\sum_{i=1}^{\infty}\rho_{Z\Psi}^i\gamma_z\right\},\end{aligned} \tag{10}$$

where lower case letters denote log variables (e.g., $c_t \equiv \ln(C_t)$, $\phi_t \equiv \ln \Phi_t$, etc.), and $r_t \approx \ln(1 + r_t)$; moreover, let $\rho_l \equiv \left[\left(1 - \frac{1}{\rho_d}\right) - \frac{\exp(\mathrm{E}[a_t + \gamma_a t - \psi_t])}{\rho_d}\right]$, $\rho_a \equiv \left[\left(1 - \frac{1}{\rho_d}\right) + \frac{\exp(\mathrm{E}[l_t + \gamma_l t - \psi_t])}{\rho_d}\right]$ and $\rho_d \equiv [1 - \exp(\mathrm{E}[l_t + \gamma_l t - \psi_t]) + \exp(\mathrm{E}[a_t + \gamma_a t - \psi_t])]$, with $\rho_a + \rho_l + \rho_d^{-1} = 1$.[12] Note that the left-hand side of (10) includes all the components of the definition of the 'Capital Account,' but these components here are in logs.[13] Because of this feature, we label the expression on left-hand side of (10) as $\widetilde{KA}_t$, making however clear from the start that this expression only resembles the capital account:

$$\widetilde{KA}_t \equiv (c_t - z_t - (\gamma_z - \gamma_c)\,t) - \rho_l\,(l_t - z_t - (\gamma_z - \gamma_l)\,t) - \rho_a\,(a_t - z_t - (\gamma_z - \gamma_a)\,t)\,.$$

An important property of $\widetilde{KA}_t$ is that we have derived a relation relating it to expected future changes in consumption, net output and returns in the form

$$\begin{aligned}\widetilde{KA}_t \;\approx\;& -\mathrm{E}_t\left\{\sum_{i=1}^{\infty}\rho_{C\Phi}^i \Delta c_{t+i} + \frac{1}{\rho_d}\sum_{i=1}^{\infty}\rho_{Z\Psi}^i \Delta z_{t+i} + \sum_{i=1}^{\infty}\left(\rho_{C\Phi}^i - \varphi_z \rho_{Z\Psi}^i\right) r_{t+i} +\right.\\ &\left.\sum_{i=1}^{\infty}\rho_{C\Phi}^i\gamma_c + \frac{1}{\rho_d}\sum_{i=1}^{\infty}\rho_{Z\Psi}^i\gamma_z\right\}.\\ \approx\;& -\frac{\rho_{C\Phi}\gamma_c}{1-\rho_{C\Phi}} - \frac{1}{\rho_d}\frac{\rho_{Z\Psi}\gamma_z}{1-\rho_{Z\Psi}}\\ &-\mathrm{E}_t\left\{\sum_{i=1}^{\infty}\rho_{C\Phi}^i \Delta c_{t+i} + \frac{1}{\rho_d}\sum_{i=1}^{\infty}\rho_{Z\Psi}^i \Delta z_{t+i} + \sum_{i=1}^{\infty}\left(\rho_{C\Phi}^i - \varphi_z \rho_{Z\Psi}^i\right) r_{t+i}\right\}\end{aligned} \tag{11}$$

Four features of (11) are worth stressing. *First*, this expression has the same form of the Present Value Model of the current account (3). Yet it has being derived without assuming specific consumers' preferences such as quadratic utility, but only based on the intertemporal budget constraint of a nation. *Second*, Assumptions 2.3 and 2.4 imply that $c_t - z_t - (\gamma_z - \gamma_c)\,t$, $a_t - z_t - (\gamma_z - \gamma_a)\,t$ and $l_t - z_t - (\gamma_z - \gamma_l)\,t$ are stationary processes. That is, the (log) consumption to output, gross assets to output and gross liabilities to output ratios are trend-stationary processes. As a result, the particular linear combination $\widetilde{KA}_t$ is also a stationary process. Even if gross assets and liabilities are not

[12] We also define $\rho_{C\Phi} \equiv 1 - \exp(\mathrm{E}[c_t + \gamma_{c,t} - \phi_t])$, and $\rho_{Z\Psi} \equiv 1 - \exp(\mathrm{E}[z_t + \gamma_{z,t} - \psi_t])$.

[13] The capital account is defined as $\mathcal{KA}_t \equiv \mathcal{C}_t - \mathcal{Z}_t - r_t\,(\mathcal{A}_t - \mathcal{L}_t)$, while our approximate expressions reads:

$$c_t - \frac{1}{\rho_d} z_t - \rho_l l_t - \rho_a a_t + \left(\gamma_c t - \frac{1}{\rho_d}\gamma_z t - \rho_l \gamma_l t - \rho_a \gamma_a t\right).$$

(trend-) stationary in levels, the transversality condition (6) prevents them from wandering away from net output and consumption. As already mentioned, the novel feature of our analysis is that, relative to previous literature, we account explicitly for the coexistence of both deterministic and stochastic trends in the expression. *Third,* expression (11) shows that $\widetilde{KA}_t$ embodies rational forecasts of rates of return, consumption growth and net output growth — a point made by Campbell [1987, 1993] and Lettau and Ludvigson [2001, 2004]. This is intuitively appealing, and an expression similar to (11) has been recently used by Gourinchas and Rey [2007a] to examine important exchange rate-related issues in external adjustment. Specifically, these authors analyze the extent to which the linear combination of (de-trended) gross assets, gross liabilities, exports and imports forecast future returns and the growth rate of net exports.[14] An expression similar to (11) has also been used by Bergin and Sheffrin [2000], to examine a PVM of the current account with time varying returns.[15] *Fourth*, $\widetilde{KA}_t$ cannot be identified from the data without auxiliary hypotheses in addition to the ones specified above. To see why, suppose that, consistent with our assumptions so far, (log) consumption and output, gross assets and output and gross liabilities and output ratios are cointegrated around linear trends. Regardless of whether the coefficients on the levels are equal to unity, it is not possible to identify the parameters ρ_d, ρ_a and ρ_l, in our approximate expression $\widetilde{KA}_t$: if $c_t + \beta_{cz} z_t + \varkappa_c t$, $a_t + \beta_{az} z_t + \varkappa_a t$ and $l_t + \beta_{lz} z_t + \varkappa_l t$ are stationary, any linear combination of these would also be stationary. Hence, there is an infinity of possible linear combinations that could be interpreted as $\widetilde{KA}_t$.[16] As the exact values of these parameters are immaterial for our results below – so long as the variables we model are cointegrated – we abstract from it altogether.[17]

The empirical approach we describe below exploits these cointegrating relations — without im-

[14]Coherently with our distinct focus on saving and the current account, we define $\widetilde{KA}_t$ including net output and consumption, rather than exports and imports as in Gourinchas and Rey [2007a]. Our main interest is to analyze the extent to which the response of consumption, net output and external wealth to shocks is consistent with the basic tenets of the intertemporal approach. In addition to differences in the questions pursued in the analysis, we note here an important technical distinction. In implementing their model, these authors extract trends obtained from low-frequency filtering, e.g. the HP filter, thereby eliminating both deterministic and stochastic trends from the variables. Then they exploit the ability of linear combinations of the so-detrended variables to forecast returns and exchange rates. Instead, consistent with the goals of our analysis, we only 'eliminate' (in fact we jointly estimate) deterministic trends in the analysis, as to preserve the possibility of carrying out our stochastic decomposition of shocks into permanent and transitory, under the maintained assumption that these trends can be approximated in sample.

[15]Essentially, as Bergin and Sheffrin [2000] assume that the steady state NFA position is zero, and that all the variables grow at the same rate, they end up with an expression linking $c_t - z_t$ to future net output growth and future returns (consumption growth is eliminated using an Euler equation). That is in their application $\rho_d = 1$, and $\rho_a + \rho_l = 0$.

[16]In related studies (e.g. Campbell [1987], Campbell and Shiller [1987], Lettau and Ludvigson [2001, 2004]) such an issue does not arise, as these authors find only one cointegrating relationship among the variables they model. We should stress here that a quantification of $\widetilde{KA}_t$ is obviously possible, under some maintained identifying assumptions. A detailed discussion in included in an appendix, available upon request.

[17]Clearly, an empirical evaluation of (11) might be of its own interest, if this equation is to be further used e.g. to study the forecasting properties of $\widetilde{KA}_t$. However, it is not a requirement per se to study the adjustment of our system of variables to permanent and transitory innovations.

posing additional structure. As long as the budget constraint holds, as implied by the transversality conditions, a country's net output, consumption, gross assets and liabilities should co-move in the long run — along a unique stochastic trend and possibly around different deterministic trends — and therefore be cointegrated. In fact, as we discuss shortly, our empirical findings support this hypothesis.

3 Econometric Framework

The key contribution of this paper consists of using cointegration to identify permanent and transitory components of consumption, net output and gross asset and liabilities positions. To detail our approach, this section describes how we work towards isolating the permanent and transitory shocks of a n-dimensional cointegrated vector $\mathbf{x}_t$. In our application, $\mathbf{x}_t = [c_t, z_t, a_t, l_t]'$.

3.1 Data and Preliminary Analysis

In our empirical analysis, net output, Z_t, is gross domestic product net of investment, durable goods consumption and government expenditure, expressed in real, per-capita terms — all variables are obtained by deflating nominal values by the same consumption price index. The total flow of consumption, c_t, is measured by the log of the real per-capita expenditure on nondurables and services — as in Blinder and Deaton [1985], Campbell [1987] and Lettau and Ludvigson [2001, 2004]. Because of the lack of observations on the service flow from most durables goods (making the total flow of consumption essentially unobservable), we add consumption expenditure on durables to investment — it could be noted here that c_t would be a good proxy of total consumption flow under the maintained assumption that the log of (unobservable) real total flow consumption is cointegrated with the log of real nondurables and services expenditures.[18]

Key to our analysis are good estimates of quarterly gross asset and liability positions of the US, incorporating capital gains and losses. We construct our series building on the dataset by Lane and Milesi-Ferretti [2007], who report valuation-corrected stocks of assets and liabilities for many countries, including the US, on an annual basis. Lane and Milesi-Ferretti synthesize information from a very large set of assets and liabilities, including equity, portfolio debt, foreign direct investment and other portfolio investment. The stocks of these four categories of assets are all valuation-adjusted, i.e. they aggregate best estimates of the market value of the underlying financial assets. To obtain quarterly data from annual series, for each of these broad categories, we use annual flows to calculate how much of the year-by-year variation can be attributed to valuation effects. We then use quarterly flows, to update the stocks on a quarterly basis, attributing to each quarter a portion of the annual change in valuation proportional to the share of the quarterly to the annual flow — a full description of the data is provided in Appendix A.

[18] Robustness exercises show that, in practice, our empirical results are virtually identical whether we adopt our preferred definition of consumption given in the text, or we include expenditure on durables in current consumption.

For the US, valuation adjusted series of US foreign assets and liabilities have been recently made available also by Gourinchas and Rey [2007a, 2007b], who elaborate data from the Bureau of Economic Analysis (BEA) and the Federal Reserve Flows of Funds Accounts (FFA) under informed assumptions regarding valuation effects of price changes on stocks and other assets. These series cover a longer period of time (1952-2004) relative to data supplied by Lane and Milesi-Ferretti. In what follows, we will first conduct our analysis on the post-Bretton Woods period using our dataset. In section 5, we will repeat it using the data from these authors, first for the period 1973-2004, and then over the longer sample. As shown below, results obtained across these exercises are virtually identical to our baseline results.

Table 1 reports the summary statistics of the data. In the analysis, all variables are measured in real per-capita terms, and expressed in logs (lower case denotes logs: $c_t,\ z_t$, a_t and l_t). The standard deviation of the quarterly gross foreign assets and liabilities growth is roughly aligned, being almost three times that of net output and almost eight to ten times (for liabilities and assets, respectively) that of consumption growth. Furthermore, gross foreign positions are highly correlated with each other (0.73), and mildly correlated with consumption growth – the correlation coefficient being 0.11 for gross assets and 0.16 for gross liabilities. Finally, gross assets and liabilities are also mildly correlated with net output (0.17 and 0.18 respectively).

3.2 Cointegration Analysis

Permanent and transitory components of the four variable system $\mathbf{x}_t$ are identified making use of the restrictions implied by cointegration. Identification is possible because cointegration places restrictions on the long-run multipliers of the shocks in a model where innovations are distinguished by their degree of persistence, as shown, for example, in Gonzalo and Granger [1995], Johansen [1995], King *et al.* [1991], and Mellander *et al.* [1992].[19] While the approach we follow does not identify structural shocks,[20] it yields results that, at least for the permanent shock, have a natural structural interpretation.

Our procedure takes several steps. First, we estimate the Vector Equilibrium Correction (VEqCM), then we use the estimated parameters to back out long-run restrictions. To specify our VEqCM correctly, we test for the presence and the number of cointegrating relations in $\mathbf{x}_t$. Results are presented in Appendix B, Table B.1. Our tests suggest the presence of three cointegrating relations in the data, albeit the evidence for the third one is not as strong as for the other two. These findings

[19] Earlier contributions that identify shocks by means of their persistence include Blanchard and Quah [1989] and Shapiro and Watson [1988], but their results are based on the assumption of no cointegration among the variables included in the analysis.

[20] Strictly speaking, cointegration allows us to find a suitable rotation that maps reduced form shocks $\mathbf{u}_t$ into shocks $\mathbf{e}_t$, such that $n-r$ of them have permanent effects on $\mathbf{x}_t$ and the rest r have only a transitory effect on $\mathbf{x}_t$. But as explained in King *et al*. [1991] and Mellander *et al.* [1992], if some structural shocks are assumed to be permanent and some transitory, then cointegration can considerably reduce the number of restrictions that need to be imposed to identify the shocks.

point in the direction of three trend stationary relations, corroborating a key theoretical assumption underlying the derivation of our log-linearized model. Furthermore, we can also examine whether the (log) ratios $c_t - z_t$, $a_t - z_t$ and $l_t - z_t$ are each trend stationary, as specifically posited in the previous section. Evidence in favor of these assumptions is presented in Table B.2. In light of these results, we proceed by imposing three cointegrating relations in our VEqCM specification. Our model derivation also posits that the cointegrating vectors are of the form $\beta_s = [1, -1, \theta_s]'$, for $s = c, a, l$, where θ_s is the trend coefficient in the cointegrating relation. Test results are mixed and less encouraging in this respect. Based on maximum likelihood methods (Johansen [1995]), the statistic for the joint test — which is asymptotically distributed as $\chi^2(3)$ — is equal to $Q(3) = 12.121$, corresponding to a p-value of $[0.007]$. Instead, using the empirical distribution function of the test statistic, based on a bootstrap Monte Carlo procedure yields a p-value of $[0.068]$. In line with other contributions to the literature building on the same approach (e.g. Lettau and Ludvigson [2001, 2004]), the restrictions on the cointegrating vector are weakly rejected. This result may be driven by measurement errors plaguing our proxies for consumption flows and especially our measures of gross assets and liabilities, which might bias our tests on the coefficients against the null hypothesis of symmetric cointegrating relations. In light of this observation, and considering our evidence that the (log) ratios $c_t - z_t$, $a_t - z_t$ and $l_t - z_t$ are trend stationary, we nonetheless prefer to impose the cointegrating relations in our VEqCM from the start (see Panel B of Table 2). Finally, to safeguard against misspecification arising from parameter instability, we tested for parameter constancy in the cointegrating relations: we detected no sign of parameter instability in our sample.[21]

Under the cointegrating restrictions just discussed, one can estimate a VEqCM representation for $\mathbf{x}_t$ which takes the form

$$\mathbf{\Gamma}(L)\,\mathbf{\Delta x}_t = \delta + \alpha\left(\hat{\beta}', \hat{\theta}_1\right)\begin{pmatrix} \mathbf{x}_{t-1} \\ t-1 \end{pmatrix} + \mathbf{u}_t, \tag{12}$$

where $\mathbf{\Delta x}_t$ is the vector of log first differences, $(\Delta c_t, \Delta z_t, \Delta a_t, \Delta l_t)'$, δ is a (4×1) vector, $\alpha \equiv (\alpha_c', \alpha_z', \alpha_a', \alpha_a')'$ is a (4×3) matrix, $\hat{\beta}$ is the (4×3) matrix of the cointegrating coefficients discussed above, $\hat{\theta}$ are the coefficients of the deterministic trends in the cointegrating space, and $\mathbf{\Gamma}(L)$ is a finite matrix polynomial in the lag operator. The term $\left(\hat{\beta}'\mathbf{x}_{t-1} + \hat{\theta}_1(t-1)\right)$ gives the previous period equilibrium errors; α is the matrix of 'adjustment' coefficients (or loadings) that tells us which of the variables react to the previous periods' equilibrium errors (cointegrating residuals); that is, which of the variables, and by how much, adjust to restore the equilibrium relations $\left(\hat{\beta}'\mathbf{x}_{t-1} + \hat{\theta}_1(t-1)\right)$ back to their means when a deviation occurs. By virtue of the Granger Representation Theorem (Engle and Granger [1987]), if a vector of variables $\mathbf{x}_t$ is cointegrated, then at least one of the adjustment parameters in the (4×3) matrix α must be non-zero in the VEqCM representation (12). Thus if x_i does at least some of the adjusting needed to restore the j-th long-run equilibrium relation subsequent to a shock that distorts this equilibrium, then the parameter α_{ij}, should be different

[21] The stability tests for the cointegrating parameters are available from the authors upon request.

from zero in the equation for Δx_i in the VEqCM representation (12). The results from estimating the first-order specification (12) are presented in Table 2. Panel A of Table 2 shows the estimated VEqCM, with the associated t-statistics and adjusted R^2 for each equation. Panel B shows the estimated restricted cointegrating vectors and the associated t-statistics along with the likelihood ratio test statistics for the restrictions on $\breve{\beta} = \left(\hat{\beta}', \hat{\theta}_1\right)'$. Note first that two variables (net output and gross liabilities) show evidence of strong equilibrium correction. Hence these two variables do much of the adjustment following a shock that caused the system to deviate from their long-run stochastic trend. Second, we observe that consumption growth and gross asset growth do not respond at all to the equilibrium errors. In order to examine this possibility, in Panel C of Table 2, we perform a series of likelihood ratio tests, one for each variable in our system. We find this is clearly the case for consumption, but not for the other three variables. As further discussed below, this finding implies that consumption is mostly driven by a permanent component, whereas there are important transitory components in net output, gross assets and liabilities. The fact that consumption is mostly driven by permanent shocks is well in line with the evidence in Lettau and Ludvigson [2004], who however cast their analysis in a closed-economy setting.

3.3 Permanent and Transitory Decomposition

Cointegration between the variables in our system is key to decompose $\mathbf{x}_t$ into shocks that are very persistent (permanent) and shocks that are transitory. Since $\mathbf{x}_t$ has four elements, and we find three cointegrating vectors, this implies that there is one common stochastic trend (Stock and Watson [1988]), or, alternatively, that there are just one permanent shock and three transitory shocks. Our identification is achieved in two steps. Specifically, cointegration restricts the matrix of long-run multipliers of shocks in the system, which identifies the permanent component. The transitory components are identified in a 'residual' manner. In order to study the dynamic impact of the permanent innovations, it is assumed that they are orthogonal to the transitory innovations. It is useful to review our methodology in some detail, and explain how it is related to our application. From the Granger Representation Theorem it follows that, under the maintained hypothesis that the growth rates in $\mathbf{x}_t$ are covariance stationary, there exists a multivariate Wold representation of the form

$$\boldsymbol{\Delta}\mathbf{x}_t = \mathbf{C}\left(L\right)\left(\mathbf{u}_t + \boldsymbol{\Upsilon}\mathbf{D}_t\right), \tag{13}$$

where $\mathbf{C}\left(L\right)$ is a 4×4 matrix polynomial in the lag operator, $\mathbf{D}_t$ denotes all deterministic variables and $\boldsymbol{\Upsilon}$ the coefficients of these variables. We want to map these $n = 4$ reduced form innovations, $\mathbf{u}_t$, into transformed innovations $\mathbf{e}_t$ that are distinguished by whether they have permanent or transitory effects. Without loss of generality the shocks $\mathbf{e}_t$ are ordered so that the first $n - r$ of them have permanent effects; and the last r of them have transitory effects. Following Gonzalo and Granger [1995], we define a shock $\mathbf{e}_t^P$ as permanent if $\lim_{h\to\infty} \partial \mathrm{E}\left(\mathbf{x}_{t+h}\right)/\partial \mathbf{e}_t^P \neq 0$, and a shock $\mathbf{e}_t^T$ as transitory if $\lim_{h\rightarrow\infty}\partial\text{E}\left(\mathbf{x}_{t+h}\right)/\partial\mathbf{e}_t^T=0$. Applying the methodology of King *et al.* [1991], as extended by Mellander *et al.* [1992], the permanent and transitory innovations may be identified using the estimated parameters of the VEqCM representation (12) of a cointegrated system. Essentially, cointegration implies that the matrices α and β are each of dimension $n\times r$ and have full rank $r<n$, ($r=3$). Let $\alpha_\perp$ and $\beta_\perp$ be $n\times(n-r)$ matrices orthogonal to α and β respectively (that is $\alpha_\perp'\alpha=\mathbf{0}$ and $\beta_\perp'\beta=\mathbf{0}$ respectively).[22] From the Granger Representation Theorem, it follows that $\beta'\mathbf{C}\left(1\right)=\mathbf{0}$ and $\mathbf{C}\left(1\right)\alpha=\mathbf{0}$. In particular, as explained in Johansen [1995], the long-run impact matrix $\mathbf{C}\left(1\right)$ of the Wold representation (13), admits a closed-form solution in terms of the parameters of the VEqCM (12), namely:

$$\mathbf{C}\left(1\right)=\beta_\perp\left(\alpha_\perp'\mathbf{\Gamma}\left(1\right)\beta_\perp\right)^{-1}\alpha_\perp', \tag{14}$$

which has rank $n-r=1$. Note that the structure of this matrix is such that it maps reduced-form disturbances $\mathbf{u}_t$ into the space spanned by the columns of $\alpha_\perp$ i.e. $sp\left(\alpha_\perp\right)$. The disturbances $\alpha_\perp'\mathbf{u}_t$ accumulate to the permanent component of $\mathbf{x}_t$, whereas transitory disturbances will be in the null-space of $\mathbf{C}\left(1\right)$. We can therefore define the permanent disturbances (permanent shocks) as:

$$\mathbf{e}_t^P=\alpha_\perp'\mathbf{u}_t. \tag{15}$$

Then by requiring that the permanent and transitory shocks be orthogonal to each other, we can define the transitory shocks as:[23]

$$\mathbf{e}_t^T=\alpha'\mathbf{\Omega}^{-1}\mathbf{u}_t. \tag{16}$$

Denoting

$$\mathbf{P}=\begin{bmatrix}\alpha_\perp' \\ \alpha'\mathbf{\Omega}^{-1}\end{bmatrix} \tag{17}$$

the transformed (permanent and transitory) shocks are given by

$$\mathbf{e}_t=\begin{bmatrix}\mathbf{e}_t^{P\prime} & \mathbf{e}_t^{T\prime}\end{bmatrix}'=\mathbf{P}\mathbf{u}_t. \tag{18}$$

It follows that[24]

$$\text{Var}\left(\mathbf{e}_t\right)=\text{diag}\left\{\text{Var}\left(\mathbf{e}_t^P\right),\text{Var}\left(\mathbf{e}_t^T\right)\right\}=\begin{bmatrix}\alpha_\perp'\mathbf{\Omega}\alpha_{\perp\,(n-r)\times(n-r)} & \mathbf{0}_{(n-r)\times r} \\ \mathbf{0}_{r\times(n-r)} & \alpha'\mathbf{\Omega}^{-1}\alpha_{\;r\times r}\end{bmatrix}=\mathbf{P}\mathbf{\Omega}\mathbf{P}'. \tag{19}$$

[22] Note that $\alpha_\perp$ and $\beta_\perp$ are (4×1) vectors.

[23] This is a rather innocuous assumption. See Quah [1992] for a discussion.

[24] Further requiring that permanent and transitory shocks are also orthogonal amongst themselves and that they have unit variance, we can use alternatively

$$\tilde{\mathbf{P}}=\begin{bmatrix}\left(\alpha_\perp'\mathbf{\Omega}^{-1}\alpha_\perp'\right)^{-1/2}\alpha_\perp' \\ \left(\alpha'\mathbf{\Omega}^{-1}\alpha\right)^{-1/2}\alpha'\mathbf{\Omega}^{-1}\end{bmatrix}.$$

Observe that we have achieved both a rotation from reduced-form shocks to permanent and transitory shocks, and orthogonalization.[25] Letting $\mathbf{B}(L) = \mathbf{C}(L)\mathbf{P}^{-1}$, and $\mathbf{e}_t = \mathbf{P}\mathbf{u}_t$, the transformed Wold representation is

$$\mathbf{\Delta x}_t = \mathbf{\Upsilon D}_t + \mathbf{C}(L)\mathbf{P}^{-1}\mathbf{P}\mathbf{u}_t = \mathbf{\Upsilon D_t} + \mathbf{B}(L)\mathbf{e}_t. \tag{20}$$

Thus each element of $\mathbf{\Delta x}_t$ has been decomposed into a function of $n-r=1$ permanent and $r=3$ transitory shocks – with only the former having a long-run effect. With this decomposition, the level of $\mathbf{x}_t$ can be written as the sum of $n-r=1$, $I(1)$ common factor (permanent component), and $r=3$, $I(0)$ transitory components. The $n-r=1$ common factor in the Granger-Gonzalo/Gonzalo-Ng decomposition described above are determined by $\alpha'_{\perp}\mathbf{x}_t$. Given the structure of our estimated adjustment coefficients, it follows that $\alpha'_{\perp} = [1,0,0,0]$, hence the permanent component in our four system variable can be identical to innovations in the consumption equation.[26] This further implies that consumption is mostly driven by permanent shocks at all horizons.

4 Dynamic Analysis of Temporary and Permanent Shocks

4.1 Identifying and Interpreting Shocks

Using the methodology discussed in section 3, it is straightforward to investigate how each of the variables in our system is related to permanent and transitory shocks. This decomposition can be understood by looking at the properties of the matrix $\mathbf{P}$ in (17) that achieves the rotation from the reduced form to permanent and transitory shocks. Intuitively, any variable x_j participates little in the equilibrium correction when the row α_j of α contains elements that are small in absolute value, so that the element of $\alpha'_{\perp}$ that multiplies u_{jt} is large in absolute value. In this case x_j has a large weight in the permanent and a small weight in the transitory innovations. Conversely, x_j has a small weight in the permanent innovations and a large weight in the transitory innovations when the row α_j contains elements that are large — implying that the element of $\alpha'_{\perp}$ that multiplies u_{jt} is small in absolute value.

[25] An alternative scheme for identifying permanent and transitory shocks is due to Gonzalo and Ng [2001]. A problem with this approach is that the matrix that achieves the permanent-transitory decomposition is

$$\mathbf{G} = \begin{bmatrix} \alpha'_{\perp} \\ \beta' \end{bmatrix},$$

which is not guaranteed to have full rank in all cases. See Johansen [1995], exercise 4.3, for a counter-example. In contrast, the matrix $\mathbf{P}$ that we employ is always guaranteed to have full rank.

[26] This permanent component may contain serial correlation around the random walk component given by the multivariate Beveridge-Nelson decomposition. Alternatively, as explained in Proietti [1997], one can take into account the short-run dynamics of the systems, as these are captured by the lag polynomial $\mathbf{\Gamma}(L)$, and use the identity

$$\mathbf{x}_t = \mathbf{C}(1)\mathbf{\Gamma}(1)\mathbf{x}_t + \{\mathbf{I}_n - \mathbf{C}(1)\mathbf{\Gamma}(1)\}\mathbf{x}_t,$$

where the $n-r=1$ common factor is given by $\mathbf{C}(1)\mathbf{\Gamma}(1)\mathbf{x}_t$.

The key finding in our analysis — already referred to above — is that consumption has a large permanent component: for consumption $\alpha_c = 0$, a parameter restriction that we impose in the analysis to follow.[27] Conversely, the other three variables have a strong transitory component, i.e. they do much of the adjustment needed to restore equilibrium. In our application, with the important exception of consumption, most of the elements of the adjustment matrix α are relatively large and statistically significant (see Table 2): net output, gross assets and liabilities have a non-negligible weight in the transitory innovations.[28]

Now, cointegration and the identification of permanent and transitory shocks impose the restriction that the last three columns of the $\mathbf{B}(1) = \mathbf{C}(1)\mathbf{P}^{-1}$ matrix are zero vectors. The assumption of orthogonality between permanent and transitory shocks is sufficient to identify the single permanent shock. Identifying econometrically all the shocks in our four-variable system would then require three extra restrictions, on which economic theory and/or econometrics provide little or no guidance. For the purpose of analyzing the effects of the single permanent shock, however, identifying separately the three transitory shocks is immaterial. So, without imposing any additional restriction, we will examine the effect of the former against the joint effect of the latter combined together.

The permanent shock — denoted by η_t^P — is the only shock that affects net output, consumption, assets and liabilities in the long run, and can therefore be read as a linear combination of structural shocks that lead to permanent changes in our four variables.[29] A natural interpretation for this shock in our analysis is that of a *permanent technology shock* — e.g. TFP.[30] More generally, though, this shock could reflect any economic factor (e.g. tax reforms) which cause the supply of domestic output to increase in the long run — a permanent supply shock.

4.2 Variance Decomposition

An important issue that can be naturally addressed using our decomposition concerns the contribution of temporary and permanent shocks to explaining the variability of the four elementary components of the current account we included in our analysis: consumption, net output and the stocks of foreign assets and liabilities. For this purpose, in Table 3 we report variance decompositions. Specifically, the second to ninth columns of Table 3 report the fraction of the total variance in the forecast error of c_t, z_t, a_t and l_t that is attributable to the permanent shock, η_t^P, and the three transitory shocks combined, η_t^T. Sampling uncertainty is quantified using a bootstrap Monte Carlo procedure. Namely, Table 3 displays the fraction of the h-step ahead forecast-error variance in

[27] Through a robustness exercise we verified that relaxing this assumption is not consequential for our results.

[28] Recall that the estimated adjustment coefficients on gross assets examined one-by-one seem insignificant, but when jointly tested, they are found to be significant. In addition, examining these point estimates relative to those of consumption, we find them to be large.

[29] Note that the first identified shock in our system, η_t^P, is the permanent shock, e_t^P, normalized to have unit variance.

[30] Such a shock is dubbed "common trend shock" by King et al. [1991].

consumption, net output, assets and liabilities that is attributable to the one permanent shock and the three transitory shocks. For $h = 1, 2, ...,$ we compute the portion of the total variance of each variable that is attributable to each type of disturbance.[31]

At virtually all horizons, the transitory shocks account for only a negligible portion of consumption variation. Only the permanent shocks matter for this variable — something that follows from the fact that the permanent shock is identified from the consumption equation, as we have explained above. However, at horizons between one and four quarters, transitory shocks account for most of the variance for the other three variables in our analysis – between 73 and 76 percent of the variance in net output, between 87 and 91 percent of the variance in foreign assets, and around 94 percent of the variance in foreign liabilities. The transitory shocks continue to contribute considerably to the forecast error variance of foreign assets and liabilities also at horizons of eight to twenty quarters ahead: between 77 and 84 percent, and between 80 and 91 percent, respectively. Over these horizons, however, transitory shocks become progressively less relevant in accounting for the variance of net output.

At a horizon of forty quarters, the permanent shock accounts virtually for the whole variance of consumption, and 83 percent of the variance of net output, but only 28 percent of the variance of assets and liabilities. Notably, at a forty quarters horizon, the transitory shocks still contribute between 47 and 76 percent to the variance of gross assets and between 53 and 73 percent to the variance of gross liabilities.

To shed further light on the dynamics of the system, it is instructive to look at a measure of the US current account as the quarterly change of US net foreign assets. That is, defining net foreign asset position $NFA_t \equiv [\exp(a_t) - \exp(l_t)]$, a theory-consistent measure of the current account is $CA_t^{\star} \equiv [\exp(a_{t+1}) - \exp(l_{t+1})] - [\exp(a_t) - \exp(l_t)] \equiv \Delta NFA_{t+1}$. Results from this exercise are reported in the last two columns of Table 3, which shows the fraction of the h-step ahead forecast-error variance of the change in net foreign assets — i.e. the current account — that is attributable to permanent and transitory shocks. As in our results above, transitory shocks account for the vast majority of the fluctuations in (this proxy of) the current account. More specifically, transitory shocks account for fluctuations of the current account ranging between 96 and 98 percent at virtually all horizons. Permanent shocks contribute between two and four percent to the variance of the current account.

These results from variance decomposition analysis are strikingly aligned with current account theory in the following dimensions. In response to permanent shocks to net output, consumption almost completely adjusts on impact, while the current account fluctuates in the short and the long

[31]Note that cointegration with $r = 3$ implies that $\mathbf{C}(1)$ is a matrix of rank one. Hence in the limit, only permanent shocks will have an impact on the four variables will model, since the cumulative effect of transitory shocks is zero. The property that only permanent shocks affect the (levels of the) variables in the long-run, whereas transitory do not, follows from cointegration and is not specific to the rotation of the shocks we have chosen (see Gonzalo and Ng [2001] for a discussion). In our application, cointegration and the assumption of orthogonality between permanent and transitory shocks imply that only the first column of $\mathbf{B}(1) = \mathbf{C}(1)\mathbf{P}^{-1}$ has elements that differ from zero.

run. While consumption has almost no temporary component, temporary fluctuations in the system affect jointly net output and the stocks of external assets and liabilities (and their combination). In addition, the fact that transitory movements in assets and liabilities are quite significant, and last longer than transitory movements in net output, is consistent with the idea that international financial markets are a quantitatively relevant source of shocks which need to be smoothed via intertemporal trade.[32] To our knowledge, these intriguing results are novel relative to existing empirical literature.

4.3 Impulse Responses Analysis of the Permanent Shock

As the single permanent shock in our system is identified in isolation (as opposed to the transitory shocks, which we combine together), we can complement the analysis above with a study of the impulse responses to it. As already discussed above, the identified permanent shock in our approach is not structural. Yet, because of its long-run effects on net output and consumption, it has a natural interpretation as a technology shock, and more generally may capture a variety of factors that translate into a higher supply of output in the long run.

The graphs in Figure 1 plot the accumulated impulse response of $\Delta z_t, \Delta c_t, \Delta a_t$, Δl_t, as well as the responses of $CA_t^{\star} \equiv \Delta NFA_{t+1}$, together with the associated bootstrap confidence bands.[33] The first two graphs, showing net output and consumption, illustrate a remarkable result. After a strong response on impact, net output rises gradually for about 20 quarters, then settles at a higher permanent level, following a typical hump-shaped pattern. In the long run, net output rises significantly — the point estimate is somewhat above 0.6%. Interestingly, the new long-run level is not very different from the initial response. Conversely, consumption jumps on impact, and quickly reaches its new long-run level. Already after 3 quarters consumption is 0.6% higher than the initial equilibrium, while net output is still below the new long-run level and growing. From the second quarter on, the response of consumption is stronger than that of net output for about fifteen quarters. This result is noteworthy in light of the large body of literature documenting that consumption is excessively smooth vis-a-vis persistent shocks to income (e.g. Campbell and Deaton [1989]).

The third and fourth graphs, showing the response of the stocks of US foreign assets and US foreign liabilities to the permanent shock, illustrate a second remarkable result from our analysis. In response to the shock, we find that both stocks — of assets and liabilities — move in the same direction. Observe that gross assets peak early on, then decline gradually to the new long-run value — the percentage change in the long run is the same for all variables in the system. Gross liabilities display a non-linear behavior: their initial increase is below that of gross assets; however, they keep

[32]Observe that the stocks A and L are choice variables for national residents, and they are adjusted in each period. The allocation is however chosen against fluctuations not only in net output, but also in the value of assets traded internationally.

[33]We employ Hall's [1992] percentile intervals, as detailed in Benkwitz et al. [2001].

rising gently for about 12 quarters — surpassing gross assets over time — before declining equally gently to the new steady state value. This information is synthesized by the last graph in the figure, showing the response of our proxy to the current account, $CA_t^{\star}$. This variable displays a non-linear behavior, corresponding to the different patterns of assets and liabilities described above: a strong improvement for about three quarters is followed by a clear deterioration up to about the 15th quarter, when the initial balance is effectively restored. [34]

The correlation in the movements of assets and liabilities is a novel empirical result in the literature, which however turns out to be robust to different methodologies — for instance, a simultaneous increase in both assets and liabilities is also found by Corsetti et al. [2008b], in response to productivity (and demand) shocks to US tradables identified using sign restrictions. This piece of evidence raises a number of interesting empirical and theoretical issues. On empirical grounds, it is well understood that the composition of the two stocks differ markedly. US foreign liabilities are mostly denominated in dollars, with a large share of debt instruments – long-term and short-term instruments together account for roughly 66% of total liabilities on average. US foreign assets are mostly denominated in foreign currencies, with a large component of equities and FDI – which together account for about 50% of total assets on average. While these differences can be expected to influence our results, their role is not straightforward. For instance, one may observe that a dollar depreciation would naturally tend to increase the value of US foreign assets: if a permanent output expansion is matched by a fall of the dollar, the appreciation of the stock of foreign assets could simply reflect the movement in the exchange rate.[35] However, while our empirical analysis does not account for exchange rates as a separate variable, related results by Corsetti et al. [2008b] provide evidence that positive productivity shocks raising US manufacturing output and aggregate consumption, actually cause both the stock of US foreign assets to rise, and the dollar (real) exchange rate to appreciate (together with the US terms of trade). This result clearly warns against trying to infer exchange rate movements from the evidence on the dynamics of stocks. On the other hand, if the permanent shock we identify has a global component — we do not control for the rest of the world — it may well be possible that our permanent shock is correlated with an increase in stock prices in both the US and abroad. In this case, at least part of the increase in US foreign assets would be due to capital gains on foreign equities.

Overall, the above results provide an intriguing empirical benchmark for theoretical work on

[34]This impact response of the current account may appear at odds with the textbook's intertemporal model prediction, that permanent shocks raising per capita output in the long run by more than in the short run should immediately lead to an external deficit. However, while Panel B of Figure 1 shows that the long-run increase in z_t is larger than its initial increase – definitely larger than its response after two quarters —, it also shows a strong response of net output on impact. A delayed response of the current account to persistent productivity shock in the tradable sector is also detected by Corsetti et al. [2008a, 2008b], while similar nonlinearities are discussed by Kraay and Ventura [2000, 2003].

[35]As is well understood, about 75% of the U.S. foreign assets is denominated in foreign currency. A back of the envelope calculation suggests that, holding asset prices constant, a rise by 1.53% in the value of foreign assets could be generated by an exchange rate devaluation of about 2%.

portfolio diversification (see e.g. Devereux and Sutherland [2007]). To the extent that optimal portfolio strategies prescribe domestic agent to re-scale their asset holding as a function of wealth, a permanent increase in net output (translating into higher US wealth) should indeed lead US households and firms to invest more abroad, while possibly adjusting their foreign liabilities by more. Early instances of models stressing this point — in the framework of Merton's portfolio analysis —.are put forward by Kraay and Ventura [2000, 2003].

4.4 The Role of Transitory Shocks to Net Output and (Returns on) Foreign Assets

The distinct novel feature of our analysis, largely absent from PVM tests as well as from recent empirical models, is the decomposition of shocks into transitory and permanent components. As discussed in Section 2, the fact that in most PVM empirical models shocks to net output are all permanent by assumption has severely limited the ability of these frameworks to account for a key component in the movements of net foreign wealth. In our results, temporary fluctuations are indeed important driver of net output, and even more so, of the implied current account dynamics. Thus, a crucial question addressed by our study is whether the failure to allow for differential effects of permanent and transitory shocks to both net output and income from foreign assets is actually at the root of rejections of many empirical models of the current account — in line with the argument by Nason and Rogers [2006].

In this respect, accounting for capital gains and losses on foreign assets and liabilities is key to current account analysis — as these gains and losses produce large and growing deviations of the officially measured current account from the actual change in the net foreign asset position of a country. The series employed in our analysis — much closer to theory than their officially measured counterparts used in early empirical studies — arguably provide a much more accurate picture of the stochastic environment faced by national residents (firms and households) in their intertemporal allocation decisions.

As Table 3 shows, over all horizons we examine, most of the variation in gross positions (and in the implied current account) is generated by transitory innovations. Since the effect of transitory innovations on net output die out relatively quickly, the transitory components in gross positions must be primarily associated with fluctuations in returns. In order to investigate this issue, we extract the transitory components of gross assets and liabilities by means of a multivariate Beveridge-Nelson decomposition, employing our cointegrated VAR. These components are displayed in Figure 2.A, normalized in such a way that, whenever gross positions are above trend, the transitory components are positive. The top panel in the figure refers to assets, the bottom panel to liabilities. The same figure also displays a four-quarter moving average of returns.[36]

Results are striking. First, it is apparent that transitory swings in gross positions are persistent and quantitatively large, especially during the 1990's. For instance, back of the envelope calcula-

[36] We have calculated the returns on gross assets and liabilities along the lines of Gourinchas and Rey [2007b] — a detailed description is provided in Appendix A.

tions reveal that at its peak in 1999, the transitory component of assets is about 2.15 percent of its permanent component. Translated into dollar amounts, assets exceeded their long-run trend by as much as $ 56,729 per capita, in 1996 dollars. Second, the cyclical components in the stocks of foreign assets and liabilities are highly correlated with returns (e.g. the contemporaneous correlation is 0.37 for assets and 0.44 for liabilities). In other words, the swings in stocks of foreign assets and liabilities match those in returns, thereby indicating that a great deal of the transitory variation in gross positions is associated to (transitory) variation in returns.[37]

The conclusion suggested by this evidence is straightforward. Empirical tests of current account theory should place stochastic fluctuations in returns centerstage in the analysis, as crucial drivers of current account dynamics. Ignoring this dimension cannot but severely limit test results.

5 Robustness Experiments and Extensions

In this section, we carry out four sets of experiments. In the first two, we examine the robustness of our results when we replace nondurables and services consumption with total consumption, and we look at sub-sample. Third, we allow consumption to adjust to restore equilibrium errors, i.e. we allow the adjustment coefficients α_c to be different from zero — even when these are not significant in our tests. Finally, we employ the time series for foreign assets and liabilities calculated by Gourinchas and Rey [2007a, 2007b] based on different data sources and also covering a longer time span. As a by-product, we thus extend our analysis so to include the period prior to the collapse of the Bretton Woods in our analysis.[38]

Total Consumption The first issue we examine is whether our findings are robust to the use of total real consumption expenditure as the relevant measure of consumption — an issue forcefully raised by Rudd and Whelan [2006] and Palumbo, Rudd and Whelan [2006]. To this end, we have repeated the analysis using this new variable. Consistently, we have re-calculated the real values of all the series (net output, gross assets and liabilities) using the deflator for total consumption.

To start with, we establish that in our data there are three cointegrating relations around deterministic trends, as was the case for our analysis with nondurables and services consumption. Then, we examine whether the “symmetry” restrictions are also satisfied, obtaining mixed results: these

[37] Periods in which gross assets/liabilities are above (below) trend, are typically followed by periods of negative (positive) real returns on assets. An instance is the upward spike in assets relative to trend in 1999, which is followed by a sequence of negative real returns during the early 2000’s. The decline in assets relative to trend in 1994 is followed by positive returns until the late 1990’s. This negative correlation between the transitory component of gross positions (a_t^T and l_t^T respectively) with future returns (r_{t+h}^a and r_{t+h}^l respectively) is best appreciated by calculating the cross-correlation function. We find that the correlation between l_t^T and r_{t+h}^l is increasingly negative for $h > 0$, such that future liability-returns realizations are negatively correlated with current deviations of gross liabilities from trend. The same is true for gross assets. These results are available upon request.

[38] We report part of our findings only when employing total consumption. The rest of our results, that are not reported here, are available upon request.

restrictions are not rejected when they are examined one-by-one; they are rejected when jointly examined. As in section 3,[39] however, we proceed by assuming that the restrictions are satisfied in the data. Finally, we examine whether any of the variables can be treated as 'not adjusting' to restore the cointegrating relations to their mean. We find, once again, that this holds for total consumption – similarly to our previous results for nondurables and services consumption.

Next, using our methodology we disentangle the influence of permanent and transitory shocks. Our results are almost identical to those reported above. Table 4 reports the fraction of the total variance in the forecast error of c_t, z_t, a_t and l_t that is attributable to the permanent shock η_t^P and the three transitory shocks η_t^T, where c_t is (the log of) total consumption. The only notable difference relative to Table 3 is that the permanent shock has a more pronounced effect on net output at all horizons, whereas it is even less important for fluctuations of our proxy to the current account, highlighting the importance of transitory shocks for current account fluctuations.

The impulse responses to the permanent shock are shown in Figure 2. It is apparent that, overall, the patterns are the same as in Figure 1. In response to a permanent shock, consumption increases almost on impact, while net output displays a non-linear response. Gross assets increase on impact and keep increasing for about twelve quarters, gently declining afterwards to their new steady state level. Gross liabilities increase gradually, reaching a peak of 1.12%, rise after thirteen quarters and then declines to the new steady state level. The response of our measure of the current account is also non linear: it improves on impact – for two quarters; then it turns into a deficit between the third and the fourteenth quarters after the shock. The only notable difference relative to our baseline result lies in the magnitude of the responses.

Sub-Samples during the Post Bretton Woods Period Many analysts have stressed the possibility that the marked deterioration of the US current account in the second half of the 1990s may be driven by bubbles in the asset market, driving the boom of stock prices in the US and elsewhere (see e.g. Kraay and Ventura [2008]). Bubbles have potential implications for the intertemporal budget constraint as deficits may at least in part be financed by issuing ultimately worthless assets. An important question is thus whether our results are sensitive to the inclusion of the post-1995 years in our sample. To address this issue, we have run our model on different samples truncated in both in 1990 and 1995 i.e. the new samples run from the first quarter of 1973 to the fourth quarter of 1990, and 1995, respectively. Results are substantially unaffected. The pattern of impulse responses to the permanent shock is very similar to the ones displayed in Figure 1, although the exact magnitudes of the responses differ. Equally robust are our results regarding the relative contribution of permanent and transitory shocks in total variation.

A different question is whether our findings may be sensitive to the extent of financial liberalization. Our main results remain substantially unaffected when we estimate the model using 1980

[39] Once again, we should stress that we are using proxies of the true variables, which might bias our test on the coefficients against the null hypothesis of symmetric cointegrating relations.

as a starting point.

Deviations from the 'Permanent Income Hypothesis' A third set of experiments consists of carrying out the analysis allowing the equilibrium adjustment coefficients in the consumption equation, α_c, to be different from zero — even though these parameters were found statistically insignificant. We estimate them freely as in Table 2 in two version of our analysis, employing nondurables and services consumption, as well as using total consumption.

In these exercises we find two quantitative differences relative to our baseline analysis. First, the permanent shock plays a bigger role in explaining the variation of gross assets. As a consequence the permanent shock accounts for a larger share of the variation of the current account. Specifically, focusing on the case of nondurables consumption: Transitory shocks account between 19% (at horizon of one quarter) and 3% (at horizon of forty quarters) in the variation of consumption, but their contribution is not statistically significant. Relative to our baseline, the contribution of transitory shocks to the variability of net output (between one and twelve quarters ahead) is slightly more pronounced; results regarding gross liabilities are almost identical; but permanent shocks now account for a larger fraction of the variance of gross assets, between 31% and 37% (between one and eight quarters) — their contribution becoming larger as the horizon increases. As a consequence, we now find that the permanent shock accounts for between 38% and 40% of the variability of the current account, at almost all horizons.

Results are similar when we use total consumption, including durables, except that transitory shocks seem to contribute even more to the variation of consumption — recall however that their contribution is not statistically significant. As above, we find a more pronounced contribution of permanent shocks to the variance of gross asset, a finding which is mirrored in the contribution of the permanent shock to the current account (between 41% and 42%).

The second difference with our baseline analysis concerns the impulse responses to permanent shocks. Consumption now adjusts more gradually to its new steady state level, making the nonlinearity in the response of the current account more apparent: the current account improvement in the first two quarters is larger; the subsequent deficit lasts between the third and the nineteenth quarters after the shock.

These two quantitative differences, however, do not affect our main conclusions regarding the relative importance of permanent and transitory shocks in driving the dynamics of our four variables. The majority of the fluctuations in the current account are driven by transitory shocks, while its response to permanent shocks is qualitatively consistent with the intertemporal model of the current account.

Different Dataset and Sample Extensions As a final exercise, we verify whether our results go through when we employ the dataset built by Gourinchas and Rey [2007a, 2007b]. This is an important exercise, because our results could be sensitive to different methodologies in calculating valuation-adjusted stocks of assets and liabilities. We proceed as follows. First, we repeat our analysis looking the same sample period 1973–2004 as in our baseline analysis. Then we examine the robustness of our results to extending the sample period backward, up to 1952. Remarkably, in either case, we find that our main conclusions are unaffected. Yet there are interesting pieces of information that one can learn from the second exercise.

Using these authors' quarterly gross assets and liabilities positions over the sample 1973–2004, we confirm all our results above. We find evidence in favor of the trend–stationarity of the 'great ratios', based on bivariate system–tests and unit root tests. Imposing these cointegration restrictions on our VAR, we find that consumption does not display evidence of equilibrium correction, as was the case for our dataset. Furthermore, our impulse responses and variance decompositions are almost identical to the ones we report in Figures 1 and Table 3 — the only minor difference being that the effects of transitory shocks on net output, gross assets and liabilities are now a bit more pronounced, accounting for a larger portion of the variability of the aforementioned variables. Similarly, when we employ total consumption as measure of consumption-flow, we find results that are in line with those reported in our first robustness exercise (i.e. Figure 2 and Table 4)

The use of the dataset over the period 1952–2004 presents a challenge to the empirical methodology laid out in Section 3, namely, the ratios of gross assets and liabilities to net output cannot be characterized as trend stationary processes – hence violating Assumption 2.4. Consistently with our approach, however, we conjecture the presence of a break in the deterministic trends in the sample (fully consistent with Assumptions 2.1–2.3), prior to the beginning of the large increase in cross-border asset holding with market liberalization. We test this hypothesis employing the Zivot and Andrews [1992] unit root test, which allows for deterministic trend breaks in the two ratios to be identified endogenously in the sample. Most interestingly, it turns out that there is a deterministic trend break in the assets to (net) output ratio occurring in 1974:Q1 and a break in the liabilities to output ratio occurring in 1970:Q1. These dates precede somewhat the official liberalization initiatives in the US, Germany, the UK and Japan in the seventies. Yet they are placed at the time in which Bretton Woods arrangements were already under strain, with large speculative capital flows pointing to a *de facto* relaxation of controls across borders.

Allowing for these deterministic trend breaks in the cointegrating space, we re-do our analysis estimating our cointegrated VARs, to obtain impulse responses and forecast error variance decompositions, employing non-durables and services consumption and total consumption respectively. The estimated impulse responses are strikingly similar to those obtained in our main results. That is, consumption increases on impact reaching its long run level swiftly, while the adjustment of net output to its new long-run level is much slower. Gross positions increase on impact, while the implied current account dynamics are again non-linear. The variance decomposition analysis also conveys a message consistent with our baseline results.

6 Conclusion

Understanding the dynamic behavior of a country's current account requires a careful assessment of the stochastic nature of shocks hitting the economy. In this paper, we carry out an empirical analysis of the US external balance differentiating between trend- and cycle components in US consumption, net output, gross foreign assets and gross foreign liabilities. We identify permanent and transitory shocks to the system of these four variables, and analyze the dynamics of the adjustment mechanism.

A key finding of our analysis is that transitory variations in output, gross asset positions and on the current account are quantitatively large over both short and long horizons. In our estimates, transitory shocks contribute to the vast majority of fluctuations in quarterly gross positions and the current account — their effects lasting much longer than the typical business cycle frequency. Strikingly, temporary fluctuations in the stocks of valuation-adjusted US foreign assets and liabilities match fluctuations in the rates of returns on these stocks.

Yet, in line with the intertemporal trade approach to the current account, consumption is 'insulated' from the corresponding transitory variations in output and gross asset positions: consumption is well described by a trend component, and its variation is dominated by permanent shocks. Furthermore, consumption responds swiftly to permanent shocks, adjusting within a year. In response to positive shocks that raise net output gradually towards its new long-run level, the economy thus runs a current account deficit.

These results are strikingly consistent with current account theory, and help explain why existing empirical frameworks, downplaying the distinction between temporary and permanent shocks, or ignoring temporary fluctuations in returns, have yielded inconclusive results. By the same token, they have relevant implications for the ongoing debate on external imbalances. Recent research has emphasized the role of asset prices and exchange rates adjustment (Gourinchas and Rey [2007a]) in addition to the role of quantity adjustments traditionally stressed by the conventional theory. Complementing their analysis, we find that much of the movements in valuation-adjusted gross external positions by the US are of transitory nature, but these movements are quite persistent. This suggests that, while transitory build up of assets and liabilities can be expected to revert to trend at some point in the future, the process may take quite some time. Along this process, our findings clearly underscore the relevance of macro adjustment in quantities, as reflected in the behavior of consumption and net output — adjustment that cannot be neglected in studies of the dynamics of the US external balance.

References

Benkwitz, A., Lütkepohl, H. and Wolters, J. [2001] Comparison of Bootstrap Confidence Intervals for Impulse Responses of German Monetary Systems, *Macroeconomic Dynamics, 5, 81-100*

Bergin, P. R. and Sheffrin, S. M. [2000] Interest Rates, Exchange Rates and Present Value Models of the Current Account, *Economic Journal, 110, 535-558*

Beveridge, S. and Nelson, C. R. [1981] A New Approach to Decomposition of Economic Time Series into Permanent and Transitory Components with Particular Attention to Measurement of the Business Cycle, *Journal of Monetary Economics, 7, 151-74*

Blanchard, O.-J. and Quah, D. [1989] The Dynamic Effects of Aggregate Supply and Demand Disturbances, *American Economic Review, 79, 655-73*

Blinder, A. S. and Deaton, A. [1985] Time Series Consumption Function Revisited, *Brookings Papers on Economic Activity (2), 465–511*

Breitung, J., Brüggemann, R. and Lütkepohl, H. [2004] Structural Vector Autoregressive Modelling and Impulse Responses, *in* **Lütkepohl, H. and Krätzig, M.** (eds), *Applied Time Series Econometrics*, Cambridge: Cambridge University Press.

Campbell, J. Y. [1987] Does Saving Anticipate Declining Future Labor Income? An Alternate Test of the Permanent Income Hypothesis, *Econometrica, 55, 1249-73*

Campbell, J. Y. [1993] Intertemporal Asset Pricing without Consumption Data, *American Economic Review, 83, 487-512*

Campbell, J. Y. and Deaton, A. [1989] Why is Consumption So Smooth?, *Review of Economic Studies, 56, 357-374*

Campbell, Y. Y., Lo, A. W., and MacKinlay, A. C. [1997] *The Econometrics of Financial Markets*, Princeton NJ: Priceton University Press.

Campbell, J. Y. and Mankiw, N. G. [1989] Consumption, Income, and Interest Rates: Interpreting the Time Series Evidence *in* **Blanchard O.-J. and Fisher, S.** (eds.) *1989 NBER Macroeconomics Annual, 185-244,* Cambridge MA: MIT Press

Campbell, J. Y. and Shiller, R. [1987] Cointegration and Tests of Present-Value Models, *Journal of Political Economy, 95, 1063-1088*

Corsetti, G., Dedola, L. and Leduc, S. [2008a] Productivity, External Balance and Exchange Rates: Evidence on the Transmission Mechanism Among G7 Countries, *in* **Reichlin, L. and West, K.** (eds.) *NBER International Seminar on Macroeconomics 2006, 117-194*, Chicago IL: The University of Chicago Press

Corsetti, G., Dedola, L. and Leduc, S. [2008b] The International Dimension of Productivity and Demand Shocks in the US Economy, *CEPR DP No. 7003*

Devereux, M. B. and Sutherland, A. [2007] Country Portfolio Dynamics, *CEPR DP No. 6208*

Engel, C. and Rogers, J. H. [2006] The U.S. Current Account Deficit and the Expected Share of World Output, *Journal of Monetary Economics, 52, 1063-1093*

Engle, R. F. and Granger, C. W. J. [1987] Cointegration and Error-Correction: Representation, Estimation, and Testing, *Econometrica, 55, 251-276*

Ghosh, A. R. [1995] International Capital Mobility Amongst the Major Industrialized Countries: Too Little or Too Much? *Economic Journal, 105, 107–128*

Glick,R. and Rogoff, K. [1995] Global versus Country-specific Productivity Shocks and the Current Account, *Journal of Monetary Economics, 35, 159-92*

Gonzalo, J. and Granger, C. W. J. [1995] Estimation of Common Long-Memory Components in Cointegrated Systems, *Journal of Business and Economic Statistics, 13, 27-35*

Gonzalo, J. and Ng, S. [2001] A Systematic Framework for Analyzing the Dynamic Effects of Permanent and Transitory Shocks, *Journal of Economic Dynamics and Control, 25, 1527-1546*

Gourinchas, P.-O. and Rey, H. [2007a] International Financial Adjustment, *Journal of Political Economy, 115, 665-703*

Gourinchas, P.-O. and Rey, H. [2007b] From World Banker to World Venture Capitalist: The US External Adjustment and The Exorbitant Privilege, *in* **Clarida, R.** (ed.) *G7 Current Account Imbalances: Sustainability and Adjustment, 11-57*, Chicago IL: The University of Chicago Press

Gregory, A. and Head, A. [1999] Common and Country-Specific Fluctuations in Productivity, Investment and the Current Account, *Journal of Monetary Economics, 44(3), 423-451*

Hall, P. [1992] *The Bootstrap and Edgeworth Expansion*, New York: Springer-Verlag

Hansen, P. R. and Johansen, S. [1998] *Workbook on Cointegration*, Oxford: Oxford University Press

Hoffmann, M. [2001] The Relative Dynamics of the Current Account and Investment in the G7 Economies, *Economic Journal, 111, C148-C163*

Hoffmann, M. [2003] International Macroeconomic Fluctuations and the Current Account, *Canadian Journal of Economics, 36, 401-420*

Iscan, T. [2000] The terms of Trade, Productivity Growth, and the Current Account, *Journal of Monetary Economics, 45, 189-211*

Johansen, S. [1995] *Likelihood-Based Inference in Cointegrated Vector Autoregressive Models,* Oxford: Oxford University Press

King, R. G., Plosser, C., Stock, J. H. and Watson, M. W. [1991] Stochastic Trends and Economic Fluctuations, *American Economic Review, 81, 819-840*

Kraay, A. and Ventura J. [2000] Current Accounts in Debtor and Creditor Countries, *Quarterly Journal of Economics, November 2000*

Kraay, A. and Ventura J. [2003] Current Accounts in the Long and Short Run, *in* **Gertler, M. and Rogoff, K.** (eds.) *2002 NBER Macroeconomic Annual*, Cambridge MA: MIT Press

Kraay, A. and Ventura J. [2008]. The Dot-Com Bubble the Bush Deficits, and the US Current Account, *in* **Clarida, R.** (ed.) *G7 Current Account Imbalances: Sustainability and Adjustment, 457-496* Chicago IL: The University of Chicago Press

Kwiatkowski, D., Phillips, P. C. B. Schmidt, P. and Shin, Y. [1992] Testing the Null Hypothesis of Stationary against the Alternative of a Unit Root, *Journal of Econometrics, 54, 159-178*

Lane, P. R and Milesi-Ferretti, G.-M. [2001] The External Wealth of Nations: Measures of Foreign Assets and Liabilities in Industrial and Developing Countries, *Journal of International Economics, 52, 263-94*

Lane, P. R and Milesi-Ferretti, G.-M. [2007] The External Wealth of Nations Mark II: Revised and Extended Estimates of Foreign Assets and Liabilities, 1970-2004 , *Journal of International Economics, 73, 223-250*

Lettau, M. and Ludvigson, S. [2001] Consumption, Aggregate Wealth and Expected Stock Returns, *Journal of Finance, 109 (6), 815-849*

Lettau, M. and Ludvigson, S. [2004] Understanding Trend and Cycle in Asset Values, *American Economic Review, 94, 276-299*

Lütkepohl, H. [2006] *New Introduction to Multiple Time Series Analysis*, Berlin: Springer

MacKinnon, J. G. [1996] Numerical Distribution Functions for Unit Root and Cointegration Tests, *Journal of Applied Econometrics, 11, 601-618*

MacKinnon, J., G., Haug, A.A. and Michelis, L. [1999] Numerical Distribution Functions of Likelihood Ratio Tests For Cointegration, *Journal of Applied Econometrics, 14, 563-577*

Mellander, E., Vredin, A. and Warne, A. [1992] Stochastic Trends and Economic Fluctuations in a Small Open Economy, *Journal of Applied Econometrics, 7, 369-394*

Nason, J. M. and Rogers, J. H. [2006] The Present-Value Model of the Current Account Has Been Rejected: Round Up the Usual Suspects, *Journal of International Economics, 68, 159-187*

Obstfeld, M. and Rogoff, K. [1995] The Intertemporal Approach to the Current Account, *in* **Grossman, G. and Rogoff, K.** (eds.) *Handbook of International Economics, vol. 3*, Amsterdam: North Holland

Obstfeld, M. and Rogoff, K. [1996] *Foundations of International Macroeconomics*, Cambridge MA: MIT Press

Palumbo, M., **Rudd, J. and Whelan, K.** [2006] On the Relationships Between Real Consumption, Income, and Wealth, *Journal of Business and Economic Statistics, 24, 1-11*

Perron, P. [1989] The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis, *Econometrica, 58, 165-193*

Proietti, T. [1997] Short-Run Dynamics in Cointegrated Systems, *Oxford Bulletin of Economics and Statistics, 59, 405-422*

Phillips, P.C.B. and Perron, P. [1988] Testing for a Unit Root in Time Series Regression, *Biometrika, 75, 335-346*

Quah, D. [1992] The Relative Importance of Permanent and Transitory Components: Identification and Some Theoretical Bounds, *Econometrica, 60, 107-118*

Rudd, J. and Whelan, K. [2006] Empirical Proxies for the Consumption-Wealth Ratio, *Review of Economic Dynamics, 9 (1), 34-51*

Sachs, J. D. [1982] The Current Account in the Macroeconomic Adjustment Process, *Scandinavian Journal of Economics, 84, 147-59*

Shapiro, M. D. and M. W. Watson [1988] Sources of Business Cycle Fluctuations, *in* **S. Fisher** (ed.) *1988 NBER Macroeconomics Annual, 111-156*, Cambridge, MA: MIT Press

Sheffrin, S. M. and Woo, W. T. [1990] Present Value Tests of an Intertemporal Model of the Current Account, *Journal of International Economics, 29, 237-53*

Stock, J. H. and Watson, M. W. [1988] Testing for Common Trends, *Journal of the American Statistical Association, 83, 1097-1107*

Tille, C. [2003] The Impact of Exchange Rate Movements on US Foreign Debt, *FRB of New York, Current Issues in Economics and Finance, 9, 1-7*

Tille, C. [2005] Financial Integration and the Wealth Effect of Exchange Rate Fluctuations,*FRB of New York, Staff Report 226*

Zivot, E. and Andrews, D. W. K. [1992] Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root Hypothesis, *Journal of Business and Economic Statistics, 10, 251-70*. Reprinted in *Journal of Business and Economic Statistics, 20, 25-44*

Appendix A Data Description

This appendix briefly describes the variables employed in the analysis. For all variables except net foreign liabilities, our source is the FRED II Database of the Federal Reserve Bank of the Saint Louis.

CONSUMPTION C_t

Total Consumption is measured as real personal consumption expenditure (PCECC96). The quarterly series are seasonally adjusted at annual rates, in billions of chain-weighted 2000 dollars.

Non-durables and Services Consumption is computed by combining consumption expenditures on non-durables goods and consumption expenditure on services. Real measures are combined using a Fisher chain-aggregation formula that replicates the procedure used by the Bureau of Economic Analysis in producing the original series.

NET OUTPUT Z_t

Nominal Net Output is defined as $Z_t^n \equiv Y_t^n - I_t^n - G_t^n$, whereas Y_t^n is the nominal gross domestic product (GDP) and G_t^n is nominal government consumption expenditures & gross investment (GCEC).

When employing consumption expenditure on nondurable goods and services, the nominal investment series I_t^n is obtained as nominal gross private domestic investment (GPDI) + change in private inventories (CBI) + nominal personal consumption expenditure on durable goods (PCDGC).

When employing total consumption expenditure, the nominal investment series I_t^n is obtained as nominal gross private domestic investment (GPDI) + change in private inventories (CBI).

The nominal series are expressed in real terms using the appropriate consumption deflator.

POPULATION

Our measure of population obtained by sampling the last month value for each quarter, from the monthly population series [POPTHM].

PRICE DEFLATOR

When we used total consumption as the appropriate measure of consumption, the deflator employed is the personal consumption expenditure chain-type deflator (2000=100), seasonally adjusted (PCECTPI), as a proxy of the unobserved price deflator corresponding to our measure of consumption.

When employing consumption on non-durables and services, we use the implicit deflator of consumption on non-durables and services (i.e. the ratio of nominal to the corresponding real series).

A.1 Constructing Quarterly Stocks of Gross Positions

Gross Foreign Assets Position A_t

In order to build our series of quarterly gross foreign assets, we employ annual and quarterly data on flows for four broad asset categories: Equity, FDI, Portfolio Debt and Other Portfolio Investment; and annual data on stocks of assets for each of these categories from Lane and Milesi-Ferretti [2007]. The annual and quarterly data on flows are obtained from IMF's International Financial Statistics database. the quarterly flows we employ, available from 1972:Q4 on, are:

- Flow of Equity Assets: Equity Securities, Code: 11178BKDZF...
- Flow of Debt Assets: Debt Securities, Code: 11178BLDZF...
- Flow of FDI Assets: Direct Investment Abroad, Code: 11178BDDZF...
- Flow of Other Portfolio Investment Assets: Other Investment Assets, Code: 11178BHDZF...

Gross Foreign Liabilities Position L_t

In a similar fashion, we build our series of gross foreign liabilities, employing annual and quarterly data on flows for the same broad liabilities categories. The annual and quarterly data on flows are obtained from IMF's International Financial Statistics database. Specifically, we employ:

- Flow of Equity Liabilities: Equity Securities, Code: 11178BMDZF...
- Flow of Debt Liabilities: Debt Securities, Code: 11178BNDZF...
- Flow of FDI Liabilities: Dir. invest. in rep. econ., N.I.E., Code: 11178BEDZF...
- Flow of Other Portfolio Investment Liabilities: Other Investment Liabilities, n.i.e., Code: 11178BIDZF...

Quarterly series are obtained as follows. Let S_τ^i denote the stock of assets of type i at the end of the year τ, F_τ^i denote the yearly flow of assets in category i, and DS_τ^i denote the yearly valuation effect. The total valuation effect on a yearly basis (for the year τ) is calculated as:

$$DS_\tau^i = S_\tau^i - S_{\tau-1}^i - F_\tau^i.$$

Similarly, let S_t^i denote the value at the end of quarter t of assets of type i, and F_t^i denote the quarterly flow of assets in category i. The quarterly stocks are obtained as

$$S_{t+1}^i = S_t^i + F_{t+1}^i + \left(\frac{F_{t+1}^i}{F_\tau^i}\right) DS_\tau^i.$$

Note that the end of fourth quarter stock S_{t+4}^i equals S_τ^i, so that

$$\begin{aligned} S_\tau &= S_{t+4}^i = \left(F_{t+4}^i + F_{t+3}^i + F_{t+2}^i + F_{t+1}^i\right) + S_t + \left(\frac{F_{t+4}^i + F_{t+3}^i + F_{t+2}^i + F_{t+1}^i}{F_\tau^i}\right) DS_\tau^i \\ &= F_\tau^i + S_{\tau-1} + DS_\tau^i. \end{aligned}$$

A.2 Constructing Quarterly Returns

A.2.1 Assets

Equity Total Return: Equity total returns from the rest of the world. The country weights are constructed from IMF's Coordinated Portfolio Investment Survey (**CPIS**) Table 1.1 (Reported Portfolio Investment Assets by Economy of Nonresident Issuer: Equity Securities) for 2001.[40] The country weights represent about 83% of total equity holdings by US investors. For each country, a series for

[40] As the survey covers only the years 1997, 2001-2005, the weights for 2001 were used for the whole period 1973:Q1-2004:Q4.

total stock return is constructed, denominated in US dollars, employing the MSCI Share Price Index (**MSCI Inc**) or the Datastream Total Return Index (**Datastream**). As for some countries stock market data are not available (e.g. Finland, Korea, Mexico, Brazil, Singapore and Taiwan, before 1988), the weights are adjusted accordingly. The weights are reported in Panel A of Table A.1.

Long-Term Debt: Weighted average of holding period return on foreign long-term bonds. The currency weights have been constructed based on **CPIS** Table 2, for 2001, and reflect the currency breakdown of U.S. long-term foreign debt assets.[41] This covers about 93% of long-term positions. The currency weights are reported in Panel B of Table A.1. Total quarterly holding period returns are calculated from the changes in yields (see Campbell et al [1997], Ch. 10):

$$r_{n,t+1} = y_{n,t} - (D_n - 1)(y_{n-1,t+1} - y_{n,t}), \tag{21}$$

where $r_{n,t+1}$ is the one-period holding-period log return on a n-period coupon bond purchased at time t and sold at time $t+1$; $y_{n,t}$ is the bond's log yield to maturity; and D_n is the Macaulay's duration for the coupon bond, given by:

$$D_n = \frac{1-(1+Y_{n,t})^{-n}}{1-(1+Y_{n,t})^{-1}}, \tag{22}$$

where $Y_{n,t}$ denotes government bond yields. Yields on 10-year government bond (in foreign currencies) were obtained from IFS. The holding-period returns were expressed in U.S. dollars by using the end-of-period nominal exchange rates from **IFS/Eurostat**. The Euro-denominated yields before 1990 are calculated as the average yield for Germany, France and Italy (IFS) and after 1990, we use Euro-zone average long-term government bond yield.

Short-Term Debt (Other Portfolio Investment): Weighted average holding period return on foreign short term bonds. The currency weights are constructed based on **CPIS** Table 2 for 2001. This covers about 99% of short-term positions. The currency weights are reported in Panel C of Table A.1. Returns in Euros are calculated as the average return from Germany (Call Money Rate), France (TBill Rate, 3 months), Italy (Money Market Rate), and Netherlands (Call Money Rate) prior to 1990. After 1990, we employ the Euro-zone 3-Month Average Money Market Rate (**ECB**). Short term local currency returns are converted into US dollars using end of period nominal exchange rates obtained from **IFS/Eurostat**.

Debt: Weighted average of total return on long-term bonds and total return on short-term bonds. The maturity decomposition is 82% long-term, and 18% short-term, from Tables 1.2.A and 1.2.B of CPIS, obtained as average maturity shares for all reporting periods.

Foreign Direct Investment: Returns constructed using different weights based on Foreign Direct Investment (FDI) database from OECD. As the FDI database reports data from 1982 on, the weights for the period 1973-1981 employed are the average weights over the period 1982-1985, constructed using FDI historical cost positions. For all the remaining years we employ time-varying weights for each year (1982 on) that are base on FDI historical cost positions. On average we cover about 77% of US FDI The relevant weights for 1973-1981 as well as those employed for 2004 are reported in Panel D of Table A.1. In addition, whenever data for some countries are unavailable the weights are adjusted accordingly. For each country, total stock return (in US dollars) is computed using the corresponding MSCI Share Price Index, or using the corresponding Datastream Total return Index.

[41] This is because using country weights (that is, based on the economy of nonresident issuers) would ignore that most of the U.S. foreign debt is in U.S. dollars.

A.2.2 Liabilities

Equity Total Return: Equity total returns to the rest of the world. Total stock return is constructed, employing the **MSCI** Share Price Index, denominated in local currency (base 1969).

Long-Term Debt: Quarterly holding period return on US long-term bonds. Total quarterly holding period returns are calculated from the changes in yields (see (21)). Yields are obtained from IFS (11161...ZF...), corresponding to 10-year constant maturity bonds.

Short-Term Debt (Other Portfolio Investment): Holding period return on US short-term bonds. Yields are obtained from IFS (11160C..ZF...) corresponding to the TBill rate (3 month).

Debt: Weighted average of total return on long-term bonds and total return on short-term bonds. The maturity decomposition is 83% long-term, and 17% short-term, from Tables 5.2.A and 5.2.B of CPIS,.obtained as an average for all reporting periods.

Foreign Direct Investment: Returns are identical to those on equity.

Table A.1: UNITED STATES, Country-Weights for Assets, Total Returns

Panel A: Country-Weights Equity Assets			
Country	**Prior 1988**	**Post 1988**	**Series**
United Kingdom	29.81%	26.14%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
Japan	14.54%	12.75%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
Netherlands	9.60%	8.42%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
France	9.56%	8.38%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
Canada	7.63%	6.69%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
Switzerland	6.44%	5.64%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
Germany	6.15%	5.39%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
Finland	0.00%	3.83%	MSCI Share Price Index w/ Gross Div, US$ (base 1987)
Australia	3.16%	2.77%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
Italy	2.87%	2.52%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
Spain	2.76%	2.42%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
Hong Kong	2.57%	2.25%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
Korea	0.00%	2.21%	MSCI Share Price Index w/ Gross Div, US$ (base 1987)
Ireland	2.42%	2.12%	Datastream, Total Return Index, US$ (TOTMKBX(RI))
Mexico	0.00%	1.96%	MSCI Share Price Index w/ Gross Div, US$ (base 1987)
Sweden	2.49%	1.81%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
Brazil	0.00%	1.63%	MSCI Share Price Index w/ Gross Div, US$ (base 1987)
Singapore	0.00%	1.60%	MSCI Share Price Index w/ Gross Div, US$ (base 1987)
Taiwan	0.00%	1.46%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)

Panel B: Currency Weights, Long-Term Debt Assets		
Currency	**Weight (%)**	**Source**
U.S. Dollar	71.98%	Yields on U.S. government 10-year constant maturity bonds (IFS)
Euro	18.98%	Yields on Euro government 10-year constant maturity bonds (IFS/Eurostat)*
U.K. Pound	3.53%	Government Bond Yield (IFS)
Japanese Yen	5.41%	Government Bond Yield (IFS)
Swiss Franc	0.09%	Government Bond Yield (IFS)

Panel C: Currency Weights, Short-Term Debt/Other Investment Assets		
Currency	**Weight (%)**	**Source**
U.S. Dollar	92.09%	Treasury Bill Rate (IFS)
Euro	5.08%	Money Market Rate (IFS/ECB)†
U.K. Pound	2.09%	Treasury Bill Rate (IFS)
Japanese Yen	0.74%	Call Money Rate (IFS)
Swiss Franc	0.00%	Money Market Rate (IFS)

Table A.1 Cont'd

Panel D: Foreign Direct Investment Country-Weights, Assets			
Country	**1973-1981**	**2004**	**Series**
United Kingdom	18.98%	20.74%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
Canada	29.57%	13.35%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
Germany	10.16%	4.87%	MSCI Share Price Index w/ Gross Div, US$ (base 1987)
Switzerland	9.35%	6.86%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
Brazil	0.00%	1.79%	MSCI Share Price Index w/ Gross Div, US$ (base 1987)
Australia	5.84%	3.23%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
Japan	5.07%	4.33%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
France	4.57%	3.85%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
Netherlands	4.29%	13.72%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
Belgium-Luxembourg	3.76%	7.78%	Datastream, Total Return Index, US$ (TOTMKBX(RI))
Italy	3.13%	1.63%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
Mexico	0.00%	4.16%	MSCI Share Price Index w/ Gross Div, US$ (base 1987)
Hong Kong	2.03%	1.74%	MSCI Share Price Index w/ Gross Div, US$ (base 1987)
Ireland	1.79%	5.14%	Datastream, Total Return Index, US$ (TOTMIR$(RI))
Spain	1.48%	3.01%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)
Singapore	0.00%	3.81%	MSCI Share Price Index w/ Gross Div, US$ (base 1969)

Notes for Table A.1: The table reports the weights used in constructing total returns for each subcategory of assets for the U.S., as well as the source and the series used in computing these returns.

$*$ Average yield on 10-year government bonds for Germany, France, Italy and the Netherlands up to 1989 (obtained from IFS). From 1990 to 2004, Euro Area average long-term bond yield (obtained from Eurostat).

† Average Call Money Rate (Germany and Netherlands), Treasury Bill Rate (France) and Money Market Rate (Italy) prior to 1990 (obtained from IFS). After 1990, Euro-Area 3-Month Average Money Market Rate (obtained from the ECB).

Appendix B Tests for Cointegration

Table B.1: **Trace (Cointegration) Statistics**

$H_0 : r$	$r = 0$	$r \leq 1$	$r \leq 2$	$r \leq 3$
$n - r$	4	3	2	1
Panel A: Test Statistics				
$Q\left(r \mid n\right)$	80.111	45.374	23.719	8.589
Asymptotic p-val.	[0.001]	[0.028]	[0.091]	[0.207]
Bootstrap p-val.	[0.004]	[0.049]	[0.123]	[0.239]
Panel B: Asymptotic Critical Values				
$Q_{90}\left(r \mid n\right)$	60.086	39.755	23.342	10.666
$Q_{95}\left(r \mid n\right)$	63.876	42.915	25.872	12.518
$Q_{99}\left(r \mid n\right)$	71.479	49.363	31.154	16.554
Panel C: Tests on the Deterministic Trend				
Test Statistic	$W\left(4\right)$	$Q\left(3\right)$		
	15.926	**7.795**		
Asymptotic p-val.	[0.003]	[0.050]		

NOTES for Table B.1: $Q(r|n)$ denotes the trace statistic as defined in Johansen [1995], i.e. $Q(r|n) = -T\sum_{i=r+1}^{n} \ln\left(1-\hat{\lambda}_i\right)$. Results are based on a VAR with two lags, ensuring that no autocorrelation is present in the residuals. The asymptotic critical values and asymptotic p-values reported are calculated using the methods in MacKinnon, Haug and Michelis [1999]. The bootstrap critical values and p-values are based on a Monte Carlo Bootstrap Simulation for T=128 with 10000 replications. Panel C reports two tests regarding the trend specification. W is a Wald test on the VAR in levels without any assumptions on cointegration, distributed as $\chi^2\left(4\right)$. $Q\left(3\right)$ is a likelihood ratio test for the presence of the trend in the cointegrating space, distributed as $\chi^2\left(3\right)$ under the assumption that there are three cointegrating relations. The sample spans the first quarter of 1973 to the fourth quarter of 2004.

Table B.2: **Unit Root Tests on "Great Ratios"**

Panel A: Unit Root Tests (Non Durables and Services Consumption)						
x_t	$c_t - z_t$	$a_t - z_t$	$l_t - z_t$	$CV_{0.90}$	$CV_{0.95}$	$CV_{0.99}$
PP	**-4.385**	**-3.378**	**-3.114**	-3.148	-3.446	-4.032
$[p - value]$	[0.003]	[0.059]	[0.108]			
$KPSS$	0.151	0.056	0.070	0.119	0.146	0.216
Panel B: Bivariate Cointegration Tests (Non Durables Consumption)						
	$\mathbf{x}_t = [c_t, z_t]'$		$\mathbf{x}_t = [a_t, z_t]'$		$\mathbf{x}_t = [l_t, z_t]'$	
$H_0 : r$	$r = 0$	$r \leq 1$	$r = 0$	$r \leq 1$	$r = 0$	$r \leq 1$
$n - r$	2	1	2	1	2	1
$Q\,(r\vert\, n)$	*21.718*	7.009	**23.551**	8.165	**30.645**	9.756
Asymptotic p-val.	[0.151]	[0.344]	[0.095]	[0.238]	[0.012]	[0.139]
Bootstrap p-val.	[0.176]	[0.106]	[0.108]	[0.261]	[0.014]	[0.147]

Notes for Table B.2: Panel A of the table reports the unit root tests of Phillips and Perron [1988] and the stationarity tests of Kwiatkowski et al. [1992] when employing nondurables and services consumption. Both test include a constant and time trend in the estimated equation. The PP test examines the null of a unit root against the alternative of trend-stationarity of the ratios. The KPSS test examines the null of trend-stationarity against the alternative of a unit root. The asymptotic p-values for the PP test are calculated using the method of MacKinnon [1996]. The bandwidth parameter is set to 8 for all tests. Panel B reports bivariate cointegration tests, when using nondurables and services consumption. See also notes for Table B.1.

Figures

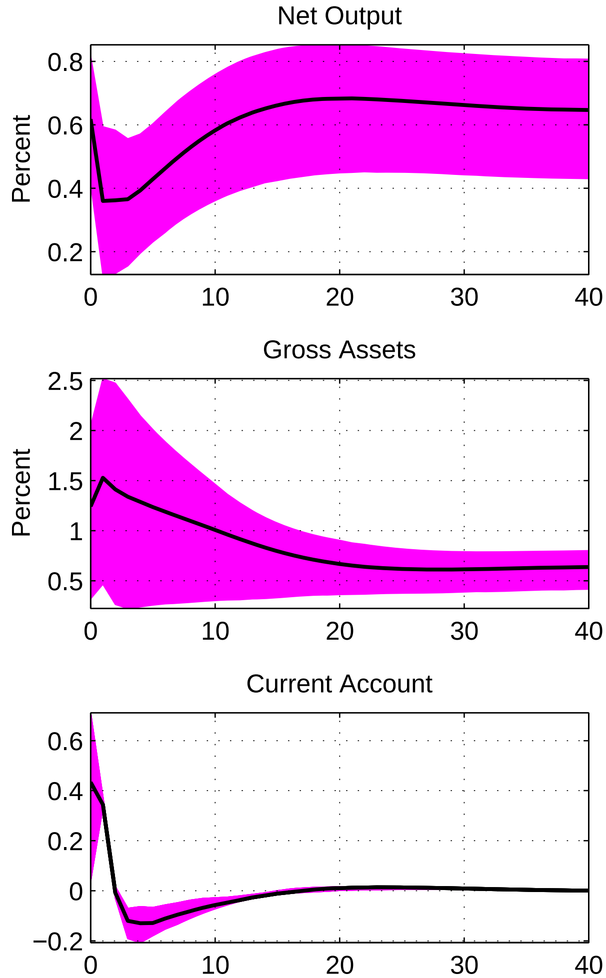

Figure 1a. Impulse Responses to the Permanent Shock with $\alpha_c = \mathbf{0}$.

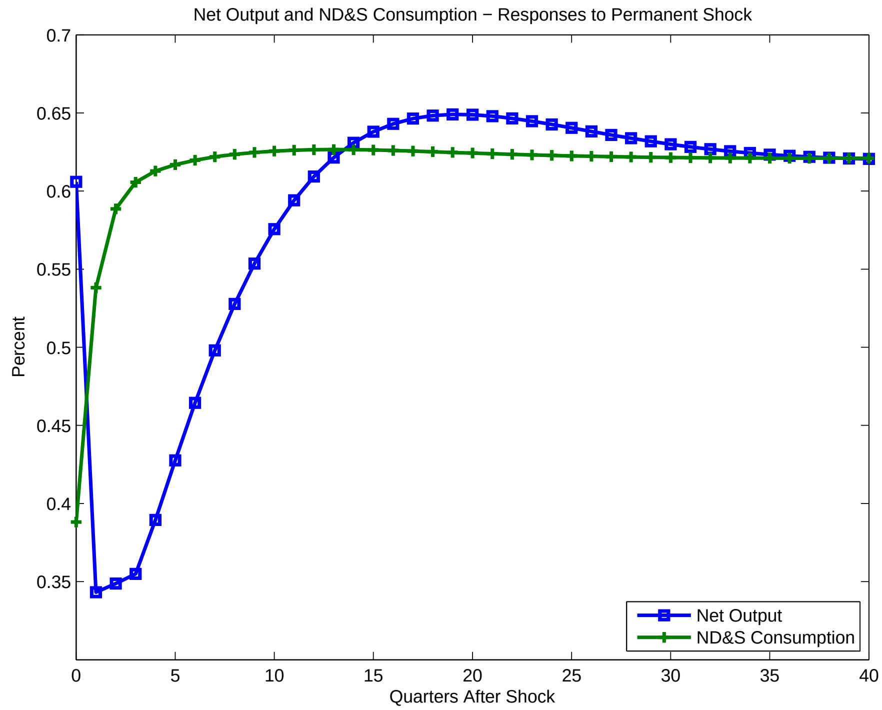

Figure 1b. Impulse Responses of Net Output and Nondurables and Services Consumption to the Permanent Shock with $\alpha_c = \mathbf{0}$.

Notes for Figure 1: Panel A reports the impulse responses of net output, nondurables and services consumption, gross assets and liabilities (in percentage terms) following a permanent shock. The lower left panel displays the impulse response (multiplied by 100 for comparison) of the current account following a permanent shock. The horizon is in quarters after the shock. The figure also reports the associated 95 per cent bootstrap confidence bands using Hall's [1992] percentile intervals. Panel B reports the estimated responses of net output and nondurables and services consumption. The adjustment coefficients of consumption have been restricted to zero. The estimation sample is: 1973:Q1-2004:Q4.

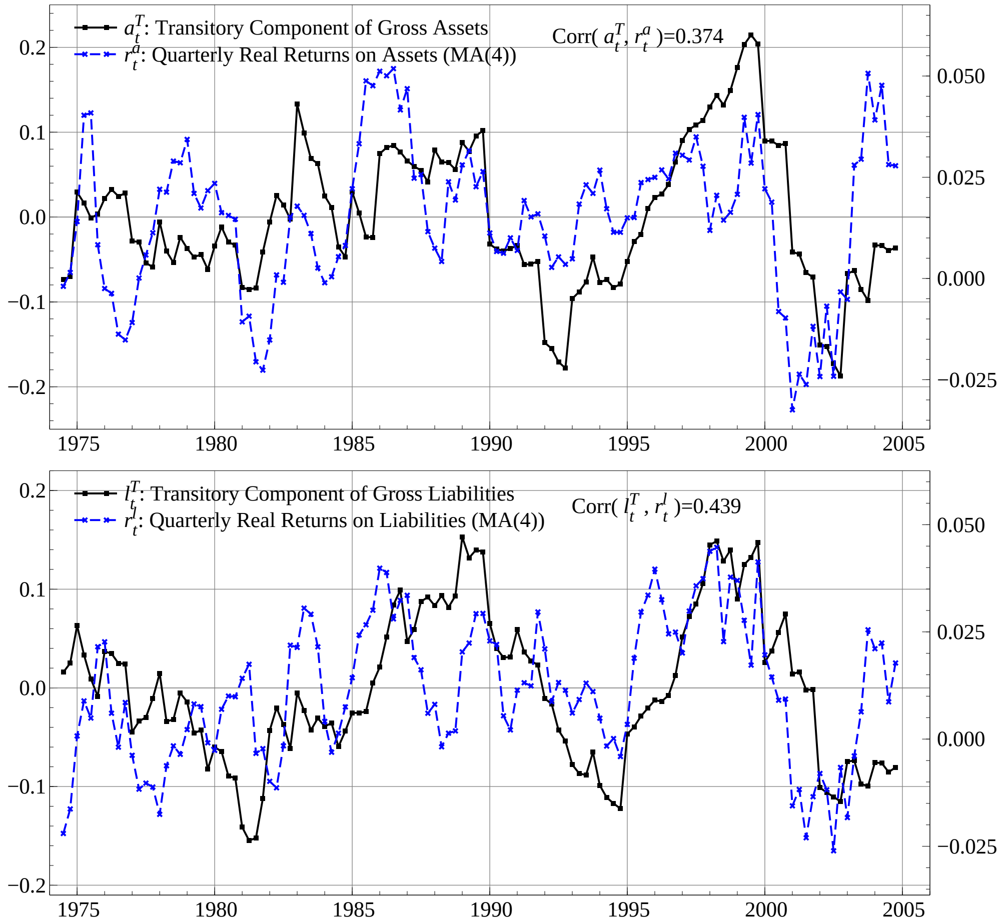

Figure 2. Transitory Components of Assets and Liabilities and Returns.

Notes for Figure 2: Top Panel reports the transitory component of (log real per-capita) gross assets and a four quarter moving average of quarterly real returns on gross assets. Bottom Panel reports the transitory component of (log real per-capita) gross liabilities and a four quarter moving average of quarterly real returns on gross liabilities. The cyclical components have been obtained by means of a multivariate Beveridge-Nelson decomposition from the cointegrated VAR employing non-durables and services consumption. The estimation period is: 1973:Q1-2004:Q4.

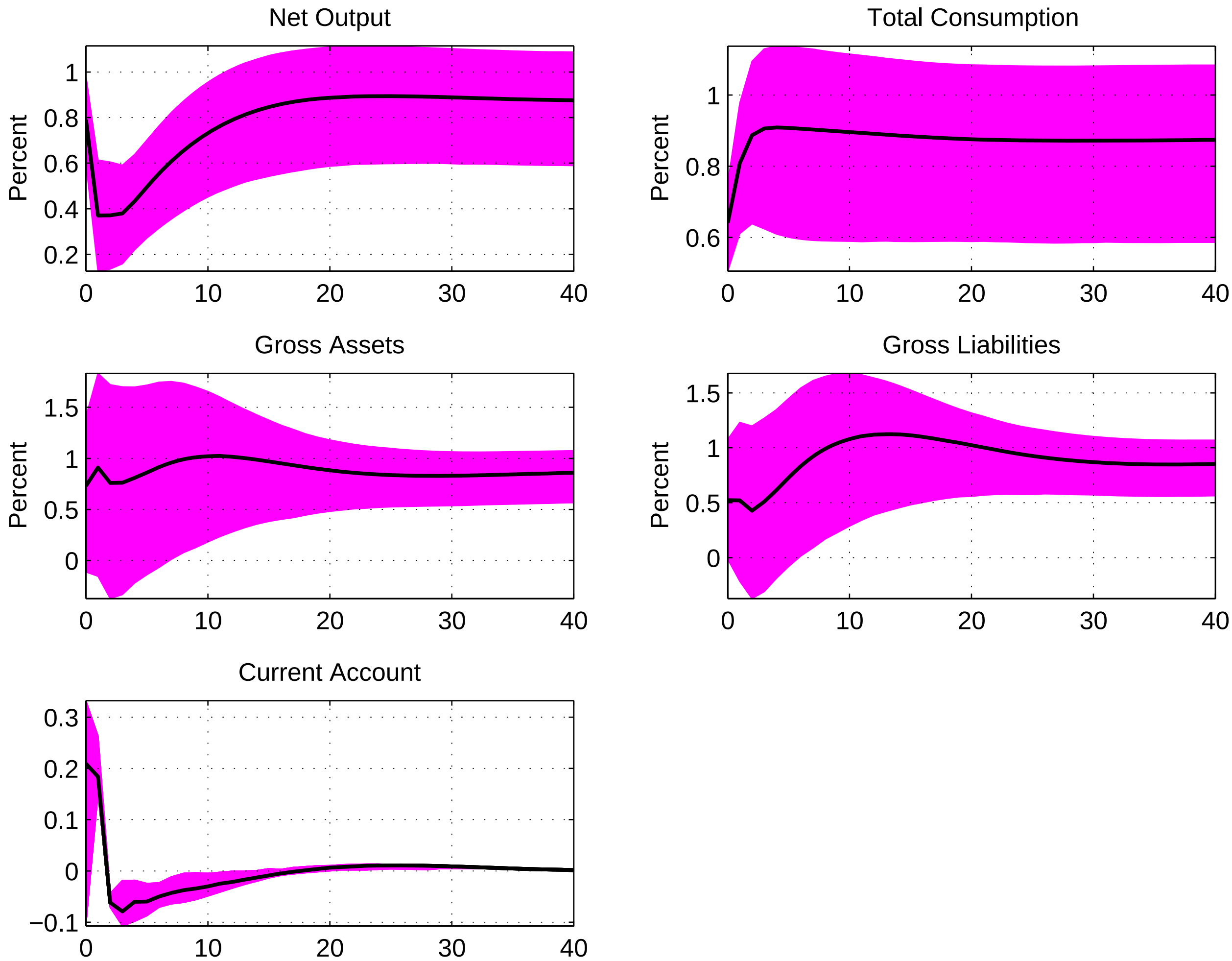

Figure 3a. Impulse Responses to Permanent Shock (using Total Consumption) with $\alpha_c = \mathbf{0}$.

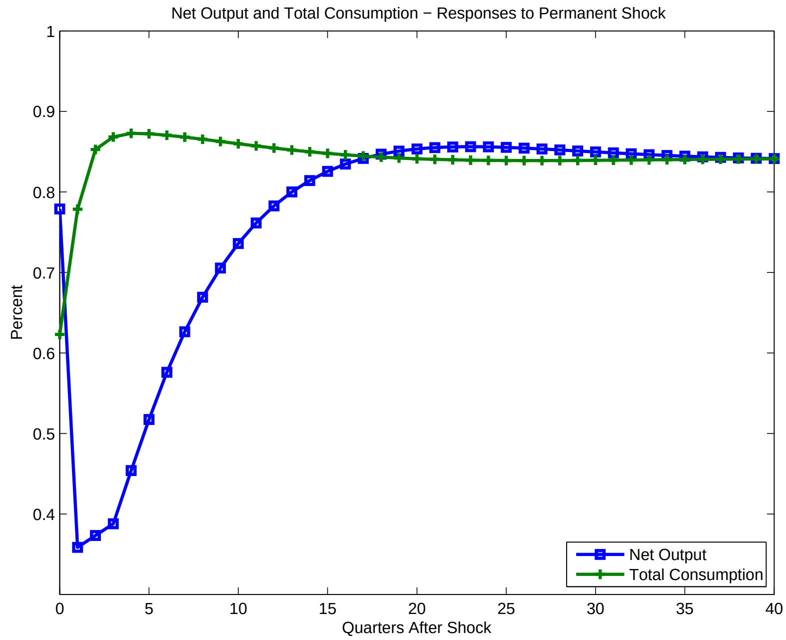

Figure 3b: Impulse Responses of Net Output and Total Consumption to the Permanent Shock with α_c= **0**.

Notes for Figure 3: Panel A reports the impulse responses of net output, total consumption, gross assets and liabilities (in percentage terms) following a permanent shock. The lower plot displays the impulse response of the current account following a permanent shock (responses have been multiplied by 100 for comparison purposes). The horizon is in quarters after the shock. The figure also reports the associated 95 per cent bootstrap confidence bands using Hall's [1992] percentile intervals. Panel B reports the estimated impulse responses of net output and total consumption. The adjustment coefficients of consumption have been restricted to zero. The estimation sample is: 1973:Q1-2004:Q4.

Tables

Table 1: **Summary Statistics**

	Δc_t	Δz_t	Δa_t	Δl_t
Univariate Summary Statistics				
Mean ($\times 100$)	0.461	0.372	1.591	1.975
Standard Deviation ($\times 100$)	0.424	1.335	4.164	3.099
Correlation Matrix				
Δc_t	1.000	0.383	0.230	0.241
Δz_t		1.000	0.181	0.202
Δa_t			1.000	0.734
Δl_t				1.000

NOTES for Table 1: This table reports summary statistics for quarterly growth of consumption Δc_t, net output Δz_t, gross foreign assets Δa_t, and gross foreign liabilities Δl_t, where all variables are expressed in real, per-capita terms. c_t denotes nondurables and services consumption. The data on gross assets and liabilities positions include valuation effects, along the lines of Lane and Milesi-Ferretti [2007]. The sample spans the first quarter of 1973 to the fourth quarter of 2004.

Table 2: **Estimates from a Cointegrated VAR(2) - using ND&S Consumption**

Panel A: Cointegrated VAR				
	Equation			
Dependent Variable	Δc_t	Δz_t	Δa_t	Δl_t
Δc_{t-1}	$\mathbf{0.283}$	$-\mathbf{0.700}$	0.244	-0.665
$[t-stat.]$	$[2.918]$	$[-2.401]$	$[0.240]$	$[-0.882]$
Δz_{t-1}	0.024	-0.070	0.256	0.332
$[t-stat.]$	$[0.775]$	$[-0.743]$	$[0.775]$	$[1.355]$
Δa_{t-1}	-0.005	$\mathbf{0.104}$	-0.080	-0.063
$[t-stat.]$	$[-0.351]$	$[2.634]$	$[-0.584]$	$[-0.615]$
Δl_{t-1}	0.009	-0.050	0.194	0.078
$[t-stat.]$	$[0.506]$	$[-0.949]$	$[1.061]$	$[0.578]$
$\breve{\beta}_1'\mathbf{x}_{t-1}$	0.019	$\mathbf{0.307}$	0.216	0.311
$[t-stat.]$	$[0.766]$	$[4.177]$	$[0.843]$	$[1.636]$
$\breve{\beta}_2'\mathbf{x}_{t-1}$	0.012	-0.020	-0.083	0.083
$[t-stat.]$	$[1.635]$	$[-0.914]$	$[-1.095]$	$[1.493]$
$\breve{\beta}_3'\mathbf{x}_{t-1}$	-0.004	$\mathbf{0.059}$	-0.070	$-\mathbf{0.148}$
$[t-stat.]$	$[-0.498]$	$[2.456]$	$[-0.844]$	$[-2.395]$
δ	$\mathbf{0.017}$	$\mathbf{0.128}$	$-\mathbf{0.222}$	-0.083
$[t-stat.]$	$[1.634]$	$[4.133]$	$[-2.056]$	$[-1.041]$
$\bar{R}^2$	0.142	0.218	0.023	0.031
$\hat{\sigma}_u \times 100$	0.392	1.181	4.119	3.052

Table 2 Cont'd

Panel B: Cointegrating Relations and $\mathcal{LR}$-tests			
$\hat{\beta}_s'\mathbf{x}_t + \hat{\theta}_s t$	$Q(v)$	Asymptotic p-value	Bootstrap p-value
$c_t - z_t - \underset{[-4.451]}{\mathbf{0.0005}} t$	$Q(1) = 6.539$	[0.011]	[0.059]
$a_t - z_t - \underset{[-27.329]}{\mathbf{0.013}} t$	$Q(1) = 1.971$	[0.160]	[0.250]
$l_t - z_t - \underset{[-34.505]}{\mathbf{0.018}} t$	$Q(1) = 2.733$	[0.098]	[0.254]
Joint Test	$Q(3) = 12.121$	[0.007]	[0.068]

Panel C: No Equilibrium Corrections Tests		
$\mathcal{H}_0$	$Q(\nu)$	Asymptotic p-value
$\alpha_c = \mathbf{0}$	$Q(3) = 5.433$	[0.143]
$\alpha_z = \mathbf{0}$	$Q(3) = \mathbf{23.120}$	[0.000]
$\alpha_a = \mathbf{0}$	$Q(3) = \mathbf{9.620}$	[0.022]
$\alpha_l = \mathbf{0}$	$Q(3) = \mathbf{10.643}$	[0.014]

NOTES for Table 2: Panel A of the table reports the estimated coefficients from a cointegrated vector autoregressive (VAR) model of the column variable on the row variable, where c_t denotes nondurables and services consumption; t-statistics are given in square brackets. For each equation the adjusted $\bar{R}^2$ and the estimated standard error are reported. Estimated coefficients that are significant at the 10 percent level are highlighted in bold face. The terms $\breve{\beta}_s'(\mathbf{x}_t, t) = \hat{\beta}_s'\mathbf{x}_t + \hat{\theta}_s t$ are the estimated equilibrium errors (cointegrating residuals) with the "symmetry" restriction imposed on the parameters. Panel B reports the restricted cointegrating coefficients and their associated standard errors, as well as the likelihood ratio test ($\chi^2(1)$-distributed) and the associated asymptotic and bootstrap p-values. Panel C reports a likelihood ratio test of the null of no equilibrium correction ($\chi^2(3)$-distributed) and the associated asymptotic p-values. Test statistics that are significant at the 5-percent level are highlighted in bold face. The sample spans the first quarter of 1973 to the fourth quarter of 2004.

Table 3: **Forecast Error Variance Decomposition using ND&S Consumption (Orthogonalized Shocks)**

h	$c_{t+h} - E_t c_{t+h}$		$z_{t+h} - E_t z_{t+h}$		$a_{t+h} - E_t a_{t+h}$		$l_{t+h} - E_t l_{t+h}$		$CA^\star_{t+h} - E_t CA^\star_{t+h}$	
	η_t^P	η_t^T	η_t^P	η_t^T	η_t^P	η_t^T	η_t^P	η_t^T	η_t^P	η_t^T
1	1	0	0.268	0.732	0.087	0.913	0.067	0.933	0.023	0.977
			[0.196, 0.362]	[0.638, 0.804]	[0, 0.166]	[0.834, 1]	[0.014, 0.130]	[0.870, 0.986]	[0, 0.044]	[0.956, 1]
2	0.999	0.001	0.240	0.760	0.112	0.888	0.063	0.937	0.036	0.964
	[0.995, 1]	[0, 0.005]	[0.186, 0.336]	[0.664, 0.814]	[0.026, 0.219]	[0.781, 0.974]	[0.006, 0.127]	[0.873, 0.994]	[0.001, 0.051]	[0.949, 0.999]
3	0.999	0.001	0.244	0.756	0.121	0.879	0.059	0.941	0.035	0.965
	[0.993, 1]	[0, 0.007]	[0.191, 0.353]	[0.647, 0.809]	[0.029, 0.245]	[0.755, 0.971]	[0, 0.119]	[0.881, 1]	[0.001, 0.050]	[0.950, 0.999]
4	0.998	0.002	0.258	0.741	0.128	0.872	0.060	0.940	0.036	0.964
	[0.993, 1]	[0, 0.008]	[0.212, 0.378]	[0.622, 0.788]	[0.034, 0.267]	[0.733, 0.965]	[0, 0.127]	[0.873, 1]	[0.001, 0.053]	[0.947, 0.999]
8	0.997	0.003	0.368	0.632	0.159	0.841	0.088	0.912	0.040	0.960
	[0.993, 1]	[0, 0.007]	[0.362, 0.493]	[0.507, 0.638]	[0.072, 0.344]	[0.656, 0.928]	[0.013, 0.203]	[0.797, 0.987]	[0.002, 0.061]	[0.938, 0.998]
12	0.997	0.003	0.498	0.502	0.188	0.812	0.128	0.872	0.042	0.958
	[0.994, 1]	[0, 0.006]	[0.490, 0.585]	[0.415, 0.510]	[0.108, 0.400]	[0.600, 0.892]	[0.065, 0.284]	[0.716, 0.935]	[0.002, 0.063]	[0.937, 0.998]
16	0.998	0.002	0.597	0.403	0.210	0.790	0.166	0.834	0.042	0.958
	[0.995, 1]	[0, 0.005]	[0.587, 0.667]	[0.333, 0.413]	[0.135, 0.436]	[0.564, 0.865]	[0.115, 0.343]	[0.657, 0.885]	[0.002, 0.063]	[0.937, 0.998]
20	0.998	0.002	0.669	0.331	0.226	0.774	0.196	0.804	0.042	0.958
	[0.996, 1]	[0, 0.004]	[0.658, 0.736]	[0.264, 0.341]	[0.156, 0.461]	[0.539, 0.844]	[0.156, 0.382]	[0.618, 0.844]	[0.002, 0.063]	[0.937, 0.998]
40	0.999	0.001	0.827	0.173	0.280	0.720	0.275	0.725	0.042	0.958
	[0.998, 1]	[0, 0.002]	[0.818, 0.874]	[0.126, 0.182]	[0.238, 0.525]	[0.475, 0.763]	[0.269, 0.465]	[0.534, 0.731]	[0.002, 0.063]	[0.937, 0.998]

NOTES for Table 3: The table reports the fraction of the variance in the h step-ahead forecast error of the variable listed at the head of each column that is attributable to innovations in the permanent shock, η_t^P and the transitory shocks, η_t^T. Horizons are in quarters, and the underlying VEqCM is of order 1. At each horizon the table shows the estimate of the fraction due to each type of shock (permanent vs. transitory), the associated bootstrap confidence interval. c_t denotes nondurables and services consumption per capita. In the analysis we impose the restriction that the adjustment coefficients of consumption are statistically insignificant, $\alpha_c = \mathbf{0}$. The sample spans the first quarter of 1973 to the fourth quarter of 2004. The reported confidence intervals were computed using a bootstrap Monte Carlo procedure. Specifically, we have constructed 10000 time series of the vector $\mathbf{x}_t$ as follows. Let $\{\hat{\mathbf{u}}_t\}_{t=1}^T$ denote the vector of residuals from the estimated VEqCM. We constructed 10000 sets of new time series residuals, $\{\hat{\mathbf{u}}_t(j)\}_{t=1}^T$, $j = 1, ..., 10000$. The t^{th} element of $\{\hat{\mathbf{u}}_t(j)\}_{t=1}^T$ was selected by drawing randomly, with replacement, from the set of fitted residual vectors $\{\hat{\mathbf{u}}_t\}_{t=1}^T$. For each $\{\hat{\mathbf{u}}_t(j)\}_{t=1}^T$, we have constructed a synthetic time series $\tilde{\mathbf{x}}_t$, denoted $\{\tilde{\mathbf{x}}_t(j)\}_{t=1}^T$, using the estimated VEqCM and the historical initial conditions on $\mathbf{x}_t$. We the re-estimated the VEqCM using $\{\tilde{\mathbf{x}}_t(j)\}_{t=1}^T$ and calculated the implied forecast error variance decompositions for $j = 1, ..., 10000$.

Table 4: **Forecast Error Variance Decomposition Using Total Consumption (Orthogonalized Shocks)**

	$c_{t+h} - E_t c_{t+h}$		$z_{t+h} - E_t z_{t+h}$		$a_{t+h} - E_t a_{t+h}$		$l_{t+h} - E_t l_{t+h}$		$CA^\star_{t+h} - E_t CA^\star_{t+h}$	
h	η_t^P	η_t^T	η_t^P	η_t^T	η_t^P	η_t^T	η_t^P	η_t^T	η_t^P	η_t^T
1	1	0	0.437	0.563	0.030	0.970	0.028	0.972	0.005	0.995
			[0.393, 0.502]	[0.498, 0.607]	[0, 0.063]	[0.937, 1]	[0, 0.062]	[0.938, 1]	[0, 0.009]	[0.990, 1]
2	0.986	0.014	0.346	0.654	0.039	0.961	0.028	0.972	0.009	0.991
	[0.982, 1]	[0, 0.018]	[0.321, 0.406]	[0.594, 0.679]	[0, 0.084]	[0.916, 1]	[0, 0.060]	[0.940, 1]	[0, 0.016]	[0.984, 1]
3	0.982	0.018	0.317	0.683	0.039	0.961	0.024	0.976	0.009	0.991
	[0.977, 1]	[0, 0.023]	[0.290, 0.392]	[0.608, 0.710]	[0, 0.086]	[0.914, 1]	[0, 0.056]	[0.944, 1]	[0, 0.016]	[0.984, 1]
4	0.981	0.019	0.313	0.687	0.040	0.960	0.025	0.974	0.010	0.990
	[0.975, 1]	[0, 0.025]	[0.291, 0.398]	[0.601, 0.709]	[0, 0.095]	[0.905, 1]	[0, 0.064]	[0.936, 1]	[0, 0.016]	[0.983, 1]
8	0.983	0.017	0.425	0.575	0.058	0.942	0.053	0.947	0.011	0.989
	[0.979, 1]	[0, 0.021]	[0.420, 0.507]	[0.492, 0.580]	[0, 0.159]	[0.841, 1]	[0, 0.139]	[0.863, 1]	[0, 0.018]	[0.982, 1]
12	0.987	0.013	0.573	0.427	0.087	0.913	0.098	0.902	0.011	0.989
	[0.983, 1]	[0, 0.016]	[0.560, 0.642]	[0.358, 0.440]	[0, 0.233]	[0.767, 1]	[0.039, 0.237]	[0.763, 0.961]	[0, 0.019]	[0.981, 1]
16	0.990	0.010	0.678	0.322	0.117	0.883	0.146	0.854	0.011	0.989
	[0.987, 1]	[0, 0.013]	[0.664, 0.750]	[0.250, 0.336]	[0.026, 0.293]	[0.707, 0.974]	[0.105, 0.322]	[0.678, 0.899]	[0, 0.019]	[0.981, 1]
20	0.991	0.008	0.748	0.252	0.142	0.858	0.187	0.813	0.011	0.989
	[0.989, 1]	[0, 0.011]	[0.734, 0.816]	[0.184, 0.266]	[0.061, 0.338]	[0.663, 0.939]	[0.161, 0.382]	[0.618, 0.839]	[0, 0.018]	[0.981, 1]
40	0.996	0.004	0.883	0.117	0.235	0.765	0.318	0.683	0.011	0.989
	[0.994, 1]	[0, 0.005]	[0.874, 0.926]	[0.074, 0.126]	[0.205, 0.465]	[0.535, 0.795]	[0.310, 0.517]	[0.483, 0.690]	[0, 0.019]	[0.981, 1]

NOTES for Table 4: The table reports the fraction of the variance in the h step-ahead forecast error of the variable listed at the head of each column that is attributable to innovations in the permanent shock, η_t^P and the transitory shocks, η_t^T. Horizons are in quarters, and the underlying VEqCM is of order 1. See also notes for Table 3.