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

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*We are especially grateful to Mark Gertler (the editor) and the referees for detailed feedback on this project. 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, Kostas Karfakis, 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 España 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”, the CESifo Area Conference, the 2010 ASSET Conference, and seminar participants at the Banca d’Italia, European University Institute/RSCAS, Humboldt University, the University of Athens, the University of Macedonia, the University of Piraeus and Athens University of Economics and Business. 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.’ Any errors or omissions are our responsibility.

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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 consistent with current account theory. US consumption is virtually insulated from transitory shocks, while these contribute considerably to variations in net output and, even more so, gross foreign positions — consumption is smoothed against temporary fluctuations in returns. A single permanent shock – naturally interpreted as a supply shock – raises consumption swiftly while causing net output to adjust only gradually. This leads to persistent, procyclical external deficits, moving 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: February 5, 2011
1 Introduction

What determines the dynamic evolution of foreign borrowing and lending by a country? Theoretical advances during the past 30 years have provided fundamental insights into this issue, essentially by articulating the permanent income hypothesis and later development of consumption theory 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 temporary idiosyncratic shocks lower the current level of domestic output, or increase the current level of government spending and investment, relative to their permanent level, and vis-à-vis temporary fluctuations in the real rate of return around its long run level.

Do the effects of different shocks — output versus return, transitory versus permanent— in the data match the main predictions of the model? What is the relative weight of different shocks in explaining external deficits? 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, in 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.¹

Our findings lend overall support to theory. Namely, we find that the majority of fluctuations of gross positions, the current account and output net of government spending and investment (usually referred to as ‘net output’) are primarily driven by transitory shocks, from which consumption is ultimately insulated. As consumption is mainly driven by permanent shocks, we find little evidence that this is excessively smooth. In addition, we document that both gross external assets and liabilities commove in the same direction in response to permanent shocks, contributing an empirical benchmark to the recent literature encompassing portfolio diversification in open economy dynamic general equilibrium models.

In greater detail, we can summarize the results of our analysis as follows. A first set of results supports the notion that transitory shocks are key drivers of the dynamics of foreign borrowing, consistently with current account theory, while virtually all variation in aggregate consumption is dominated by permanent innovations. 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, at horizons up to 8 quarters

¹As 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 a set of assumptions ensuring the existence of a stationary limiting equilibrium (a balanced growth path), to provide an empirical characterization of the joint dynamics of the four variables in our system.
temporary shocks account for about 55 percent of the variance of net output, and for more than 82 and 67 percent of the variance of assets and liabilities respectively. At longer horizons, transitory innovations to net output still account for about 15 percent of its variance, whereas for the stocks of foreign assets and liabilities they account for about 60 and 77 percent of their fluctuations. Combining assets and liabilities as to proxy for the change in net foreign assets, i.e. the current account, transitory shocks explain well above 77 percent of its fluctuations at virtually all horizons. In contrast, the share of consumption variance explained by the permanent shock is strictly above 80 percent at all horizons.

In our dataset, assets and liabilities 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), and Gourinchas and Rey (2007a,b). A specific contribution of our study consists of documenting 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.

A second set of results is noteworthy in light of the literature arguing that consumption is excessively smooth vis-à-vis persistent shocks to income (see e.g. Campbell and Deaton, 1989). According to the standard argument in this literature, since permanent (net) output growth is more volatile than current output growth – due to the positive autocorrelation of the latter – consumption growth should be more volatile than current net output— a prediction seemingly contradicted by the data. In our analysis, we find consumption growth to be highly correlated with permanent shocks — hence consumption does not appear to be excessively smooth.

A key feature of our theoretical and empirical framework is that we do not assume constant rates of returns on foreign wealth. Rather, we recognize that the presence of a strong transitory component in asset income may actually lower the volatility of consumption growth relative to current (non-asset) income growth. For instance, in response to permanent shocks to net output, domestic consumption should reach its new permanent level swiftly but gradually, along the optimal path dictated by short-run changes in the real rate — not necessarily on impact. In our impulse-response analysis, indeed, we find that US consumption responds to permanent shocks over time, but quite rapidly, reaching its new permanent level much faster than net output.

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2This statement rests on the assumption of constant returns to savings, under which in response to permanent shocks to net output domestic consumption should jump on impact, and reach its new permanent level immediately.
Finally, as the permanent shock raises net output gradually towards its new long-run level, optimal consumption smoothing would imply a current account deficit. Correspondingly, we find a deterioration in the US external accounts in the medium run, although with non-linear dynamics: after an improvement on impact — corresponding to the initial peak in net output — the current account deteriorates persistently for about 16 quarters.\(^3\)

However, as the disturbances that raise US output in the long run result in a deficit, they also move the stocks of US Foreign assets and liabilities in the same direction — i.e. they cause a simultaneous increase in both positive and negative external financial positions. Together with our findings on the consumption and net output dynamics, this novel result — also confirmed in structural VAR analyses of shocks to US manufacturing (see Corsetti et al., 2008c) — may provide an interesting benchmark for dynamic general equilibrium models of international portfolio diversification (Devereux and Sutherland, 2010).

Our empirical methodology is structured as follows. As a preliminary step, we test that consumption, the stock of gross assets and liabilities are cointegrated with net output, as a precondition for our analytical framework to be valid. Then we make use of the long-run restrictions implied by cointegration to identify empirically permanent and transitory shocks,\(^4\) 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 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, sharing a limitation of many contributions to the empirical literature on the current account, 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, such limitation of our analysis may be expected to be 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, specific to the US.\(^5\)

\(^3\)This non-linearity is not specific to our methodology — similar dynamics has been documented by 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. (2008b,c), analyzing the response of an identified shock to productivity, external deficits emerge only with a lag of a few quarters.

\(^4\)There are several studies that employ the restrictions implied by cointegration to identify specific innovations in a range of VAR models models (e.g. King et al., 1991; Gonzalo and Granger, 1995; Gonzalo and Ng, 2001).

\(^5\)For an analysis of global vs. country-specific shocks see Glick and Rogoff (1995), Gregory and Head (1999) and
In general, our approach is naturally related to studies placing the intertemporal budget constraint of a country at the core of empirical and quantitative analyses. A relevant instance is Engel and Rogers (2006), who argue that the US current account deficits after 1990 can be explained by anticipation of a persistent rise of the share of US net output in world net output. The transmission mechanism emphasized by these authors is essentially the same as the one our study unveils in the data, in response to permanent shocks. More specifically, the methodology we adopt in this paper has already proven useful in many promising areas of research in international finance. In fact, our study is closely related to Gourinchas and Rey (2007a), which, also building on Campbell and Mankiw (1989) and Lettau and Ludvigson (2001, 2004), studies the role of predictable exchange rate and return movements in correcting external imbalances through valuation effects in the assets markets — whereas we analyze adjustment through the response of consumption, net output and foreign aggregate portfolio positions to temporary and permanent disturbances. Both analyses have similar implications for quantity, returns, and valuation adjustment — indeed, in an extension of our analysis, we perform a forecast exercise similar to the one at the core of the financial account theory by Gourinchas and Rey. By focusing our study on quantity as well as valuation adjustments, however, we are able to show 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, with a substantial share of the external adjustment going through predictable changes in net output.

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 discusses the robustness of our results and some extension of the analysis. The last section concludes.

2 Analytical Framework

2.1 From the Existing Literature to Our Approach

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

\[ \mathcal{CA}_t \equiv [A_{t+1} - L_{t+1}] - [A_t - L_t] = Y_t - C_t - G_t - I_t + r_t [A_t - L_t] \]  
(1)

\[ = Z_t - C_t + r_t [A_t - L_t] \]  
(2)

in more general settings Kose et al. (2003, 2008) *inter alia*. Hoffmann (2001, 2003) exploits cointegration to identify permanent and transitory, global and country-specific shocks, requiring that the current account does not respond on impact to global shocks.
where $A_t$ is the (value of the) stock of gross assets and $L_t$ the stock of gross liabilities at the beginning of period $t$, $Y_t$ denotes output, $C_t$ denotes private consumption, $G_t$ is government spending on final goods and services, $I_t$ investment, $Z_t$ net output, defined as $Z \equiv Y - G - I$. — all these variables are expressed in units of domestic consumption — 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.

The theory of the determinants of external deficits has evolved over time, progressively shifting the focus from intratemporal ‘competitiveness’ considerations, at the core of the traditional trade-elasticity approach to the current account, onto equilibrium intertemporal trade in environments with imperfect risk-sharing (i.e. incomplete markets), building on consumption smoothing (see e.g. Obstfeld and Rogoff, 1995). Two are the key predictions from this theory, which hold across a large class of model specifications: first, to the extent that 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. Conversely, as a result of optimal smoothing, consumption should have a large permanent component. Second, by virtue of their access to foreign resources, domestic agents should adjust their consumption rapidly to the new long-run level. So, in response to positive shocks that raise net output gradually towards a higher permanent level, consumption smoothing implies that the economy should run a current account deficit.

Under the assumption of incomplete markets, various versions of the intertemporal trade model have been assessed empirically based on the present value model (PVM) of the current account, so called because it builds on the result that, under rational expectations and some auxiliary assumptions, today’s external deficits is equal to the present discounted value of future changes in net output. The main issue with PVMs is that, typically, they are derived and implemented empirically under a set of highly restrictive assumptions. Notably, net output is assumed to be hit by a unit root (permanent) country-specific shock (Nason and Rogers, 2006). Imposing a single permanent shock prevents the empirical model from accounting for the vastly different implications of shocks with different degrees of persistence, predicted by theory — on which we focus our analysis. Another common assumption consists of imposing constant returns to savings. This amounts to ruling out by construction a source of shocks (on asset income) which can be potentially quite relevant. Not

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6Following Campbell (1987), these tests focus usually on small open economies (see e.g. Sheffrin and Woo, 1990; Ghosh, 1995).
surprisingly, as shown by Bergin and Sheffrin (2000) and Nason and Rogers (2006), developing the PVM as to encompass stochastic rates of return, markedly improves the performance of the model. Furthermore, recent work by Gourinchas and Rey (2007a,b) and Lane and Milesi-Ferretti (2001, 2007) underscores capital gains and losses (and therefore stochastic returns) on foreign gross positions, as an important determinant of the current account — a point that is confirmed and reinforced by our results. Our approach and results, discussed below, do not rest on either of these assumptions.

The theoretical predictions of current account theory are nonetheless sensitive to the degree of cross-border risk sharing. To wit: if markets are complete (a common theoretical benchmark in the literature on international business cycles), permanent gains in net output would not translate into a one-to-one increase in domestic consumption in the long run, because through asset diversification both domestic and foreign residents would benefit from the output gains symmetrically. Symmetric wealth movements in response to shock would in turn imply that intertemporal trade is driven by investment, not by consumption smoothing (see Baxter and Crucini, 1995; Corsetti et al., 2008a).

An open question thus concerns whether, by virtue of international financial market development and integration, the complete market model could provide a better benchmark for empirical work. While, to date, the empirical literature provides mostly negative answers to this question,7 we should emphasize that our empirical model can accommodate a variety of equilibrium responses in the relevant variables.

Much of our empirical work below will be focused on the empirical dimensions of standard current account theory discussed above. Yet, our model will also provide evidence on the dynamics of gross foreign positions, on which such theory is silent. One may indeed expect that the stock of external asset and liabilities respond to both permanent shocks, affecting the optimal long-run portfolio composition, and transitory shocks, reflecting consumption smoothing. In this dimension, our study will contribute novel evidence on the extent to which gross positions respond to either type of shocks.

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

As in Campbell and Mankiw (1989) and Lettau and Ludvigson (2001, 2004) in a closed economy, and Bergin and Sheffrin (2000) in an open economy setting, the main building block of our analysis consists of a set of cointegrating relationships which characterize an economy on a balanced growth path, and can be used to decompose shocks into permanent and temporary components.

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7Key evidence at odds with a high degree of cross-border risk sharing builds on the work by Backus and Smith (1993). Recently, evidence conditional on identified productivity shocks is provided by Corsetti et al. (2008b,c).
In our case, the cointegrating relations of interest are between net output, consumption, foreign assets and liabilities.\textsuperscript{8} We thus proceed by imposing enough conditions as to ensure that a well-defined balanced-growth path exists for the economy in the long run — conditions which in turn have testable implication on the data. Conditional on the existence of a balanced growth path, we derive a version of the present value model, by taking a first-order Taylor approximation of the intertemporal budget constraint.\textsuperscript{9}

### 2.2.1 Key maintained assumptions

An issue that we need to take into account in our study is raised by the fact that our sample is characterized by a long process of deregulation and liberalization of international financial markets, as well as by the integration in the global economy of new, growing countries — phenomena clearly at the roots of the steady increase in the stock of cross-border foreign assets and liabilities recorded over the last two decades. Gourinchas and Rey (2007a) argue that explaining the steady growth in cross holding in the last decades does not pertain to the analytical core of studies of current account adjustment, and advocate the need to abstract from it, as to insulate the main features of a financial transmission channel which should be active at different degrees of capital market integration.

Starting from the same premise, we rewrite the flow budget constraint of a country (2), distinguishing, for each variable $W_t$, between a deterministic trend $\exp(\gamma_{w,t} + i)$, and a non-deterministic-trend component $W_t$, so that $W_t = W_t \exp(\gamma_{w,t})$, where the mean of $W_t$ may be non-zero. Under this notational convention, (2) reads:

$$A_{t+i+1} \exp(\gamma_{a,t+i+1}) - L_{t+i+1} \exp(\gamma_{l,t+i+1}) = Z_{t+i} \exp(\gamma_{z,t+i}) - C_{t+i} \exp(\gamma_{c,t+i}) + (1 + r_{t+i}) [A_{t+i} \exp(\gamma_{a,t+i}) - L_{t+i} \exp(\gamma_{l,t+i})], \quad i = 0, 1, \ldots; \ A_t, L_t: \text{given} \quad (3)$$

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, $r_{t+i}$ is the real rate of return and $\gamma_{w,t+i}$ denotes the deterministic trend component of variable $w = A, L, Z, C$ in period $t + i$ which need not be linear a linear function of time (e.g. $\gamma_{w,t+i}$ is not necessarily equal to $\gamma_w \times (t + i)$). Observe that, in this way, we can accommodate a wide range of deterministic functions. Now, by the same notational convention, let

$$\Delta \hat{w}_{t+i} \equiv \Delta \ln W_{t+i} \equiv \Delta \ln W_{t+i} + \Delta \gamma_{w,t+i} \text{ for } w \in \{A, L, Z, C, \}$$

\textsuperscript{8}Lettau and Ludvigson (2004) focus instead on the cointegrating relationships linking consumption, human capital and asset wealth.

\textsuperscript{9}A detailed discussion of our assumptions, their empirical implications, and the approximation of the intertemporal budget constraint is included in an online appendix.
where $\Delta \ln W_{t+i}$ are zero-mean variables, so that $\mathbb{E}(\Delta \hat{w}_{t+i}) = \Delta \gamma_{w,t+i}$ is the growth rate of each variable of interest. 

For the purpose of our analysis, it is crucial to allow for enough flexibility in the model as regards the trend-evolution of variables over the sample period. As already mentioned, our sample is characterized by a large increase in the stock of international assets and liabilities following 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 the new balanced growth path, we impose that these trends converge, for all variables, to the same long-run value. We posit:

**Assumption 1**

(a) The NFA portfolio returns $r_{t+i}$ are a stationary process, with mean $\mathbb{E}(r_{t+i}) = r$ and bounded second moments independent of time.

(b) The growth rates of all the variables $\Delta \hat{w}_{t+i}$ for $w \in \{A, L, Z, C\}$ have means $\mathbb{E}(\Delta \hat{w}_{t+i}) = \Delta \gamma_{w,t+i}$ and bounded second moments independent of time, around these mean values.

(c) The deterministic trends, $\gamma_{w,t+k}$, converge asymptotically to the same value, $\lim_{k \to +\infty} \gamma_{w,t+k} = \gamma_{\infty,t}$, such that $r = \mathbb{E}(r_{t+i}) > \mathbb{E}(\Delta \hat{w}_{t+i}) = \Delta \gamma_{\infty,t}$, for $w \in \{A, L, Z, C\}$.

(d) The transversality condition

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

holds.

While by Assumption 1(a) the returns on the NFA portfolio are stationary processes, Assumption 1(b) allows the mean growth rates of consumption, net output, gross assets and liabilities to vary over time. But net of these time-varying trend-growth rates ($\mathbb{E}(\Delta \hat{w}_{t+i})$), growth rates in these variables are actually stationary: $\Delta \hat{w}_{t+i} - \mathbb{E}(\Delta \hat{w}_{t+i})$ are zero mean stationary processes. Consider now the possibility that average growth rates change (possibly more than once) conditional on specific, non-stochastic events. While the first two parts of Assumption 1 allow variables to have different trends in the sample, Assumption 1(c) imposes that, in the limit, all variables will eventually grow at the same rate, $\gamma_{\infty,t}$, along the balanced-growth path. By insuring the existence of a balanced growth path out–of–sample, this last assumption essentially brings us back, if only in the limit, to the standard case, where all variables are assumed to grow at the same rate, lower than the
long-run rate of return on assets — a common equilibrium condition in growth models.\footnote{Note that our assumption rules out the possibility that the rate of growth of gross assets and liabilities permanently exceeds the rate of growth of consumption and output.} Finally, if \( \lim_{k \to +\infty} (\gamma_{a,t+k+1} - \gamma_{l,t+k+1}) = 0 \), as implied by Assumption 1(c), in the limit gross assets and liabilities grow at the same deterministic rate (\( \gamma_{\infty,t} \)). What condition (4) requires is that in the limit, the return on the NFA portfolio exceeds the growth rates of gross assets and liabilities.

Under these assumptions, by repeated substitutions, we may write the intertemporal budget constraint as:

\[
E_t \sum_{i=0}^{\infty} R_{t,t+i} Z_{t+i} \exp (\bar{\gamma}_{z,t+i}) = L_t \exp (\bar{\gamma}_{l,t}) - A_t \exp (\bar{\gamma}_{a,t}) + E_t \sum_{i=0}^{\infty} R_{t,t+i} C_{t+i} \exp (\bar{\gamma}_{c,t+i}), \tag{5}
\]

where \( \bar{\gamma}_{w,t+i} \equiv \gamma_{w,t+i} - \gamma_{\infty,t} \) denotes the deviation of the deterministic trend component of each variable, \( \gamma_{w,t+i} \), from its limiting value, \( \gamma_{\infty,t} \). By defining \( \Phi_t \equiv \sum_{i=0}^{\infty} R_{t,t+i} C_{t+i} \exp (\bar{\gamma}_{c,t+i}) \) and \( \Psi_t \equiv \sum_{i=0}^{\infty} R_{t,t+i} Z_{t+i} \exp (\bar{\gamma}_{z,t+i}) \), it is analytically convenient to rewrite (5) more synthetically as

\[
E_t \Psi_t = L_t \exp (\bar{\gamma}_{l,t}) - A_t \exp (\bar{\gamma}_{a,t}) + E_t \Phi_t \tag{6}
\]

The three conditions spelled out in the following assumption are necessary in deriving a linearized version of this constraint, and, more importantly, have empirical implications which we explore in the data.

**Assumption 2** (a) The process \( \Phi_t/\Psi_t \) is stationary, with bounded moments, independent of time.
(b) The processes \( A_t \exp (\bar{\gamma}_{a,t})/\Psi_t \) and \( L_t \exp (\bar{\gamma}_{l,t})/\Psi_t \) are stationary, and have bounded moments independent of time.
(c) The processes \( Z_t \exp (\bar{\gamma}_{z,t})/\Psi_t \) and \( C_t \exp (\bar{\gamma}_{c,t})/\Phi_t \) are stationary with bounded moments.

Assumption 2(a) states that the ratio of present value of consumption to the present value of net output is a stationary process, regardless of the potentially differential trending behavior of consumption and net output. Essentially they imply that (log) consumption and net output are cointegrated with coefficients (1,-1) around some deterministic trends, namely \( (\gamma_{zt} - \gamma_{ct}) \). Analogous conditions are imposed by Assumption 2(b), on the ratio of gross assets (including the deterministic trend) to the present value of (trending) net output, and the ratio of gross liabilities (with the trend) to the present value of (trending) net output, whereas the relevant deterministic trends are now given by \( (\gamma_{zt} - \gamma_{at}) \) and \( (\gamma_{zt} - \gamma_{lt}) \), respectively. Finally, part (c) of Assumption 2 simply states that the ratio of net output and consumption to their respective present values are well defined processes, e.g. stationary. Note that this follows directly from Assumption 1, where we have assumed that rates of
return and growth rates are stationary processes. These cointegrating restrictions – the fact that consumption, gross assets and liabilities should cointegrate with net output with particular coefficients – should be verified in the data, as a necessary condition for our log-linearization of the intertemporal budget constraint to be valid.

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.\textsuperscript{11} 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 3 (Empirical in–sample Approximation)** The deterministic trend components $\gamma_{w,t}$ may be expressed (in–sample) as linear functions of time, i.e. $\gamma_{w,t} = \gamma_w \times t$, for $w = c, z, a, l$.

Assumption 3 adds empirical flexibility to our framework, by allowing variables to grow at different deterministic rates within our sample. Clearly, in order for Assumption 1(c) 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, not their stochastic structure.\textsuperscript{12}

While 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 arguably preferable to alternative procedures, such as low-frequency filtering the data, which remove both deterministic and stochastic trend (permanent) components. We actually find that deterministic trends do help describing the equilibrium relationships among aggregate consumption, net output, gross assets and liabilities positions. To the extent that there exists an exogenous factor which is well approximated by deterministic components, the omission of these components from the empirical analysis would bias the results.

\textsuperscript{11}For example, consider $\gamma_{w,t} = (\gamma + \zeta_w) t$. This allows for trend shifts depending on whether $\zeta_w$ differs 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).

\textsuperscript{12}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.
Assumptions 1–2 are sufficient for the purpose of studying the effects of permanent and transitory shocks on our variables of interest — as they imply a set of particular cointegrating relations, with coefficients (1,-1) around some deterministic functions of time, which one can exploit in identifying permanent and temporary innovations. Assumption 3 simplifies somewhat the analysis – without being necessary to the main argument – by positing that these trends are linear. So as a first step in our empirical section, we will examine whether consumption, gross assets and liabilities are cointegrated with net output, around linear deterministic trends.

2.2.2 An approximate, present-value relation

Conditional on the existence of three stationary relations among our variables, according to the conditions defined by Assumptions 1–3, we proceed by deriving an approximation to the intertemporal budget constraint of a country (6). Leaving to an appendix details on the derivation, and letting \( \bar{\gamma}_w \equiv \gamma_z - \gamma_w \) for \( w = c, a, l \), this approximation reads:

\[
\begin{align*}
- (c_t - z_t - \bar{\gamma}_z t) + \rho_a (a_t - z_t - \bar{\gamma}_a t) + \rho_l (l_t - z_t - \bar{\gamma}_l t) \\
\approx E_t \left\{ - \frac{1}{\rho_d} \sum_{i=1}^{\infty} \rho_{Z\Psi}^i \Delta \hat{z}_{t+i} + \sum_{i=1}^{\infty} \rho_{C\Phi}^i \Delta \hat{c}_{t+i} - \sum_{i=1}^{\infty} \left( \rho_{C\Phi}^i - \frac{1}{\rho_d} \rho_{Z\Psi}^i \right) r_{t+i} \right\} \\
or: \quad \tilde{\Sigma} A_t \approx E_t \left\{ - \frac{1}{\rho_d} \sum_{i=1}^{\infty} \rho_{Z\Psi}^i \Delta \hat{z}_{t+i} + \sum_{i=1}^{\infty} \rho_{C\Phi}^i \Delta \hat{c}_{t+i} - \sum_{i=1}^{\infty} \left( \rho_{C\Phi}^i - \frac{1}{\rho_d} \rho_{Z\Psi}^i \right) r_{t+i} \right\}.
\end{align*}
\]

where lower case letters denote logs, \( r_t \approx \ln (1 + r_t) \) and \( \Delta \hat{w}_{t+i} \equiv \Delta w_{t+i} + \Delta \gamma_w,t+i \equiv \Delta \ln W_{t+i} \) for \( w = z, c \); the coefficients \( \rho_{C\Phi} \) and \( \rho_{Z\Psi} \) are, respectively, \( \rho_{C\Phi} \equiv 1 - \exp (E [c_t + \gamma_c t - \phi_t]) \), and \( \rho_{Z\Psi} \equiv 1 - \exp (E [z_t + \gamma_z t - \psi_t]) \); the parameters \( \rho_a, \rho_l, \) and \( \rho_d \) are defined as follows:

\[
\begin{align*}
\rho_d &\equiv [1 - \exp (E [l_t + \gamma_l t - \psi_l]) + \exp (E [a_t + \gamma_a t - \psi_a])]
\rho_a &\equiv [(1 - (1/\rho_d)) + (\exp (E [l_t + \gamma_l t - \psi_l]) / \rho_d)]
\rho_l &\equiv [(1 - (1/\rho_d)) - (\exp (E [a_t + \gamma_a t - \psi_a]) / \rho_d)],
\end{align*}
\]

with \( \rho_a + \rho_l + \rho_d^{-1} = 1; \bar{\gamma}_w \equiv \gamma_w - \gamma \); (\( \gamma \) denotes the limiting growth rate); and \( \psi_t \) being a function of \( \rho_{Z\Psi} \).

\footnote{As we show in an online appendix, \( \psi_t \simeq +z_t + \gamma_z t - f(\rho_{Z\Psi}) + \sum_{i=1}^{\infty} \rho_{Z\Psi}^i (r_{t+i} - \Delta \hat{z}_{t+i}) \), where \( f(\rho_{Z\Psi}) \) is a (constant) function of \( \rho_{Z\Psi} \). It can easily be seen that \( \rho_a, \rho_l \), and \( \rho_d \) will then depend on \( \rho_{Z\Psi} \).}

Note that the left-hand side of (7) includes the same variables with the Current Account identity (2), but here they are in logs.

\footnote{The current account is defined as \( \Sigma A_t \equiv Z_t + r_t (A_t - L_t) - C_t \), while the approximate expression in (7) reads:

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

We label the expression on left-hand side of (7) as \( \tilde{\Sigma} A_t \).
Three points are worth stressing. First, equations (7)–(8) define a present-value relation, equating a deficit in $\tilde{CA}_t$ to the discounted value of future expected changes in net output and consumption, as well as expected asset returns. The expression is however based on a much smaller set of maintained assumptions, relative to present value models derived in the literature. It suggests that a deficit in $\tilde{CA}$ arises when (i) net output is temporarily low, and is expected to rise in the future; (ii) the returns on the NFA portfolio are expected to increase in the future if the sign of $\rho_{C\Phi} - \frac{1}{\rho_d}\rho_{Z\Psi}$ is positive; (iii) consumption is expected to fall in the future; or some combination of these three. Note that, differently from the standard intertemporal trade model, we do not make use of the households’ optimality conditions dictating the optimal intertemporal consumption allocation (but requiring further maintained assumptions on preferences), to eliminate consumption from the left-hand side of the expression. Second, $\tilde{CA}_t$ is a stationary process, since it is a linear combination of processes which are stationary around some deterministic trends. Even if gross assets and liabilities are not (trend-) stationary in levels, the transversality condition (4) 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, $\tilde{CA}_t$ cannot be identified from the data without auxiliary assumptions: In particular, obtaining time series estimates of $\tilde{CA}_t$, requires some assumptions on the parameter $\rho_{Z\Psi}$. We return to this issue in an extension of our analysis.

Under our assumptions, a country’s net output, consumption, gross assets and liabilities should commove 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. The empirical approach we describe below then exploits the assumed cointegrating relations — without imposing additional structure — to identify permanent and transitory innovations.

An expression similar to (8) is derived in closely related work by Gourinchas and Rey (2007a), whose analysis, like us, starts from the current account identity, to derive empirical implications on the dynamics of cyclical external adjustment. As these authors focus on the adjustment mechanism via financial channels, they most naturally write the current account identity by including the series on imports and exports, and focus on the role of NFA returns, as a function of the exchange rate, in the adjustment process. Conversely, since 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, we include these variables (rather than imports and exports) in the model, and focus on the decomposition of shocks by their persistence. Also, we include ex post rates
of return, without distinguishing their exchange rate component.\textsuperscript{15} We should however stress that, in both studies, the log-linearized budget constraints share exactly the same empirical properties (e.g. stationarity of ‘great ratios’ around trends and predictability of future expected returns), which we will use in an extension of our analysis below.

Specific differences instead pertain to methodology. Notably, we explicitly allow from the start for both deterministic and stochastic trends in variables, to be estimated jointly by the data. The key advantage of this approach is that, while being consistent with our theoretical framework, it allows us to treat explicitly stochastic trends underpinning cointegration analysis. In their forecasting exercise, instead, Gourinchas and Rey (2007a) rely on cyclical components of series obtained by applying low frequency filters, which eliminate both deterministic and stochastic trends from the analysis.

In general, the empirical implications of the intertemporal budget constraint of a country have also been exploited by a number of contributions on the determinants of the US current account deficits. An important instance is Engel and Rogers (2006), who emphasize that, throughout the 1990s and beyond, the share of US output in world output was expected to trend upwards over reasonably long horizons. As this share cannot grow without bound, these authors posit that, at some point, it would converge and stabilize around a new long-run value — analogously to our Assumption 1(c).\textsuperscript{16} Essentially, starting from (5), Engel and Rogers (2006) make the point the external ‘imbalance’ of the U.S. can be reconciled with optimal intertemporal decisions driven by (expectations of) a permanent increase in US output (relative to world output). In our empirical analysis, we find evidence for the mechanism underlying their argument, that consumption adjust swiftly to permanent shocks raising US net output in the long run, generating a current account deficit.

\section*{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

\textsuperscript{15}In both studies, the nominal return on foreign assets is defined as \( r_{a,n}^{t} = r_{a,n}^{t,*} + \Delta s_{t} \), where \( r_{a,n}^{t,*} \) is the nominal return on gross assets denominated in foreign currency, and \( \Delta s_{t} \) denotes exchange rate depreciation. This observation is important, insofar as it clarifies that the nominal exchange rate actually enters our analysis, albeit it appear only implicitly in our equations. Regarding definitions, however, we also should note a minor difference, referring to the timing convention (we work with end-of-period \( t \) gross assets and liabilities positions, whereas these authors work with beginning of period \( t \) gross positions) and the variable used in normalizing variables (net output instead of household wealth).

\textsuperscript{16}These authors make an implicit assumption of how this trend in the share of US output is going to end in their sample, whereas we assume that the differential trend is eliminated out of our sample.
of a $n$-dimensional cointegrated vector $x_t$. In our application, $x_t = [c_t, z_t, a_t, l_t]'$ where all variables are expressed in real per capita terms, and $c_t$ denotes consumption, $z_t$ net output, $a_t$ and $l_t$ denotes gross assets and liabilities respectively. A full account of our data is included in an online appendix.

### 3.1 Cointegration Analysis

Permanent and transitory components of the four variable system $x_t$ 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), Gonzalo and Ng (2001), Johansen (1995), and King et al. (1991). While the approach we follow does not identify structural shocks, it yields results that, at least for the permanent shock, have a natural structural interpretation.

Our procedure takes several steps. First, we estimate a 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 $x_t$. 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 point in the direction of three trend stationary relations, corroborating our key theoretical assumptions, and we proceed by imposing three cointegrating relations in our VEqCM specification. Our assumptions imply that the cointegrating relations are of the form $s_t = \mu_s + \beta_s z_{t+1} + \theta_s t$ for $s = c, a, l$, with $\beta_s = 1$. We use dynamic least-squares (DOLS) to obtain “superconsistent” estimates of the required parameters (Stock and Watson, 1993).

We note the $\beta_s$’s differ from their assumed value of unity, and evaluate the restrictions by means of likelihood ratio tests (as in Johansen, 1995) and Wald-type tests, employing empirical critical values based on a bootstrap Monte Carlo procedure (see Panel B of Table 1). Wald tests indicate that the restrictions are valid, whereas likelihood ratio tests are very close to the rejection region. As the former tests are based on DOLS, which is more robust estimation method, especially in short samples, on balance, we decide in favor of the restricted cointegrating relations, and impose these in our VEqCM.

---

17 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.

18 Cointegration results and unit root tests of the ‘great rations’ are available in an online appendix to conserve space. We should stress however, that evidence favoring the existence of three cointegrating relations are robust across lag-length specifications.

19 We have used four leads and lags of the first differences of $\Delta z_t$, but our results are robust for different leads/lags constellations. Similar parameter estimates were obtained by means of a Fully-Modified OLS procedure (Phillips and Hansen, 1990).

20 The bootstrap procedure for the Wald tests follows Chang et al. (2006).
Under the cointegrating restrictions just discussed, one can estimate a VEqCM representation for $x_t$ which takes the form

$$\Gamma(L) \Delta x_t = \delta + \alpha(\hat{\beta}, \hat{\theta}) \left( \begin{array}{c} x_{t-1} \\ t-1 \end{array} \right) + u_t,$$  \hspace{1cm} (10)

where $\Delta x_t$ is the vector of log first differences, $(\Delta c_t, \Delta z_t, \Delta a_t, \Delta l_t)'$, $\delta$ is a $(4 \times 1)$ vector, $\alpha \equiv (\alpha', \alpha, \alpha, \alpha)'$ is a $(4 \times 3)$ matrix, $\hat{\beta}$ is the $(4 \times 3)$ matrix of the cointegrating coefficients discussed above, $\hat{\theta}$ are the coefficients of the deterministic trends in the cointegrating space, and $\Gamma(L)$ is a finite matrix polynomial in the lag operator. The term $(\hat{\beta}' x_{t-1} + \hat{\theta} (t - 1))$ gives the previous period equilibrium errors; $\alpha$ is the matrix of ‘adjustment’ coefficients that tells us which of the variables react and by how much to previous periods’ equilibrium errors, to restore them back to their means when a deviation occurs. By virtue of the Granger Representation Theorem (Engle and Granger, 1987), if a vector of variables $x_t$ is cointegrated, then at least one of the adjustment parameters in the $(4 \times 3)$ matrix $\alpha$ must be non-zero in the VEqCM representation (10). Thus if $x_i$ does at least some of the adjusting needed to restore the $j$-th long-run equilibrium relation after a shock that distorts this equilibrium, the parameter $\alpha_{ij}$, should be different from zero in the equation for $\Delta x_i$ of the VEqCM representation (10). The results from estimating the first-order specification (10) are presented in Table 1. Panel A of Table 1 shows the estimated VEqCM, with the associated $t$-statistics and adjusted $R^2$ for each equation. Note first that net output and gross liabilities show evidence of strong equilibrium correction; hence they do much of the adjustment following a shock that caused the system to deviate from its long-run stochastic trend. Second, we observe that consumption growth and gross asset growth do not respond to the equilibrium errors. In order to evaluate the possibility that some variables do not ‘equilibrium correct’, in Panel C of Table 1, we perform a series of 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.

3.2 Permanent and Transitory Decomposition

Cointegration between the variables in our system allows us to decompose $x_t$ into shocks that are very persistent (permanent) and shocks that are transitory. Since $x_t$ has four elements, and we find three cointegrating vectors, this implies that there is one common stochastic trend (Stock and Wat-
son, 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. Then, in order to study the dynamic impact of the permanent innovations, we assume that they are orthogonal to the transitory innovations — an assumption which is not essential for our main results, but serves in interpreting impulse response functions. We later show that our conclusions also follow from a variance-covariance decomposition, for which the assumption of orthogonality is not necessary.

It is useful to review our methodology, 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 \( x_t \) are covariance stationary around some deterministic terms, there exists a multivariate Wold representation of the form

\[
\Delta x_t = \Upsilon D_t + C(L) u_t, \tag{11}
\]

where \( C(L) \) is a \( 4 \times 4 \) matrix polynomial in the lag operator, \( D_t \) denotes all deterministic variables (constant and trend) and \( \Upsilon \) the coefficients of these variables. We want to map these \( n = 4 \) reduced form innovations, \( u_t \), into transformed innovations \( \eta_t \) that are distinguished by whether they have permanent or transitory effects. Without loss of generality the shocks \( \eta_t \) 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 \( \eta_t^P \) as permanent if \( \lim_{h \to \infty} \partial \mathbb{E} (x_{t+h}) / \partial \eta_t^P \neq 0 \), and a shock \( \eta_t^T \) as transitory if \( \lim_{h \to \infty} \partial \mathbb{E} (x_{t+h}) / \partial \eta_t^T = 0 \).

The permanent and transitory innovations may be identified using the estimated parameters of the VEqCM representation (10) of a cointegrated system. Essentially, cointegration implies that the matrices \( \alpha \) and \( \beta \) 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 \( \alpha \) and \( \beta \) respectively (that is \( \alpha'_\perp \alpha = 0 \) and \( \beta'_\perp \beta = 0 \)). From the Granger Representation Theorem, it follows that \( \beta' C (1) = 0 \) and \( C (1) \alpha = 0 \). As in Gonzalo and Ng (2001) we may define the permanent disturbances as \( \eta_t^P = \alpha'_\perp u_t \) and the transitory ones as \( \eta_t^T = \beta' u_t \). Letting \( G = [\alpha_\perp, \beta]' \) the transformed (permanent and transitory) shocks are given by

\[
\eta_t = \begin{bmatrix} \eta_t^P & \eta_t^T \end{bmatrix}' = G u_t \text{ with } \text{Var}(\eta_t) = G \Omega G',
\]

and the transformed Wold representation is

\[
\Delta x_t = \Upsilon D_t + C(L) G^{-1} G u_t = \Upsilon D_t + B(L) \eta_t.
\]
Thus each element of $\Delta x_t$ 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 $x_t$ 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 is determined by $\alpha'_\perp x_t$. Given the structure of our estimated adjustment coefficients, it follows that the permanent component in our four system variable will be closely related to innovations in the consumption equation.\textsuperscript{21} This further implies that consumption is mostly driven by permanent shocks at all horizons.

This decomposition can be understood by looking at the properties of the matrix $G$: intuitively, any variable $x_j$ participates little in the equilibrium correction when the row $\alpha_j$ 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 (large) weight in the permanent (transitory) innovations when the row $\alpha_j$ contains elements that are large — so the element of $\alpha'_\perp$ that multiplies $u_{jt}$ is small in absolute value.

The key finding in our analysis — already referred to above — is that consumption has a large permanent component. 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 $\alpha$ are relatively large and statistically significant (see Table 1): net output, gross assets and liabilities have a non-negligible weight in the transitory innovations.\textsuperscript{22}

4 Empirical Findings

4.1 Variance Decompositions

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. The permanent shock — denoted by $\eta^P_t$ — 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. A natural interpretation for this shock in our analysis is

\textsuperscript{21}This permanent component may contain serial correlation around the random walk component given by the multivariate Beveridge-Nelson decomposition.

\textsuperscript{22}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.
that of a permanent technology shock — e.g. TFP. 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.

Table 2 shows the fraction of the \( h \)-step forecast error of \( \Delta c_t, \Delta z_t, \Delta a_t \) and \( \Delta l_t \) that is attributable to the permanent shock, and the three transitory shocks combined (which we do not identify separately). In this table, we assume that the permanent shock is orthogonal to the transitory shocks — an assumption that we will also use in our impulse response analysis below, but will relax later. For \( h = 1, 2, \ldots \), we compute the portion of the total variance of each variable that is attributable to each type of disturbance. Panel A of the Table shows results setting \( \alpha_c = 0 \), while panel B shows results setting \( \alpha_c \) to their point estimates (see Table 1). In all cases, sampling uncertainty is quantified using a bootstrap Monte Carlo procedure.

The results in Panel A show that, at virtually all horizons, the transitory shocks account for only a negligible portion of consumption variation: only the permanent shocks matter for this variable. Conversely, transitory shocks account for most of the variance for the other variables in our analysis, especially at horizons between one and four quarters, over which they account between 70 and 74 percent of the variance in net output, between 85 and 88 percent of the variance in foreign assets, and around 86 percent of the variance in foreign liabilities. For foreign assets and liabilities, transitory shocks continue to contribute considerably to the forecast error variance also at horizons of eight to forty quarters ahead. Notably, at a 40-quarters horizon, the transitory shocks still contribute between 52 and 94 percent to the variance of gross assets and between 45 and 87 percent to the variance of gross liabilities — while the permanent shock only accounts for 30 and 35 percent of the variance of assets and liabilities, 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 for 85 percent of the variance of net output. Over the same horizon, the permanent shock virtually accounts for the whole variance of consumption.

To shed further light on the dynamics of the system, it is instructive to build a measure of the US

---

23 Such a shock is dubbed “common trend shock” by King et al. (1991).

24 Note that cointegration with \( r = 3 \) implies that \( C(1) \) is a matrix of rank one. Hence in the limit, only the permanent shock will affect the four variables we model, since the cumulative effect of transitory shocks is zero – so all long-run variance is due to the permanent shock. 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 implies that only the first column of \( B(1) = C(1)G^{-1} \) has elements that differ from zero.

25 Given that permanent shocks dominate fluctuations of the net output at long horizons, and gross positions are cointegrated with net output, fluctuations in gross positions will ultimately be driven by the permanent shocks over the infinite horizon. Over long but finite horizons, however, nothing precludes a stronger role of temporary shocks.
current account as the quarterly change of US net foreign assets. Define net foreign asset position 
\[ NFA_t \equiv \exp(a_t) - \exp(l_t) \]: a theory-consistent measure of the current account is then 
\[ CA_t^* \equiv NFA_{t+1} - NFA_t \]. The variance-decomposition for this new variable is reported in the last two 
columns of Table 2. Consistent with our previous results, transitory shocks account for the vast 
majority of the fluctuations in (this proxy for) the current account, ranging between 98 and 99 
percent at virtually all horizons. Correspondingly, the upper bound of the contribution of permanent 
shocks is between two and four percent.

In Panel B, where all elements of \( \alpha_c \) are set to their estimated values (even if these are not signi-
cificantly different from zero), the transitory components of gross positions and the current account 
are somewhat smaller, but still account for the bulk of their fluctuations — strictly above 50 per-
cent even at forty quarters ahead. For net output, permanent shocks become a dominant source of 
variation beyond the one year horizon, whereas they are still the dominant source of consumption 
variation at all horizons.\(^{26}\)

These results from variance decomposition analysis are in line with current account theory, in 
that temporary fluctuations in the system affect jointly net output and the stocks of external assets 
and liabilities (and their combination, \( CA_t^* \)), but not consumption — a variable that has almost 
no temporary component. In addition, the fact that transitory movements in assets and liabilities 
are quite significant, and last longer than transitory movements in net output, lends support to the 
notion that international financial markets are a quantitatively relevant source of shocks, smoothed 
via intertemporal trade.\(^{27}\) To our knowledge, these results are novel relative to existing empirical 
literature.

Thus far, our results are obtained on the premise that the permanent shock is orthogonal to the 
transitory shocks, which may not be warranted in the data. Results from a variance-covariance de-
composition analysis which does not require shocks to be orthogonal are shown in Table 3. The 
table reports the fraction of the \( h \)-step ahead forecast-error variance that is attributable to the per-
manent shock, the transitory shocks, and to two times their covariance. The transitory components 
of net output, gross assets and liabilities remain strong, and result to be only weakly correlated with 
the permanent components. By the same token, the strong permanent component of consumption is 
virtually uncorrelated with transitory components, when we restrict its equilibrium adjustment co-
efficients to zero. Permanent and transitory components are however highly correlated, especially at

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\(^{26}\) A notable difference between the two panels is that in Panel B the confidence intervals are wider, without affecting our main conclusions.

\(^{27}\) Observe that the stocks \( A \) and \( L \) are choice variables for agents, 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.
short horizons, when we use the point estimates of $\alpha_c$. We should stress nonetheless that this finding does not alter our conclusion that consumption is mostly driven by permanent shocks.\textsuperscript{28} Similarly, we find that permanent and transitory components of the change in the net foreign position ($CA^*_t$) may be correlated, once again without altering our conclusion that the majority of current account variation is attributable to transitory shocks.

Additional insights can be gained by looking at the correlation of each variable in our model with its random walk component. Given our permanent-transitory decomposition, the permanent component can be readily obtained by means of a multivariate Beveridge-Nelson decomposition. Results are shown in Panel A of Table 4. In accord with our variance decomposition results, we find that consumption is highly correlated with its random walk component (about 84 percent). In contrast, the correlation of net output, and gross positions with their random walk components is considerably weaker, ranging between 17 and 44 percent – regardless of whether we impose the restriction that consumption does not respond to the equilibrium errors.

Finally, a notable result shown in Panel B of Table 4, concerns the correlations of the transitory component of gross assets and liabilities with a four-quarter moving average of returns. These correlations are above 30%, a finding suggesting that a great deal of the transitory variation in gross positions we uncover in the data, is ultimately associated with variations in returns.

### 4.2 Impulse-Response Analysis

As the single permanent shock in our system is identified in isolation (as opposed to the transitory shocks, which are combined together), we can complement the variance decomposition analysis above with impulse responses analysis. It is worth emphasizing that 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, or 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 responses of $\Delta z_t$, $\Delta c_t$, $\Delta a_t$, $\Delta l_t$, as well as the responses of $CA^*_t \equiv \Delta NFA_{t+1}$, together with the associated bootstrap confidence bands.\textsuperscript{29} The left column shows the impulse responses setting $\alpha_c = 0$, whereas the right column shows the responses setting $\alpha_c$ to their estimated values.

A key result from our study is illustrated by the first two rows of graphs, showing the responses of net output and consumption. After a strong response on impact, net output rises gradually for about

\textsuperscript{28}In this dimension, we have a slight difference relative to the closed economy counterpart studied in Lettau and Ludvigson (2004).

\textsuperscript{29}We employ Hall (1992)’s percentile intervals, as detailed in Benkwitz et al. (2001).
20 quarters, then converges towards its higher permanent level, following a typical hump-shaped pattern. Given that our output measure is net of investment, the pronounced hump-shape is consistent with a delayed increase in investment, a feature commonly analyzed in the business cycle literature. Conversely, consumption jumps on impact, and reaches its new long-run level more quickly than net output — a result that holds regardless of our treatment of the consumption adjustment coefficients. Note that, from the second quarter on, the response of consumption is stronger than that of net output for about ten quarters, when $\alpha_c = 0$, or seventeen quarters, when $\alpha_c \neq 0$.

This result is noteworthy in light of the large body of literature suggesting that consumption is excessively smooth vis-a-vis persistent shocks to income. In their seminal contribution, Campbell and Deaton (1989) argue that permanent income growth is more volatile than current income growth, as the latter is positively autocorrelated. Under the permanent income hypothesis, consumption growth should then be more volatile than current income growth, a prediction which is rejected by the data — consumption is found to be excessively smooth. Our results, however, suggest that $\Delta c_t$ is mostly driven by permanent shocks, and accordingly highly correlated with its random walk component. As such, it does not appear to be either excessively smooth or excessively volatile.

In our analysis we do not impose constant returns to savings (as it is often done in the literature). Without this restrictive assumption, consumption is equal to the permanent component of total income, including both asset and labor income. This is consistent with consumption growth being less volatile than non-asset income growth. Indeed, this will be the case as long as there is a large transitory component in asset income (returns).

Another important result is illustrated by the third and fourth row of graphs, showing the response of the stocks of US foreign assets and liabilities to the permanent shock. In response to a positive permanent innovation, we find that both gross assets and liabilities rise together. Observe that gross assets peak early on, then decline gradually to their new long-run value. While the initial increase of gross liabilities is below that of gross assets, they keep rising gently – surpassing gross assets over time – before declining equally gently to the new steady state value. This information is synthesized by the last row in the figure, showing the response of our proxy to the current account, $CA^\star_t$. Such variable displays a non-linear behavior, corresponding to the different patterns of assets and liabilities described above: an initial improvement, for about three quarters, is followed by a clear deterioration up to about the 15th quarter, when the balance is effectively restored.\(^{30}\)

\(^{30}\)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 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
A positive correlation in 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. (2008c), in response to productivity (and demand) shocks to US tradables identified using sign restrictions. This result may provide an empirical benchmark for theoretical work on portfolio diversification (see e.g. Devereux and Sutherland, 2010). 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 a similar point – in the framework of Merton’s portfolio analysis – are put forward by Kraay and Ventura (2000, 2003).

5 Robustness Experiments and Extensions

5.1 Robustness Results

The results from our analysis are found to be robust to a number of experiments. The following three are particularly informative. First, we verify whether our results are robust to adopting alternative methods to identify permanent and transitory shocks. In particular, letting the permanent shock be \( \eta^P_t = \alpha'_\perp u_t \), if we require this to be orthogonal to the transitory ones, the latter can be defined as \( \eta^T_t = \alpha'\Omega^{-1}u_t \). In this way, one achieves both a rotation from reduced-form errors to permanent/transitory shocks, and an orthogonalization. Results from this identification scheme are virtually identical to those reported above, so our results are independent on the chosen identification of permanent/transitory innovations.

Second, as we do not model returns explicitly, one could argue that these are treated as exogenous. In order to explore the extent to which this modeling choice affects our conclusions, we have repeated our analysis including the return differential \( r^a_t - r^l_t \) in our VARs, thereby making it an endogenous variable. Essentially, the cointegrating dimension increases by one – as returns are stationary. Again, our conclusions are largely unaffected. In addition, we do find that the fluctuations of the return differentials are mostly driven by transitory shocks to the system, while their response to permanent shocks is statistically indistinguishable from zero.

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delayed response of the current account to persistent productivity shock in the tradable sector is also detected by Corsetti et al. (2008b,c), while similar nonlinearities are discussed by Kraay and Ventura (2000, 2003).

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.
Third, we examine the validity of our results employing the time series for foreign gross positions put together by Gourinchas and Rey (2007a,b). These series cover a longer time span, including many years from the pre-Bretton Woods period, and are based on slightly different data sources and on different methodologies in calculating valuation-adjusted stocks. One potential benefit from applying our analysis to this longer sample, consists of verifying whether our methodological approach works for the case in which the determinist trends in the series can be expected to be non-linear. Consistently with our assumptions (e.g. Assumption 2), over the longer sample it would be natural to expect a break in the deterministic trends in our variables, marking the beginning of the process of financial liberalization at the root of the large increase in cross-border asset holdings. In line with such conjecture, our Assumption 3 — the in-sample approximation of deterministic trends — turns out to be violated. However, when we test whether the ratios of gross assets and liabilities to net output can be characterized as trend stationary around piece-wise linear deterministic trends, based on the Zivot and Andrews (1992) unit-root test, this test detects a deterministic trend break in the assets to (net) output ratio occurring in 1974:Q1 and a break in the liabilities ratio occurring in 1970:Q1. These dates precede somewhat the official liberalization initiatives in the US, Germany, the UK and Japan in the seventies, but fall in a period 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 non-linear deterministic trends in the cointegrating relations, we re-do our analysis, including the impulse responses analysis and the forecast error variance decomposition: Our main conclusions remain largely unaffected, and robust to using alternative methods in disentangling permanent and transitory shocks, or even to including return differentials in the VARs.32

5.2 Extensions and Further Discussion

In this section, we discuss additional empirical results that can be derived by relying on the approximate present value relation (8). Specifically, (8) implies that \( \widetilde{CA}_t \) should have some predictive power over future consumption growth, future net output growth and future portfolio returns. However, as already noted, the expression for \( \widetilde{CA}_t \) includes three parameters \( \rho_d, \rho_a \) and \( \rho_l \), which depend on \( \rho_{Z\Psi} \) — that is, a function of the ratio of net output to its present value one cannot estimate directly from the data. To proceed, we take an educated guess and set \( \rho_{Z\Psi} \) equal to 0.99 — experimenting with different values nonetheless suggests that results are not particularly sensitive

32Further robustness results include variations in the lag-length and using total consumption instead of our measure of nondurables and services consumption (see the discussion in Palumbo et al. (2006)). All our robustness results are available in an online appendix.
to this parameter. Given a value for $\rho_{Z \Psi}$, we can exploit Assumption 1 about the stationarity of returns and growth rates, to derive values for $\rho_d$, $\rho_a$ and $\rho_1$ as defined in (9)—recall for instance that $\rho_d \equiv [1 - \exp (E [l_t + \bar{\gamma}_l t - \psi_l]) + \exp (E [a_t + \bar{\gamma}_a t - \psi_l])]$. Leaving the details of the derivation to the online appendix, we note here that the terms $E [a_t + \bar{\gamma}_a t - \psi_l]$ and $E [l_t + \bar{\gamma}_l t - \psi_l]$ can be approximated as follows

$$E [(a_t - z_t - \bar{\gamma}_a t)] + \frac{\rho_{Z \Psi} \kappa_{Z \Psi}}{1 - \rho_{Z \Psi}} + \frac{\rho_{Z \Psi}}{1 - \rho_{Z \Psi}} (E (r_{t+i}) - E (\Delta \hat{z}_{t+i}))$$

$$E [l_t - z_t - \bar{\gamma}_l t] + \frac{\rho_{Z \Psi} \kappa_{Z \Psi}}{1 - \rho_{Z \Psi}} + \frac{\rho_{Z \Psi}}{1 - \rho_{Z \Psi}} (E (r_{t+i}) - E (\Delta \hat{z}_{t+i}))$$

where $\kappa_{Z \Psi} = \log (\rho_{Z \Psi}) + \left( \frac{1 - \rho_{Z \Psi}}{\rho_{Z \Psi}} \right) \log (1 - \rho_{Z \Psi})$. To derive returns $r_t$ on $NFA$, let $w_{at} \equiv \mathcal{A}_t / (\mathcal{A}_t - \mathcal{L}_t)$ and $w_{lt} \equiv \mathcal{L}_t / (\mathcal{A}_t - \mathcal{L}_t)$, so that $w_{at} = 1 + w_{lt}$. By definition, gross returns then are

$$(1 + r_{t+1}) = (1 + w_t) (1 + r_{a,t+1}) - w_{lt} (1 + r_{l,t+1}),$$

and expression which further simplifies under the assumption that $r_a = r_l$:

$$r_{t+1} \simeq (1 + w_t) r_{a,t+1} - w_{lt} r_{l,t+1}.$$ 

To calculate $r_{t+1}$, all we need is an estimate of $w_l \equiv E (w_{lt})$. But this can be easily obtained from our estimated cointegrating relations, as the average value of the following

$$w_{lt} = \frac{\mathcal{L}_t}{\mathcal{A}_t - \mathcal{L}_t} = \frac{1}{\exp (\ln \mathcal{A}_t - \ln \mathcal{L}_t) - 1} = \frac{1}{\exp ([a_t - z_t - \bar{\gamma}_a t] - [l_t - z_t - \bar{\gamma}_l t]) - 1}.$$

The quality of the approximation in (8) is not a relevant issue for the results obtained in the previous sections, all independent of the magnitude of the approximation errors. It may however affect the forecast exercise presented below. It is therefore appropriate to provide a discussion of it up-front. Since the intertemporal budget constraint (5) involves two variables — the present value of net output, $\sum_{i=0}^{\infty} R_{t+i} Z_{t+i}$, and the present value of consumption, $\sum_{i=0}^{\infty} R_{t+i} C_{t+i}$ — which are unobservable, we cannot properly address the accuracy of our approximation, without enduring the cost of additional, highly restrictive assumptions to put some structure on the data. Rather than taking this route (somewhat at odds with our analysis above, resting on a minimal set of maintained assumptions), we opt for a pragmatic solution. Namely, setting $\rho_{C \Phi} \approx \rho_{Z \Psi}$, we first rewrite (8) as follows

$$\bar{C} \mathcal{A}_t \simeq E_t \left\{ \frac{1}{\rho_{d}} \sum_{i=1}^{\infty} \rho_{Z \Psi} \Delta \hat{z}_{t+i} + \sum_{i=1}^{\infty} \rho_{Z \Psi} \Delta \hat{c}_{t+i} - \sum_{i=1}^{\infty} \left( \rho_{Z \Psi} - \frac{1}{\rho_{d}} \rho_{Z \Psi} \right) r_{t+i} \right\},$$

from which we derive an (empirical) approximation error

$$\bar{\varepsilon}_{t+1} \equiv \bar{C} \mathcal{A}_{t+1} - \frac{1}{\rho_{d}} \Delta \hat{z}_{t+1} + \Delta \hat{c}_{t+1} + \left(1 - \frac{1}{\rho_{d}} \right) r_{t+1} - \frac{1}{\rho_{Z \Psi}} \bar{C} \mathcal{A}_t.$$
In the data, we find that these errors to be extremely small.\textsuperscript{33}

Table 5 reports results from regressing long-horizon consumption growth $\Delta c_{t+h} \equiv c_{t+h} - c_t$, long horizon net output growth, $\Delta z_{t+h}$ and long-horizon returns $\sum_{j=1}^{h} r_{t+j}$, on the estimated $\tilde{CA}_t$, controlling for $\Delta c_t, \Delta z_t, \Delta a_t$ and $\Delta l_t$, over horizons, $h$, ranging from 1 to 16 quarters.

Panel A of Table 5 displays the long-horizon predictability of consumption growth. We first note that time $t$ consumption growth is a significant predictor of consumption growth up to eight quarters, reflecting serial correlation in aggregate consumption spending. Similarly, time $t$ liabilities growth is a significant predictor of consumption growth from twelve to sixteen quarters out. However, the $R^2$ indicate that consumption is not very much predictable for horizons beyond two years. Furthermore, $\tilde{CA}_t$ is always statistically insignificant, explaining a negligible fraction of the variation in future consumption growth. These findings suggest, first, that short-horizon predictability of consumption growth, coming mainly from serial correlation, is quite different from predictability of consumption growth over longer horizons.\textsuperscript{34} In this dimension, our findings are in line with the closed economy counterpart in Lettau and Ludvigson (2004). Second, referring to (8), the fact that $\tilde{CA}_t$ does not have any predictive ability for future consumption growth, implies that current account deficits are not expected to be ‘adjusted’ by predictable reductions of future consumption.

Panels B and C of Table 5 show results for net output growth and portfolio returns. The results for returns are similar to those reported for consumption, with a notable difference: $\tilde{CA}_t$ is a significant predictor of future returns for horizons up to eight quarters out. The adjusted $R^2$ peaks at a 4-quarter horizon, suggesting that future returns are somewhat predictable. We should note that the horizon up to which returns are predictable (8 quarters) according to our analysis, while not negligible, is shorter relative to the results by Gourinchas and Rey (2007a), from a related exercise. Conversely, we find that $\tilde{CA}_t$ has strong forecasting power, at any horizon, for net output growth, consistent with our earlier finding that net output has a strong transitory component. In particular, $\tilde{CA}_t$ has predictive power even at horizons of 16 quarters and beyond, with adjusted $R^2$ statistics peaking at about 34 percent at the 4-quarter horizon. Referring again to (8), this last findings imply that current account deficits ($\tilde{CA}_t < 0$) are expected to be ‘adjusted’, eventually, via predictable increases in the medium-horizon returns on the $NFA$ portfolio, and by predictable increases in long-run net output.

We conclude with a comment on the view stressing the role of the housing market as a ‘determi-

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\textsuperscript{33}Plots are available in the online appendix for different values of $\rho_{YZ\Psi}$. We find that the approximation error is about 44 times less volatile than $\tilde{CA}_t$ and about 33 times less volatile than $\frac{1}{\rho_d} \Delta \hat{\delta}_{t+1} + \Delta \hat{c}_{t+1} + \left(1 - \frac{1}{\rho_d}\right) r_{t+1}$.

\textsuperscript{34}The latter would follow, for instance, if consumption adjusted sluggishly to permanent shocks in total income, since this would require consumption growth to be predictable over long horizons by $\tilde{CA}_t$, a linear combination of our cointegrating relations.
nant’ of the current account, a view which has recently gained popularity in light of the observation that housing prices and the standard current accounts series (from Balance of Payments) are found to be negatively correlated. In this respect, we first note that, although we do not explicitly treat the housing market (or any other market) in isolation in our analysis, the methodology developed in this paper fully captures the possibility that housing developments exert an influence on the current account via production, investment and consumption decisions. In our empirical framework, such influence will ultimately show up as transitory or permanent disturbances to the variables in our system. In other words, while our methodology does not identify which particular shock (preference, technology, financial) in which particular market drives the dynamics of the system, it does account for the aggregate effects of such shocks on current account (and macro) dynamics — obviously including shocks that originate in the housing sector, or transmit through housing wealth. Second, from an empirical perspective, a negative correlation between housing prices and the current account balance is detectable only when the latter series is derived from the Balance of Payment statistics, i.e. excludes changes in market valuation of assets. If the measure of the current account is consistent with its proper definition, as the change in net foreign asset (the measure we adopt in our study), the correlation is actually close to zero. This should come as no surprise, given that official current account data are very weakly correlated with the change in the net foreign asset position (see Gourinchas and Rey, 2007a,b; Lane and Milesi-Ferretti, 2001, 2007).

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

\[ \text{CA}_t = Y_t - C_t - p_{H,t}H_t + G_t - I_t - (I_{NR,t} - H_{t+1} - H_t) + r_t[A_t - C_t] + r_{H,t}H_t. \]

In this instance we could write \( CA_t = \gamma_t - C_t - p_{H,t}H_t + G_t - \frac{(I_{NR,t} - H_{t+1} - H_t)}{2} + r_t[A_t - C_t] + r_{H,t}H_t. \) Obviously, the dynamics of the stock of housing is accounted for in the investment term. Moreover, from an aggregate perspective, the consumption of housing services \( p_{H,t}H_t \) cancels out with the return on housing wealth \( r_{H,t}H_t \), while cross-border ownership of housing is accounted for by the evolution of foreign assets/liabilities, and the return on them.
the current account — their effects lasting much longer than the typical business cycle frequency. Notably, 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 stochastic trend component, and its variation is dominated by permanent shocks. Furthermore, consumption responds swiftly to permanent shocks. 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 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 by Gourinchas and Rey (2007a) has emphasized the role of asset prices and exchange rates adjustment, 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 of 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, especially in net output — adjustment that cannot be neglected in studies of the dynamics of the US external balance.

References


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


Figure 1 Impulse Responses to the Permanent Shock.

Notes for Figure 1: The left panel reports the impulse responses setting $\alpha_c = 0$ and the right panel allowing $\alpha_c \neq 0$. In particular the figure shows the response of net output, nondurables and services consumption, gross assets and liabilities (in percentage terms), and the current account $CA_t$ (multiplied by 100 for comparison) 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 (1992)'s percentile intervals. The estimation sample covers the first quarter of 1973 to the fourth quarter of 2004.
Table 1: Estimates from a Cointegrated VAR(2)

Panel A: Cointegrated VAR

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>$\Delta c_{t-1}$</th>
<th>$\Delta z_{t-1}$</th>
<th>$\Delta a_{t-1}$</th>
<th>$\Delta l_{t-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[2.390]</td>
<td>[-1.965]</td>
<td>[-0.002]</td>
<td>[-0.887]</td>
</tr>
<tr>
<td>$t$-stat.</td>
<td>[1.237]</td>
<td>[-0.815]</td>
<td>[0.903]</td>
<td>[1.406]</td>
</tr>
<tr>
<td></td>
<td>[-0.003]</td>
<td>0.109</td>
<td>-0.064</td>
<td>-0.049</td>
</tr>
<tr>
<td>$t$-stat.</td>
<td>[0.129]</td>
<td>[-0.824]</td>
<td>[0.894]</td>
<td>[0.058]</td>
</tr>
<tr>
<td>$\beta_1'x_{t-1}$</td>
<td>0.018</td>
<td>0.291</td>
<td>0.246</td>
<td>0.316</td>
</tr>
<tr>
<td>$\beta_2'x_{t-1}$</td>
<td>[0.689]</td>
<td>[4.009]</td>
<td>[0.961]</td>
<td>[1.683]</td>
</tr>
<tr>
<td>$\beta_3'x_{t-1}$</td>
<td>[1.302]</td>
<td>[-1.500]</td>
<td>[-1.172]</td>
<td>[1.253]</td>
</tr>
<tr>
<td>$\delta$</td>
<td>0.011</td>
<td>0.104</td>
<td>-0.201</td>
<td>-0.080</td>
</tr>
<tr>
<td>$t$-stat.</td>
<td>[1.113]</td>
<td>[3.720]</td>
<td>[1.881]</td>
<td>[0.263]</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.081</td>
<td>0.190</td>
<td>0.028</td>
<td>0.026</td>
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</table>

Panel B: Cointegrating Relations and LR/W-tests

<table>
<thead>
<tr>
<th></th>
<th>$\beta_i$</th>
<th>$\theta_i$</th>
<th>$\theta_i$ with $\beta_i=1$</th>
<th>$\mathcal{W}(\nu)$</th>
<th>$\mathcal{LR}(\nu)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$c_t = \hat{\beta}_c z_t + \hat{\theta}_c t$</td>
<td>0.636</td>
<td>0.002</td>
<td>0.0004</td>
<td>39.802</td>
<td>6.714</td>
</tr>
<tr>
<td>[t-stats/p-value]</td>
<td>[11.036]</td>
<td>[8.143]</td>
<td>[1.881]</td>
<td>[0.263]</td>
<td>[0.066]</td>
</tr>
<tr>
<td>$a_t = \beta_a z_t + \theta_a t$</td>
<td>1.114</td>
<td>0.013</td>
<td>0.0135</td>
<td>0.045</td>
<td>0.095</td>
</tr>
<tr>
<td>[t-stats/p-value]</td>
<td>[2.091]</td>
<td>[6.174]</td>
<td>[44.705]</td>
<td>[0.944]</td>
<td>[0.825]</td>
</tr>
<tr>
<td>$l_t = \beta_l z_t + \theta_l t$</td>
<td>2.449</td>
<td>0.012</td>
<td>0.0178</td>
<td>13.900</td>
<td>1.910</td>
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<tr>
<td>[t-stats/p-value]</td>
<td>[6.301]</td>
<td>[7.803]</td>
<td>[76.756]</td>
<td>[0.227]</td>
<td>[0.368]</td>
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<tr>
<td>Joint Test</td>
<td>$\mathcal{W}(3) = 119.280$</td>
<td>$\mathcal{LR}(3) = 139.914$</td>
<td>[0.232]</td>
<td>[0.048]</td>
<td></td>
</tr>
</tbody>
</table>

Panel C: No Equilibrium Corrections Tests

<table>
<thead>
<tr>
<th>$H_0 : \alpha_c = 0$</th>
<th>$\mathcal{LR}(3) = 3.282$</th>
<th>[0.350]</th>
<th>$\mathcal{W}(3) = 3.325$</th>
<th>[0.344]</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0 : \alpha_z = 0$</td>
<td>$\mathcal{LR}(3) = 19.670$</td>
<td>[0.000]</td>
<td>$\mathcal{W}(3) = 21.289$</td>
<td>[0.000]</td>
</tr>
<tr>
<td>$H_0 : \alpha_a = 0$</td>
<td>$\mathcal{LR}(3) = 9.997$</td>
<td>[0.019]</td>
<td>$\mathcal{W}(3) = 10.404$</td>
<td>[0.015]</td>
</tr>
<tr>
<td>$H_0 : \alpha_l = 0$</td>
<td>$\mathcal{LR}(3) = 10.054$</td>
<td>[0.018]</td>
<td>$\mathcal{W}(3) = 10.466$</td>
<td>[0.014]</td>
</tr>
</tbody>
</table>

NOTES for Table 1: Panel A of the table reports the estimated coefficients from a cointegrated vector autoregressive (VAR) model of the column variable on the row variable; $t$-statistics are given in square brackets and for each equation the adjusted $R^2$ are reported. Estimated coefficients that are significant at the 10 percent level are highlighted in bold face. The terms $\hat{\beta}'x_{t-1}$ are the estimated equilibrium errors (cointegrating residuals) with the “symmetry” restriction imposed on the parameters. Panel B reports DOLS estimates of the cointegrating coefficients and their associated robust $t$-statistics, a series of Wald and Likelihood ratio tests and their associated bootstrap $p$-values, which examine the null hypothesis of “symmetric” cointegrating vectors. Panel C reports Likelihood ratio and Wald test of the null of no equilibrium correction ($\chi^2(3)$-distributed) and the associated asymptotic $p$-values. The sample spans the first quarter of 1973 to the fourth quarter of 2004.
Table 2: Forecast Error Variance Decomposition (Orthogonalized Shocks)

<table>
<thead>
<tr>
<th>$h$</th>
<th>$\Delta c_{t+h} - E_t \Delta c_{t+h}$</th>
<th>$\Delta z_{t+h} - E_t \Delta z_{t+h}$</th>
<th>$\Delta a_{t+h} - E_t \Delta a_{t+h}$</th>
<th>$\Delta l_{t+h} - E_t \Delta l_{t+h}$</th>
<th>$C a^<em>_{t+h} - E_t C a^</em>_{t+h}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\eta^P_t$</td>
<td>$\eta^T_t$</td>
<td>$\eta^P_t$</td>
<td>$\eta^T_t$</td>
<td>$\eta^P_t$</td>
</tr>
<tr>
<td>1</td>
<td>[1, 1]</td>
<td>[0, 0]</td>
<td>[0.130, 0.388]</td>
<td>[0.612, 0.870]</td>
<td>[0, 0.230]</td>
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<tr>
<td></td>
<td>0.998</td>
<td>0.003</td>
<td>0.299</td>
<td>0.701</td>
<td>0.154</td>
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<tr>
<td>4</td>
<td>0.997</td>
<td>0.003</td>
<td>0.459</td>
<td>0.541</td>
<td>0.187</td>
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<tr>
<td>8</td>
<td>0.996, 1</td>
<td>0.004</td>
<td>[0.274, 0.694]</td>
<td>[0.306, 0.726]</td>
<td>[0, 0.347]</td>
</tr>
<tr>
<td>40</td>
<td>0.999</td>
<td>0.001</td>
<td>0.850</td>
<td>0.150</td>
<td>0.297</td>
</tr>
<tr>
<td></td>
<td>[0.999, 1]</td>
<td>[0, 0.001]</td>
<td>[0.779, 0.999]</td>
<td>[0.001, 0.221]</td>
<td>[0.055, 0.483]</td>
</tr>
</tbody>
</table>

Panel A: Consumption Adjustment Coefficients set to Zero ($\alpha_c = 0$)

Panel B: Consumption Adjustment Coefficients set to their Estimated Values ($\alpha_c \neq 0$)

NOTES for Table 2: 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, $\eta^P_t$, and the transitory shocks, $\eta^T_t$. Horizons are in quarters, and the underlying VEqCM is of order 1. Panel A reports results using the restriction that the adjustment coefficients of consumption are statistically insignificant ($\alpha_c = 0$), while Panel B uses freely estimated adjustment coefficients of consumption ($\alpha_c \neq 0$). At each horizon the table shows the estimate of the fraction due to each type of shock, and the associated bootstrap confidence interval, in square brackets. The sample runs from the first quarter of 1973 to the fourth quarter of 2004.
Table 3: Variance Decomposition (Unorthogonalized Shocks) I: 1973-2004 with Linear Trends

<table>
<thead>
<tr>
<th></th>
<th>(\Delta c_{t+h} - E_t \Delta c_{t+h})</th>
<th>(\Delta z_{t+h} - E_t \Delta z_{t+h})</th>
<th>(\Delta a_{t+h} - E_t \Delta a_{t+h})</th>
<th>(\Delta l_{t+h} - E_t \Delta l_{t+h})</th>
<th>(CA_t^{*t+h} - E_t CA_t^{*t+h})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(\eta_t^P)</td>
<td>(\eta_t^T)</td>
<td>(\eta_t^P), (\eta_t^T)</td>
<td>(\eta_t^P)</td>
<td>(\eta_t^T)</td>
</tr>
<tr>
<td><strong>Panel A: Consumption Adjustment Coefficients set to Zero ((\alpha_c = 0))</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0.000</td>
<td>0.000</td>
<td>0.167</td>
<td>0.966</td>
</tr>
<tr>
<td>4</td>
<td>0.993</td>
<td>0.004</td>
<td>0.003</td>
<td>0.153</td>
<td>0.865</td>
</tr>
<tr>
<td>8</td>
<td>0.990</td>
<td>0.003</td>
<td>0.007</td>
<td>0.324</td>
<td>0.744</td>
</tr>
<tr>
<td>40</td>
<td>0.996</td>
<td>0.001</td>
<td>0.004</td>
<td>0.799</td>
<td>0.201</td>
</tr>
<tr>
<td><strong>Panel B: Consumption Adjustment Coefficients set to their Estimated Values ((\alpha_c \neq 0))</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1.237</td>
<td>0.737</td>
<td>-0.975</td>
<td>0.168</td>
<td>1.007</td>
</tr>
<tr>
<td>4</td>
<td>1.168</td>
<td>0.548</td>
<td>-0.715</td>
<td>0.158</td>
<td>0.965</td>
</tr>
<tr>
<td>8</td>
<td>1.116</td>
<td>0.370</td>
<td>-0.486</td>
<td>0.333</td>
<td>1.125</td>
</tr>
<tr>
<td>40</td>
<td>0.994</td>
<td>0.064</td>
<td>-0.058</td>
<td>0.808</td>
<td>0.320</td>
</tr>
</tbody>
</table>

**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, \(\eta_t^P\), the transitory shocks, \(\eta_t^T\), and two times the covariance between \(\eta_t^P\) and \(\eta_t^T\). Horizons are in quarters, and the underlying VEqCM is of order 1. See also notes for Table 2.

Table 4: Correlation of Growth Rates with Random Walk Components

<table>
<thead>
<tr>
<th>Variable</th>
<th>(\Delta c_t)</th>
<th>(\Delta z_t)</th>
<th>(\Delta a_t)</th>
<th>(\Delta l_t)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: Correlation of Growth Rates with Random Walk Components</strong></td>
<td>Correlation: (\alpha_c = \text{estimated})</td>
<td>Correlation: (\alpha_c = 0)</td>
<td>Correlation: (\alpha_c = \text{estimated})</td>
<td>Correlation: (\alpha_c = 0)</td>
</tr>
<tr>
<td>(\Delta c_t)</td>
<td>0.830</td>
<td>0.847</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\Delta z_t)</td>
<td>0.287</td>
<td>0.314</td>
<td>Corr(a_t^T, r_{a_t})</td>
<td>0.353</td>
</tr>
<tr>
<td>(\Delta a_t)</td>
<td>0.439</td>
<td>0.415</td>
<td>Corr(l_t^T, r_{l_t})</td>
<td>0.307</td>
</tr>
<tr>
<td>(\Delta l_t)</td>
<td>0.172</td>
<td>0.189</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES for Table 4:** Panel A reports the correlation of growth rates with the Beveridge-Nelson trends, while panel B reports the correlation of the Beveridge-Nelson cycles of gross positions, with a four quarter moving average of their respective returns. The sample period is the first quarter of 1973 to the fourth quarter of 2004.
Table 5: Long-Horizon Regressions

<table>
<thead>
<tr>
<th>Panel A: $\sum_{h=1}^{H} \Delta c_{t+h}$ regressed on $\Delta c_{t}, \Delta z_{t}, \Delta a_{t}, \Delta l_{t}, \tilde{CA}_{t}$</th>
<th>$\Delta c_{t}$</th>
<th>$\Delta z_{t}$</th>
<th>$\Delta a_{t}$</th>
<th>$\Delta l_{t}$</th>
<th>$\tilde{CA}_{t}$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.262</td>
<td>0.038</td>
<td>0.003</td>
<td>0.002</td>
<td>-0.022</td>
<td>0.080</td>
</tr>
<tr>
<td></td>
<td>[2.674]</td>
<td>[1.100]</td>
<td>[0.216]</td>
<td>[0.127]</td>
<td>[-0.838]</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.760</td>
<td>0.053</td>
<td>0.023</td>
<td>0.063</td>
<td>-0.106</td>
<td>0.080</td>
</tr>
<tr>
<td></td>
<td>[3.286]</td>
<td>[0.740]</td>
<td>[0.907]</td>
<td>[1.240]</td>
<td>[-1.078]</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1.022</td>
<td>-0.119</td>
<td>0.014</td>
<td>0.121</td>
<td>-0.106</td>
<td>0.080</td>
</tr>
<tr>
<td></td>
<td>[2.177]</td>
<td>[-0.882]</td>
<td>[0.297]</td>
<td>[1.382]</td>
<td>[-0.122]</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>-0.283</td>
<td>0.019</td>
<td>0.017</td>
<td>0.121</td>
<td>-0.022</td>
<td>0.080</td>
</tr>
<tr>
<td></td>
<td>[-0.637]</td>
<td>[0.106]</td>
<td>[1.008]</td>
<td>[2.762]</td>
<td>[-0.122]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: $\sum_{h=1}^{H} \Delta z_{t+h}$ regressed on $\Delta c_{t}, \Delta z_{t}, \Delta a_{t}, \Delta l_{t}, \tilde{CA}_{t}$</th>
<th>$\Delta c_{t}$</th>
<th>$\Delta z_{t}$</th>
<th>$\Delta a_{t}$</th>
<th>$\Delta l_{t}$</th>
<th>$\tilde{CA}_{t}$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.512</td>
<td>-0.084</td>
<td>0.081</td>
<td>-0.008</td>
<td>-0.264</td>
<td>0.155</td>
</tr>
<tr>
<td></td>
<td>[-1.841]</td>
<td>[-0.849]</td>
<td>[2.103]</td>
<td>[-0.151]</td>
<td>[-3.490]</td>
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</tr>
<tr>
<td>4</td>
<td>-0.212</td>
<td>-0.051</td>
<td>-0.078</td>
<td>0.227</td>
<td>-0.722</td>
<td>0.336</td>
</tr>
<tr>
<td></td>
<td>[-0.439]</td>
<td>[-0.483]</td>
<td>[-1.503]</td>
<td>[2.673]</td>
<td>[-5.150]</td>
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<tr>
<td>8</td>
<td>0.584</td>
<td>-0.246</td>
<td>0.008</td>
<td>0.121</td>
<td>-0.752</td>
<td>0.227</td>
</tr>
<tr>
<td></td>
<td>[1.105]</td>
<td>[-1.181]</td>
<td>[0.141]</td>
<td>[1.237]</td>
<td>[-3.138]</td>
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</tr>
<tr>
<td>12</td>
<td>1.113</td>
<td>-0.268</td>
<td>0.033</td>
<td>0.129</td>
<td>-0.977</td>
<td>0.200</td>
</tr>
<tr>
<td></td>
<td>[2.591]</td>
<td>[-1.671]</td>
<td>[0.425]</td>
<td>[1.533]</td>
<td>[-3.138]</td>
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</tr>
<tr>
<td>16</td>
<td>0.510</td>
<td>0.056</td>
<td>0.027</td>
<td>0.129</td>
<td>-0.977</td>
<td>0.200</td>
</tr>
<tr>
<td></td>
<td>[0.675]</td>
<td>[0.234]</td>
<td>[0.639]</td>
<td>[1.640]</td>
<td>[-1.964]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel C: $\sum_{h=1}^{H} \gamma_{t+h}$ regressed on $\Delta c_{t}, \Delta z_{t}, \Delta a_{t}, \Delta l_{t}, \tilde{CA}_{t}$</th>
<th>$\Delta c_{t}$</th>
<th>$\Delta z_{t}$</th>
<th>$\Delta a_{t}$</th>
<th>$\Delta l_{t}$</th>
<th>$\tilde{CA}_{t}$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.574</td>
<td>2.747</td>
<td>0.177</td>
<td>0.038</td>
<td>-2.283</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>[-1.029]</td>
<td>[1.744]</td>
<td>[0.287]</td>
<td>[0.044]</td>
<td>[-1.891]</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>6.880</td>
<td>3.825</td>
<td>0.782</td>
<td>-2.292</td>
<td>-8.930</td>
<td>0.128</td>
</tr>
<tr>
<td></td>
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<td>[2.477]</td>
<td>[0.770]</td>
<td>[-2.130]</td>
<td>[-4.256]</td>
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</tr>
<tr>
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<td>-1.016</td>
<td>-9.670</td>
<td>0.128</td>
</tr>
<tr>
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<td>[1.295]</td>
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<td>[-0.681]</td>
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</tr>
<tr>
<td>12</td>
<td>10.058</td>
<td>5.652</td>
<td>-0.911</td>
<td>-1.155</td>
<td>-10.363</td>
<td>0.078</td>
</tr>
<tr>
<td></td>
<td>[0.532]</td>
<td>[1.177]</td>
<td>[-0.582]</td>
<td>[-0.482]</td>
<td>[-1.259]</td>
<td></td>
</tr>
</tbody>
</table>

NOTES for Table 5: The table reports output from long-horizon regressions of consumption, net output, gross assets, gross liabilities and NFA portfolio returns on lags of the first four variables and the approximate expression for the current account: $\tilde{CA}_{t} = -(c_{t} - z_{t} - (\gamma z_{t} - \gamma c_{t})) + \rho_{a} (a_{t} - z_{t} - (\gamma z_{t} - \gamma a_{t})) + \rho_{l} (l_{t} - z_{t} - (\gamma z_{t} - \gamma l_{t})))$. The dependent variables in the $h$-period regressions are $\Delta w_{t+1} + \ldots + \Delta w_{t+h}$, where $w \in (c, z, r)$. For each regression, the table reports ordinary least squares (OLS) estimates of the regressors, autocorrelation robust $t$-statistics (using the Quadratic Spectral Kernel) in square brackets and adjusted $R^2$. Significant coefficients are highlighted in bold. The sample spans the first quarter of 1973 to the fourth quarter of 2004.