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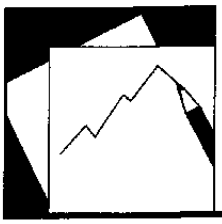

IMF Working Paper

The Role of Stock Markets in Current Account Dynamics: Evidence from the United States

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The Role of Stock Markets in Current Account Dynamics: Evidence from the United States

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Abstract

This paper tests a model of the role of stock markets in current account dynamics, developed in a companion paper[2]. With U.S. data, the model performs better than the same model without stock markets. An insight given by the model is that the current account might help predict future stock market performance. This property receives some preliminary empirical confirmation. The results also suggest that stock markets matter to the current account dynamics.

JEL Classification Numbers: F3; F32

Keywords: current account; stock markets; fundamental equation; U.S. data; forecasting

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[2] Mercereau (2003).

Contents

I. INTRODUCTION

How important is the stock market to the current account? Given the extraordinary development of financial markets during the last two decades, one would expect stock markets to play an important role in the dynamics of the current account. For example, the United States has experienced a large and unprecedented current account deficit in the late 1990s. Some have argued that it has been at least partially the result of the dramatic rise of the stock market during the same period. The current account has turned from a surplus of about $2 billion in 1980 to a deficit of about $410 billion in 2000. At the same time, holdings of equities by U.S. households have risen from $587 billion in 1980 to $8,593 billion in 2000 (see Figure 1). This paper tries to address empirically the following question: "How do holdings in equities of U.S. households and their returns affect the current account?" A formal framework is necessary to analyze the dynamics of the current account. What are the main models available in the literature?

The most popular model of the last twenty years is without doubt the so-called fundamental equation of the current account popularized by Sachs (1982).[3, 4] One of its main limitations, however, is that the model features a risk-free bond as the unique financial instrument. It is, therefore, inappropriate to study the impact of stock markets on the dynamics of the current account. The model developed in Mercereau (2003) incorporates stock markets into this traditional "Sachs model".[5] A closed-form solution for the current account is derived. This solution relates the current account to the present and expected future performance of the stock markets, as well as to the portfolio choices of households. The model thus provides a formal framework to study the dynamics of the current account and its relation to the stock market. The goal of my paper is to assess empirically whether adding these stock market elements into the fundamental equation of the current account better explains U.S. current account data.

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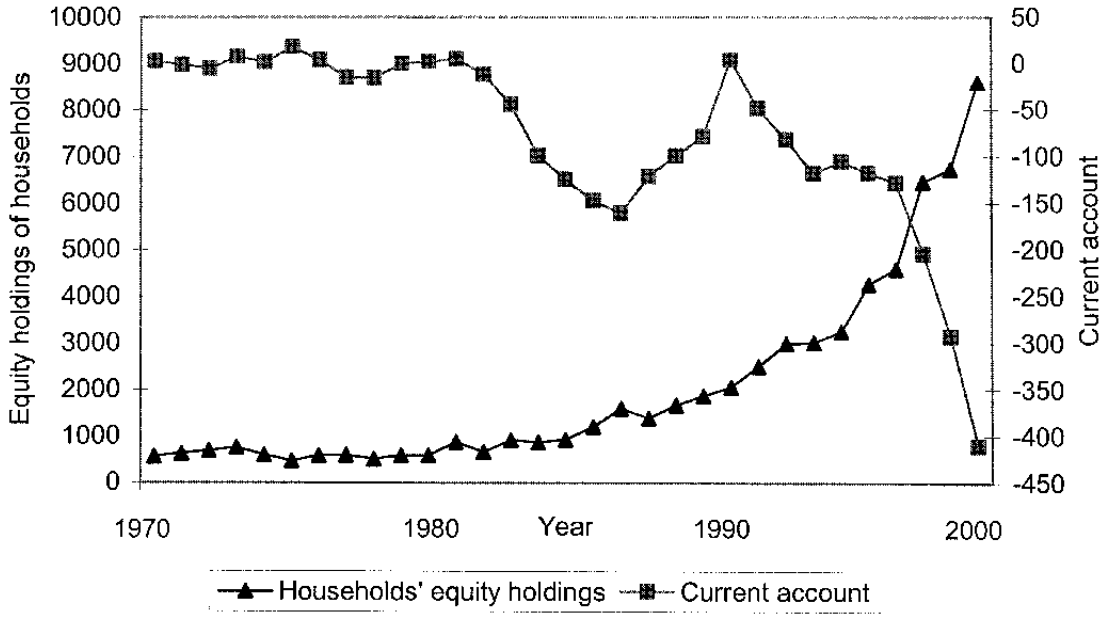
[3] For a survey of the literature on the topic, see Obstfeld and Rogoff (1995) or Obstfeld and Rogoff (1997, Chap. 2)). This model developed by Sachs has been tested for many countries. Empirical studies include work by Ghosh (1995), Sheffrin and Woo (1990), Otto (1992), Ghosh and Ostry (1995), Ostry (1997), Cashin and McDermott (1998), Agénor *et al.* (1999), Callen and Cahin (1999), Adedeji (2001), and Milo (2001).

[4] This simple model is based on consumption smoothing. A country's representative agent receives a stochastic endowment at each period. She will then borrow or lend at an international risk-free rate to maximize her expected intertemporal utility. A closed-form solution for the current account is then derived from the optimal consumption/saving choices of the agent.

[5] More precisely, the financial instruments now include an arbitrary number of risky assets (both foreign and domestic), which form an incomplete market, as well as a risk-free bond. The country's representative agent uses all the financial instruments at her disposal to maximize her expected intertemporal utility. A closed-form solution for the current account is then derived from her optimal portfolio and consumption/saving choices.

Figure 1. United States: Equity Holdings of Households and Current Account , 1970–2000
(in billions of U.S. dollars)



Sources: International Monetary Fund, Federal Reserve.

Before the results of the paper are presented, it should be mentioned that Kraay and Ventura have developed a very interesting portfolio approach to the current account in a recent series of articles.[6] This paper differs from their research in several ways. First, the models are different. In the basic model of Kraay and Ventura, the representative agent does not have income other than returns on her investments. Also, she has only one or two risky assets at her disposal. In my model, however, the representative agent receives a stochastic endowment in each period. She can also chose from many (both domestic and foreign) risky assets. Second, and more importantly, Kraay and Ventura's research focuses on testing the implications of the particular portfolio rule predicted by their model.[7] My empirical approach, however, is not to test a particular portfolio rule. It is to assess the implications for the current account of the portfolio choices of U.S. households and of the returns on this portfolio. I thus take the equity holdings of U.S. households in the data. Then, given these equity holdings, I test the predictions of my stock-market-augmented fundamental equation

[6] See, for example, Kraay and Ventura (2000), and Ventura (2001).

[7] This rule states that "investors allocate the marginal unit of wealth (the income shock) among assets in the same proportions as the average unit of wealth." As a consequence, "the current account response is equal to the saving generated by the shock multiplied by the country's share of foreign assets in total assets. This rule implies that favorable income shocks lead to current account deficits in debtor countries and current account surpluses in creditor countries." (Kraay and Ventura, 2000, p.1137).

of the current account. In other words, I try to assess whether the traditional intertemporal approach to the current account can be improved upon by adding stock market elements. I use U.S. quarterly and annual data for the period 1969:Q4, to 2000:Q2. I test the aforementioned stock-market-augmented fundamental equation of the current account. This model performs better than the "Sachs model"(i.e., the same model without stock markets). While the traditional model without stock markets is strongly rejected, the stock-market-augmented version is consistent with the data at an annual frequency. At a quarterly frequency, however, both models are rejected. Special attention is given to the construction of financial variables. The choice of the variables is carefully discussed, and many robustness checks are done.

One insight given by the model is that that the current account may help predict future stock market performance. This insight can be formally expressed by a set of Granger-causality and Granger-causal-priority propositions. Empirically, this is confirmed at a quarterly frequency.

Overall, these results suggest that stock markets matter to current account dynamics. The stock-market-augmented version of the traditional intertemporal approach to the current account also appears to be a reasonable framework to analyze current account developments, including their relation to the stock market.

The rest of the paper is organized as follows: Section II briefly summarizes the model of the role of stock markets in current account dynamics; Section III tests this model using U.S. data; and Section IV concludes the paper.

II. A Stock-Market-Augmented Fundamental Equation of the Current Account

As noted above, the goal of this paper is to empirically assess the stock-market-augmented "Sachs model" using U.S. data. Section III discusses the tests and the results. Before turning to them, this section first briefly summarizes this model[8]. The present-value model that I have developed shows that the stock market cause movements in the current account. The model allows an arbitrary number of risky assets, which form an incomplete market, as well as a risk-free bond. A closed-form solution for the current account is derived from the optimal portfolio and consumption/saving choices of a representative agent. It relates the current account to the present and expected future performance of the stock markets, as well as to the evolution of the structure of risk across markets and assets. Formally, the model can be seen as a stock-market-augmented version of the so-called fundamental equation of the current account popularized by Sachs (1982).

Let us now formally summarize the model.

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[8] For a comprehensive discussion of the model and its implications, see Mercereau (2003).

A. The Model

The basic mechanism of the model is a stock-market-augmented version of a consumption-smoothing story. A country's representative agent receives a stochastic endowment at each period. The agent will use all the financial instruments at her disposal to maximize her expected intertemporal utility. These financial instruments include an arbitrary number of risky assets (both foreign and domestic), which form an incomplete market, as well as a risk-free bond. A closed-form solution for the current account is then derived from the optimal portfolio and consumption/saving choices of the agent[9].

There is a single consumption good, which serves as a *numéraire*. As a consequence, all variables are expressed in units of this consumption good. Writing C as the vector of consumption levels and δ as the rate of time preference, the program of the agent is:

$$\underset{\{c_t;\omega_{0,t};\omega_t\}_{t=0}^{+\infty}}{\text{Max}} \; U(C) = E_0\left\{\sum_{t=0}^{+\infty}\delta^t u(c_t)\right\},$$

under the budget constraints BC_t :

$$c_t + \omega_{0,t} + \sum_{j=1}^{J}\omega_{j,t} = NI_t + R_0\omega_{0,t-1} + \sum_{j=1}^{J}R_{j,t}\omega_{j,t-1}$$

(and we have the initial conditions: $\omega_{0,-1} = \omega_{j,-1} = 0$)

And a sufficient condition of transversality is:

$$\lim_{s\to+\infty} E_t\left(\frac{1}{1+r}\right)^s\left[\omega_{0,t+s} + \sum_{j=1}^{J}\omega_{j,t+s}\right] \le 0.$$

Let us briefly define the variables used above (Appendix IV summarizes the notation):

- NI_t ("net income") is a stochastic endowment received in each period by the representative agent. This is all the income she receives in period t, with the exception of the revenues from her past financial investments.
- $R_{j,t}$ is the gross rate of return of asset j at time t. There are J stocks available on the world stock markets. They are exogenously given, and they form an incomplete market[10]. They can be either domestic or foreign stocks. Each

[9] The framework of the Sachs model is the same, except that the model featured a unique financial instrument: a risk-free bond.

[10] In the model, to have incomplete markets simply means that the agent's endowment stream cannot be duplicated, and thus cannot be perfectly hedged, with any combination of the available assets.

risky asset $j=1,\ldots,J$ pays a stochastic dividend $d_{j,t}$ at time t, and has a market price $P_{j,t}$. $R_{j,t}$ is thus formally defined by: $R_{j,t} = \frac{d_{j,t} + P_{j,t}}{P_{j,t-1}}$.

- $\omega_{j,t}$ is the holdings of risky asset j at time t (like all other variables, it is expressed in units of the *numéraire* good).
- $R_0 = 1 + r$ is the constant international risk-free rate, at which all agents can lend or borrow. This international interest rate is assumed to be constant over time and exogenously given[11].
- $\omega_{0,t}$ is the holdings of risk-free asset at time t.

In order to facilitate the derivation of the results, I need to make a few assumptions:

- The agent has an exponential utility function: $u(c) = \frac{-1}{A}\exp(-Ac)$, where A is the coefficient of absolute risk aversion.
- Net income NI_t and the gross returns have a joint normal distribution (its moments can be time varying).[12]

B. Expression of the Current Account

The full solution of the model, as well as the proofs, are given in Appendix III. I use this solution to derive a closed-form solution for the current account. In order to do this, I first recall that, by definition, the current account is the change in the net foreign position of a country[13]. I then use the expression found for the optimal portfolio of the representative agent. This gives us the following expression for the current account (I call this solution the global current account (GCA) for reasons that will become clear momentarily):

[11] Consequently, I assume a perfectly elastic supply (or demand) from foreigners for bonds. The risk-free rate can be made time-varying at the cost of additional notational complexity.

[12] The model is thus a partial equilibrium one, in which economic developments in other countries do not explicitly affect the current account. In another paper (Mercereau, 2002), I develop a general equilibrium version of the model, in which risky asset prices are determined endogenously.

[13] A perfectly equivalent way to define the current account is as the sum of the trade balance plus all returns on net foreign assets (interest payments, capital gains, and dividends).

Proposition 1[14]. Stock-market-augmented fundamental equation of the current account.

$$GCA_t = \underbrace{\left(NI_t - E_t\left(NI_t^*\right)\right)}_{\text{(1) endowment income effect}} + \underbrace{\left(X_t'\omega_{t-1} - E_t\left[\left(X_t'\omega_{t-1}\right)^*\right]\right)}_{\text{(2) stock market effect}}$$

$$+ \underbrace{\frac{1}{r.A}Ln\left[\delta.(1+r)\right]}_{\text{(3) consumption tilting}} + \underbrace{\frac{A}{2}\sum_{i=1}^{+\infty}\frac{1}{(1+r)^i}\text{var}_t\, c_{t+i}}_{\text{(4) precautionary savings}} - \underbrace{(e_t - e_{t-1})}_{\text{(5) assets stock change}},$$

where:

- X_t is the Jx1 vector of excess returns: $X_t = \left[R_{j,t} - R_0\right]_{j=1}^{J}$.
- $\omega_{t-1} = \left(\omega_{j,t-1}\right)_{j=1}^{J}$ is the Jx1 portfolio of risky assets of the representative agent at time *t-1*.
- e_t is the total per capita valuation of all financial assets located in the home country of the representative agent (note that this is independent from the citizenship of the shareholders: an asset located in a given country can be entirely owned by foreigners) . Risky assets are indeed in positive supply. There are ϕ_j shares of asset j. The total market valuation of asset j is $S_{j,t} = P_{j,t} \times \phi_j$. The total per capita valuation of all financial assets located in the home country of the representative agent is then formally defined by: $e_t = \sum_{j \in \left\{\begin{smallmatrix}\text{home country's}\\ \text{stocks}\end{smallmatrix}\right\}} S_{j,t}$.
- For any variable Z_t, Z_t^* is the "(future) **permanent level**" of the variable, which is defined so as to satisfy the following equation:

$$\sum_{i=0}^{+\infty}\frac{1}{(1+r)^i}Z_{t+i} = Z_t^*\sum_{i=0}^{+\infty}\frac{1}{(1+r)^i}$$

$$\text{(it follows that } \quad Z_t^* = \frac{r}{1+r}\sum_{i=0}^{+\infty}\frac{1}{(1+r)^i}Z_{t+i}\text{).}$$

- Primed variables denote the transpose of the corresponding vector (e.g., Z' is the transpose of vector Z).
- $E_t(Z)$ denotes the expected value of variable Z as of time t.

The above proposition stresses the three components of the current account. Terms (1) and (2) constitute the consumption-smoothing component of the current account. Term (3) is the

[14] The proof is given in Appendix III.

consumption-tilting component; term (4) the precautionary savings one; and term (5) represents the change in the stock of assets.

The traditional (i.e., stock-market-free) fundamental equation of the current account first derived by Sachs (1982) did not include terms (2) and (5), which are, therefore, new here. The fundamental equation of the current account has been very popular (for a survey of the literature on the topic, see Obstfeld and Rogoff (1995) or Obstfeld and Rogoff (1997, Chap. 2)). Its analysis, both theoretical and empirical, has focused mainly on the main current account component, the consumption-smoothing one. While terms (3) and (4) are also interesting by themselves, I will also follow this literature and focus on the consumption-smoothing component of the current account. For accounting reasons, the change in the domestic stock market valuation term must also be included in the analysis. This term is also necessary for a comprehensive study of the role of stock markets.

Let us therefore turn to the **consumption-smoothing and change-in-domestic-stock-market-valuation components of the current account**[15]. They will be written as *CA*. In the remainder of the paper, "current account" will refer to these two components of the current account:

$$CA_t = \underbrace{\left(NI_t - E_t\left(NI_t^*\right)\right)}_{\text{(1) endowment income effect}} + \underbrace{\left(X_t'\omega_{t-1} - E_t\left[\left(X_t'\omega_{t-1}\right)^*\right]\right)}_{\text{(2) stock market effect}} - \underbrace{(e_t - e_{t-1})}_{\text{(3) assets stock change}} .$$

Interpretation

Term (1) is what Sachs's traditional fundamental equation of the current account is mostly made of. Its interpretation is as follows: when the consumers' endowment income is higher than its expected future permanent level, the representative agent will save more in order to smooth her consumption. Ceteris paribus, the country's net stock of foreign assets will, therefore, increase, and the country will run a current account surplus. Following this line of reasoning, a current account deficit is nothing to be concerned about as long as it reflects expectations of future rises in the country's net output.

But term (2) suggests that a policymaker using such reasoning could well miss the point and reach inappropriate conclusions about the health of the current account level. Indeed, one also has to take into account the role of future stock market performance. The intuition behind this second effect is fairly simple: if the agents expect the stock market to do better in the future than it does today, they will borrow money in order to smooth consumption --and the country will run a current account deficit. In other (more precise) terms, if today's excess financial gains are smaller than their expected future permanent level, consumption smoothing will lead the country to run a current account deficit. Note that what matters is not the total amount of financial gains, as one might have expected, but only the share of it in excess of what the same investment made in a risk-free bond would have yielded (hence the

[15] For a discussion of the other components, see Mercereau (2003).

term "excess financial gains"). The reason for this is that all the welfare gains one can realize by using a risk-free bond to smooth intertemporal consumption are already incorporated in term (1). The extra welfare gains achieved through the stock markets should, therefore, include only the gains one could not have achieved using a risk-free bond. This is what is expressed by term (2).

The third term in the equation is the change of stocks in domestic risky assets (i.e., the change in the valuation of the domestic stock market). This term is unrelated to the behavior of the agent. It arises only because of the accounting definition of the current account. Indeed, terms (1) and (2) described the change in desired total asset holding by the representative agent. But the current account is not the change in desired total asset holding by the representative agent: the current account is, by definition, the change in net foreign assets of the country. To go from the former to the latter, one has to subtract the change in the total amount of assets located in the country. An example should help explain this point. Let us suppose that the representative agent finds it optimal to raise her total holding of assets by $10 billion, but that at the same time the valuation of the stock market increases by $15 billions. Let us first assume that the domestic stock market was entirely owned by domestic agents before the stock market boom. It is true that the total holding of assets of the agent will rise by $10 billion. But the representative agent will nevertheless sell $5 billion worth of shares (the difference between the $15 billion increase in the value of her portfolio and the $10 extra billion she decides to save). By construction, these share have to be bought by foreigners. The net effect for the country will, therefore, be a $5 billion transfer of domestic assets to foreigners, which is to say that the country will run a $5 billion current account deficit.

If, alternatively, the assets located in the home country were entirely owned by foreigners before the boom, then the $15 billion rise in domestic stock market valuation corresponds to a $15 billion decrease in the net foreign position of the home country. But the domestic agents also want to increase their holding of assets by $10 billion. This translates into a change of +$10 billion in the net foreign position of the country. So finally, the total change in the net foreign position of the country (and thus, the current account) will be +10-15=-5 billion dollars. This example makes clear how the initial degree of foreign ownership of stocks affects the *CA* impact of asset value changes.

To conclude, term (3) underscores the importance of domestic stocks as a saving instrument: when domestic stock markets rise, the total amount of domestic assets available for savings purposes also rises. As a consequence, an increase in the savings rate does not necessarily lead to a current account surplus.

This simple equation allows us to address a wide range of issues related to the role of stock markets in current account dynamics. They are extensively discussed in Mercereau (2003). One insight of the model, though non essential, will nevertheless be useful for my empirical analysis. This insight is that the current account may help predict future stock market performance and/or future endowment streams. The reason is that the current account is derived from the optimal portfolio and consumption/savings choices of the agents. As a consequence, the current account should both incorporate and reflect all the relevant

information agents have about future stock market performance and future endowment -- including the pieces of information that are not observed by econometricians. This forecasting property can be formally expressed by a set of Granger causality and Granger causal priority propositions. Since it is a well-known fact that stock market performance is very difficult to predict, one should take the above proposition with caution. I will, nevertheless, try to discuss why this property may be less surprising than it seems.

As a beginning, one should realize that in any asset-pricing model where agents are risk-averse, agents have to expect that stocks will yield higher returns than the risk-free rate (i.e., "excess returns") in order to decide to hold stocks. If there is no such risk premium to compensate people for the risk they take by holding risky securities, agents would never choose to purchase these risky assets. That agents expect excess financial gains on their risky security investment is, therefore, a necessary condition for holdings of risky assets to exist.[16] This point is of course not easy to reconcile with a random walk view of the stock market. Two steps can nevertheless be made in this direction.

The first one is that the information used by consumers to make their decisions may not be available to the traders on Wall Street (something which seems reasonable). If this is the case, then it would be possible that the current account is informative about future stock market performance without having this imply that some arbitrage opportunity has not been exploited by traders. The second one is that while arbitrage may lead to a random walk behavior of the stock markets in the short run, there may nevertheless be predictable medium-run or long run trends in the stock market movements. The model is precisely about these longer-term trends.

Second, it is interesting to notice that this property of the model that the current account may help forecast future changes in equity premium gains is in the same spirit of an argument recently made by Lettau and Ludvigson (2001). In this paper, they argue that the ratio of consumption to wealth should help forecast stock returns because it incorporates people's expectations about them. They make their point in a fairly general formal model. They then show empirically that their consumption to wealth ratio is not only significant but also the best single predictor of future stock returns. The insight given by my model can be seen as a generalization of their argument to the national open economy.

To conclude, I have developed a present-value model in which the stock markets cause movements in the current account. I can now put the model to the test using U.S. data. The methodology and the results are presented in the next section.

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[16] Determinants of these expected excess returns are discussed in the general equilibrium version of the model in Mercereau (2002). They include demographic variables, variance and covariance of dividend processes, risk aversion, etc... Since these parameters are non-stochastic but time-varying, expected excess-returns will fluctuate in a predictable way at lower frequencies.

III. Role of Stock Markets in the Dynamics of the Current Account: An Empirical Assessment

In this section, I test the stock-market-augmented equation of the current account presented in section II, using U.S. data. Some aspects of the model receive empirical confirmation. The model performs better than the traditional Sachs model without stock markets. While the Sachs model is strongly rejected, the stock-market-augmented version is consistent with the data at an annual frequency. At a quarterly frequency, though, both models are rejected. As we saw, one insight provided by the model is that that the current account may help predict future stock market performance. This relationship can be formally expressed by a set of Granger causality and Granger causal priority propositions. Empirically, this is confirmed at a quarterly frequency. The results are robust to a large number of checks.

This section will be divided in three subsections. I first explain the way the tests are done. I then discuss in detail the data used. Finally, I present the results.

A. Description of the Tests

Formal test of the model

In order to run a formal test of the model, I first need to rewrite the equation for the current account in the following way:

Proposition 2. The stock-market-augmented equation of the current account can be rewritten as $\left(CA_t + \Delta e_t\right) = -\sum_{i=1}^{+\infty}\left(\frac{1}{1+r}\right)^i\left[E_t\left(\Delta\left\{NI_{t+i} + X'_{t+i}\omega_{t+i-1}\right\}\right)\right]$.
(In this equation Δ denotes the first-difference operator.)[17]

In order to run the test, I construct the following:
$H_t \equiv \left(CA_t + \Delta e_t\right) - (1+r)\left(CA_{t-1} + \Delta e_{t-1}\right) - \Delta NI_t - \Delta\left(X'_t\omega_{t-1}\right)$.

The model then predicts that $E_{t-1}(H_t / I_{t-1}) = 0$ [18], where I_{t-1} is the information set at *t-1* containing all current and lagged values of the variables of the model. The test of the model is therefore done by regressing H_t on the variables included in I_{t-1} with the appropriate

[17] The proof of this proposition is given in Appendix III.

[18] The proof of this point is straightforward. One first replaces $\left(CA_t + \Delta e_t\right)$ and $\left(CA_{t-1} + \Delta e_{t-1}\right)$ by their expression in proposition 2. Taking the expectation of H_t at t-1 and rearranging the terms then leads to the result.

number of lags. The formal test is then a simple F-test on the joint nullity of the coefficients of all the regressors. Formally, I run the following regression:

$H_t = \sum_{i=1}^{L}\left[\alpha_i\left(CA_{t-i} + \Delta e_{t-i}\right) + \beta_i \Delta NI_{t-i} + \gamma_i X'_{t-i}\,\omega_{t-i-1}\right] + \varepsilon_t$, where ε_t is a well-behaved error term and L the number of lags. I then test the following null hypothesis:
$\alpha_1 = ... = \alpha_L = \beta_1 = ... = \beta_L = \gamma_1 = ... = \gamma_L = 0$.

Note that the risk-free rate r is to be chosen by us. I thus do the test with several values of r in order to check the robustness of the results.

Following the insights recently arrived at in the consumption and asset-pricing literature, it is arguable whether the right test of the model with quarterly data should actually be $E_{t-1}(H_t / I_{t-2}) = 0$ rather than $E_{t-1}(H_t / I_{t-1}) = 0$. There are several reasons for this. For one, many scholars have argued that agents do not respond instantaneously to changes in asset prices and that their consumption adjusts with a lag. This can happen, for example, because of non convex adjustment costs, as Grossman and Laroque (1990) show. Several recent papers (see, e.g., Lynch(1996) and Marshall and Parekh (1999)) adapt this approach and have shown that delayed adjustments can help solve the equity premium puzzle. In another paper, Gabaix and Laibson (2000) analyze a different delayed adjustment model. They reach the conclusion that delayed adjustment can fully explain the relationship between consumption and asset prices (in other words, it fully solves the Mehra-Prescott puzzle). Using a different approach, Sims (2001) shows that adjustment can be delayed when people have limited capacity for processing information. So if it is indeed the case that agents adjust their consumption to their financial gains with a lag, then the right test of the model should be $E_{t-1}(H_t / I_{t-2}) = 0$.

A different line of argument is that of Campbell (1987) in a model without stocks: he argues that $E_{t-1}(H_t / I_{t-2}) = 0$ is the appropriate test to run anyway when there is transitory consumption.

I therefore run the test for both the I_{t-1} and I_{t-2} the information sets, expecting the model to perform better with the I_{t-2} set.

Granger tests

In order to test for Granger causality and Granger causal priority, I first need to put the variables of Proposition 2 in a VAR form. Formally, the vector we use is

$V_t = \begin{bmatrix} (CA_t + \Delta e_t) \\ \Delta NI_t \\ \Delta(X'_t \omega_{t-1}) \end{bmatrix}$ [19] or $V_t = \begin{bmatrix} CA_t \\ \Delta e_t \\ \Delta NI_t \\ \Delta(X'_t \omega_{t-1}) \end{bmatrix}$ [20]. We then estimate the following L^{th} order autoregression equation: $V_t = \Phi_1 V_{t-1} + \Phi_2 V_{t-2} + ... + \Phi_L V_{t-L} + \varepsilon_t$, where ε_t is a normally distributed error term. The Granger causality and Granger causal priority tests are run in the standard way by testing the joint nullity of the relevant coefficients of the companion matrix of the VAR.

Number of lags

Another issue is the number of lags to be included in both the *H-test* regression and the VAR used to run the Granger tests. This number can be determined by using the Akaike information criterion for the VAR. Since it is a well known fact that information criteria do an imperfect job of picking up the right number of lags, I also run the tests with other numbers of lags as a robustness check.

A last step of data preparation is required before doing the test. The theory would predict that the mean of $(CA_t + \Delta e_t)$ is approximately equal to $-1/r$ times the mean of the sum of first differences of net output and excess financial gains. Although the sign is correct in my data, it turns out that one would need an unrealistically high interest rate to have this relationship hold. This is a well-known feature of the consumption literature, and I will follow Campbell (1987) and the rest of the consumption literature in my handling of it. As clearly summarized by Sheffrin and Woo (1990, pp. 246-47) in the case of the current account:

> «Essentially, the prediction [on the means] rests heavily on the representative individual assumption in which all trends in net output will be fully internalized by the country. It would not allow a country to have a persistent current account surplus in the sample with an upward trend in net output. Similar restrictions fail to hold in studies of consumption in which aggregate savings are positive in the presence of an upward trend in labor income. As has been recognized in the consumption literature, aggregate positive savings can exist with trends in labor income when there is technical progress and younger generations are thereby born with a higher level of permanent income. Following Campbell, I allow for this possibility by removing the means from the current account and from the first difference of net output [and in our case also of financial gains] for the remainder of the analysis. I thus test only the dynamic restrictions of the theory, which has been standard practice in the consumption literature.»

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[19] This is the vector used to test propositions A2Bis, A3 and A4 presented in Appendix I.

[20] This is the vector used to test proposition A2 presented in Appendix I.

A secondary reason for doing so is that removing the mean should also remove the consumption-tilting and the precautionary savings elements of the current account (see stock-market-augmented fundamental of the CA), the latter being constant under the assumption that var(c_t) is constant over time[21].

B. Data

The data are described in Appendix II. I use U.S. data for the period 1969, Q4 to 2000, Q2. The empirical definition of stock market valuation is particularly tricky. I offer two ways to define it, one based on household data, the other one based on stock market index data. The tests are run for both definitions in order to check for robustness. In the tables, the corresponding results are labeled "household based" and "index based," respectively.

C. Results

The formal tests of the model led to a strong confirmation of the model with annual data, while the traditional Sachs model performed poorly. With quarterly data, though, both my model and the Sachs one are rejected. The results are robust to all the robustness checks previously mentioned.

We will also see that our Granger causality propositions are confirmed for quarterly data. These preliminary results suggest that the current account may help predict future stock market performance. The Granger results are more mixed with annual data, which suggests that the current account contains more information about higher frequency stock market performances than about lower-frequency ones.

Let us now look at these results in greater detail. For quarterly data, the corrected Akaike information criterion selected a VAR(1) for the Sachs model (we thus used two lags in order to be able to run the test with the I_{t-2} information set). A VAR(5) (or sometimes VAR(9), depending on the specifications) was found for the stock-market-augmented equation. I therefore ran the test for all these lag specifications.

For annual data, the Akaike criterion picked a VAR(2) for most of the specifications (3 lags being sometimes chosen), and I therefore ran the tests with two and three lags.
The tests are reported for an annual interest rate r=4 percent and a quarterly rate r=1 percent[22].

H-test

For each of the specification, several tests were run. For the model with stocks (our model), I did two sets of tests. One with $CA_t + \Delta e_t$ and $\Delta(NI_t + X'_t\omega_{t-1})$ (i.e. the **sum** of the first

[21] This point is proved in Mercereau (2002).
[22] Robustness checks were conducted for an annual rate varying between 2.5 percent and 16 percent.

difference in net output and in excess financial gains) as regressors --this is referred to as the "combined" specification in the tables. The second was done with $CA_t + \Delta e_t$ and the two variables ΔNI_t and $\Delta(X'_t\omega_{t-1})$ taken separately --this specification is referred to as "split" in the tables. The advantage of the former specification is that it has the same number of regressors as the model **without** stocks, and it therefore allows more direct comparisons between the two models (to put it simply, statistical differences between the two could not be due to the fact that I estimated a different number of parameters). The advantage of the latter specification is that the variables, taken separately, should incorporate more information than their sum does. It is, therefore, a more powerful test of the model.

Results are reported in Tables 1 and 2[23].

Table 1. United States: Formal Test of the Model, 1970–2000 (annual data).

	With Stocks, Household Based		With Stocks, Index Based		Without Stocks (Sachs Model)
2 lags	Combined	Split	Combined	Split	
I_{t-1}	<	<	0.5471	0.5830	<
I_{t-2}	0.6074	0.6882	0.9230	0.9826	0.1063
3 lags					
I_{t-1}	<	<	0.2784	0.2754	<
I_{t-2}	0.1394	0.3574	0.7795	0.7765	0.0526

Note: "<" means <0.01 (i.e. one percent significance).

[23] It should be noted that, strictly speaking, the test was formally conducted from a likelihood perspective. A classical approach would run into the issue created by the possible existence of a unit root. If CA has a unit root, this does not change the fact that H_t is by construction, under the null, stationary, and indeed serially uncorrelated. But some of the right-hand-side (RHS) variables might include unit-roots. The full set of coefficients of RHS variables, when tested as a group, generates an F-statistics whose asymptotic sampling distribution under the null is not the standard F-distribution. From a likelihood perspective, things are much simpler. Under Gaussian assumptions on the residuals, the likelihood's shape is itself Gaussian, regardless of whether unit roots are present, and the F-test does not need special interpretation when unit roots are present.

Table 2. United States: Formal Test of the Model, 1970–2000 (quarterly data).

	With Stocks, Household Based		With Stocks, Index Based		Without Stocks (Sachs Model)
2 lags	Combined	Split	Combined	Split	
I_{t-1}	<	<	<	<	<
I_{t-2}	0.2098	0.3531	<	<	<
5 lags					
I_{t-1}	<	<	<	<	<
I_{t-2}	<	<	<	<	0.0346
9 lags					
I_{t-1}	0.0747	<	0.0733	<	<
I_{t-2}	0.1141	<	0.0487	<	

Note: "<" means <0.01 (i.e. one percent significance).

With annual data, both models with and without stocks were usually rejected at the 1 percent level for most specifications (except in the "index based" specification, in which the stock-market augmented equation of the current account cannot be rejected at the 25 percent level of confidence). This was to be expected if people's consumption adjusted with a lag, as had been argued before. On the other hand, with the slightly weaker (but arguably more sensible) test that allowed for delayed adjustment, the model without stocks was rejected at the 5 or 10 percent level of confidence, while the same model with stocks (our model) could not be rejected at a very high level of confidence. The results are robust to all the checks mentioned previously.

With quarterly data, both the Sachs model and my stock-market-augmented one were rejected, except for a few specifications. This suggests that the stock-market-augmented equation of the current account captures well the long-run determinants of *CA*, but that it misses part of the action for quarterly data.

Granger tests

The Granger tests include the following questions:

- Does the *CA* directly "Granger cause" first difference in either excess financial gains or net income? (See proposition 2 in Appendix I). This is tested by running a VAR with four variables: *CA, Δf, ΔNI* and Δe, and by performing the

appropriate joint nullity test on the companion matrix coefficients. This is referred to as "CA_t" ("Financial gains" and ΔNI respectively) in the tables.

- Does ($CA + \Delta e$) Granger cause first differences in either excess financial gains or net income? And is ($CA + \Delta e$) Granger causal prior to $\{\Delta f, \Delta NI\}$? (See propositions 2Bis and 3 in Appendix I). This is referred to as "$CA_t + \Delta e_t$, split" ("Financial gains", ΔNI, and GCP, respectively) in the tables.
- Does ($CA + \Delta e$) Granger cause first difference in the sum of excess financial gains and net income? (See proposition 4 in Appendix I). This is referred to as "$CA_t + \Delta e_t$, combined" in the tables.

The results are reported in Tables 3 and 4. As we can see, most of these propositions receive empirical confirmation with quarterly data[24]. In particular, the current account Granger causes future financial gains, which confirms one of the suggestions of the model: because it incorporates (and, therefore, reflects) all the information and expectations agents have about future stock market performances, the current account may help forecast the latter. Although encouraging, these results should be taken with caution. It is a well-known fact that stock market performance is difficult to predict. Nevertheless, the model allows us to say that, if it were possible to partially forecast future stock market performance, then the current account would be a reasonable candidate (for a more complete discussion of the issue, see Mercereau (2003)). Also, Granger causality tests cannot make an especially strong statement about the forecasting power of a variable. Therefore, more work is needed to explore empirically the relevance of the current account as a predictor of future stock market performance.

Finally, results for yearly data are more mixed. The null of non-Granger causality is rejected at the 10% level of confidence in only half of the tests run. How is it consistent with the non-rejection of the model at an annual frequency when I run the *H-test*? The answer probably resides in the limited number of (yearly) observations, which produces noisy estimates. As a result of these large standard errors, it is difficult to accept the null hypothesis that some coefficients are different from zero. This probably contributes to the non-rejection of the null of non-Granger causality in some instances. The results are therefore not inconsistent with the formal (*H*-)test of the model. It is also possible to argue, of course, that this non-rejection of the model at an annual frequency is partially the result of noisy estimates as well. As mentioned previously, the null hypothesis of the H-test is that a set of coefficients is equal to zero. As a consequence, the same problem could potentially arise. However, given the number of robustness checks conducted and the consistency with which the model could not be rejected, this eventuality does not seem very likely.

As a conclusion, the model with stock markets receives stronger confirmation with yearly data than the traditional model without stock markets. The role of the current account as a predictor of future stock market performance also receives some preliminary confirmation. However, because of the statistical issues mentioned above, the results still need to be taken with some caution. To further explore this issue would be a worthy goal for future research.

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[24] The results are robust to all robustness checks mentioned. A few results using the wider definition of equity holdings are slightly different in the case of a VAR(9), however.

Table 3. United States: Granger Tests, 1970–2000 (model with stocks; quarterly data).

	CA_t		$CA_t + \Delta e_t$, Combined	$CA_t + \Delta e_t$, Split		
	Financial Gains	ΔNI_t		GCP	Financial Gains	ΔNI_t
VAR(2)						
Household based	0.0159	<	<	<	<	0.8530
Index based	0.011	<	<	<	<	0.5670
VAR(5)						
Household based	0.0577	0.0247	<	<	<	0.0668
Index based	0.0806	0.0965	<	<	<	0.1876
VAR(9)						
Household based	0.0544	0.0325	0.0432	0.1357	0.0682	0.3792
Index based	0.3609	0.2228	<	<	<	0.2872

Note: "<" means <0.01 (i.e. one percent significance).

Table 4. United States: Granger Tests, 1970–2000 (model with stocks; annual data).

	CA_t		$CA_t + \Delta e_t$, combined	$CA_t + \Delta e_t$, split		
	Financial Gains	ΔNI_t		GCP	Financial Gains	ΔNI_t
VAR(2)						
Household based	0.3328	<	0.0449	0.823	0.0301	0.4375
Index based	0.4889	0.0255	0.6481	0.4129	0.8148	0.1737
VAR(3)						
Household based	0.0832	<	<	<	<	0.3949
Index based	<	<	0.3660	0.0657	0.1151	0.1781

Note: "<" means <0.01 (i.e. one percent significance).

IV. Conclusion

This paper tests a model of the role of stock markets in current account dynamics, which was developed in Mercereau (2003). The model performs somewhat better than the same model without stock markets (the so-called fundamental equation of the current account popularized by Sachs). An insight provided by the model is that the current account may help predict future stock market performance. This hypothesis also receives preliminary empirical

confirmation. These results suggest that stock markets matter to current account dynamics. The results are encouraging, as there has been very little academic work done, theoretical or empirical, on the role of stock market in the dynamics of the current account.
To explore this issue further would be a worthy goal for future research.

Appendix I. Granger Propositions

In this Appendix, the formal Granger causality and Granger causal priority propositions are given. A discussion of them, as well as their proof, can be found in Mercereau(2003).
As a beginning, it is useful to rewrite the stock-market-augmented equation of the current account in the following way. However, before doing so, and for the sake of notational simplicity, I will rewrite $f_t = X'_t . \omega_{t-1}$ **the excess financial gains** at time t.

Proposition A1. The stock-market-augmented equation of the current account can be rewritten as:

$$CA_t + \Delta e_t = -\sum_{i=1}^{+\infty}\left(\frac{1}{1+r}\right)^i \left[E_t\left(\Delta NI_{t+i}\right)\right] - \sum_{i=1}^{+\infty}\left(\frac{1}{1+r}\right)^i \left[E_t\left(\Delta f_{t+i}\right)\right] . \quad \textbf{(A1)}$$

(In this equation Δ denotes the first difference operator)

Proposition A2 (multivariate Granger causality). If equation (A1) holds, then CA_t Granger-causes *at least one of* (Δf_t and ΔNI_t), except in the very special case where CA_t is a linear combination of present and past ΔNI_t, Δf_t and Δe_t.

Proposition A2Bis (multivariate Granger causality). If equation (A1) holds, then $(CA_t + \Delta e_t)$ Granger-causes *at least one of* (Δf_t and ΔNI_t), except in the very special case where $(CA_t + \Delta e_t)$ is a linear combination of present and past ΔNI_t and Δf_t .

Proposition A3 (Granger causal priority[25]). If equation (A1) holds, then $\{\Delta f_t, \Delta NI_t\}$ is not Granger Causally Prior to $(CA_t + \Delta e_t)$, except in the very special case where $(CA_t + \Delta e_t)$ is a linear combination of present and past ΔNI_t and Δf_t.

Proposition A4 (bivariate Granger causality). If we have equation (A1), then $(CA_t + \Delta e_t)$ Granger causes $\Delta(NI_t + f_t)$, except in the very special case where $(CA_t + \Delta e_t)$ is a linear combination of present and past $\Delta(NI_t + f_t)$.

[25] For a brief and very clear presentation of the concepts of Granger causal priority and multivariate Granger causality, see Sims (1999).

Appendix II. Data

In this section, I will describe the U.S. data used. I do the tests for both quarterly and annual data. The data covers the period 1969:Q4 to 2000:Q2.

Economic data and definition of the current account

The source of economic data is the IMF's *International Financial Statistics* and is extracted using Data Resources International (DRI).

I construct the current account using its accounting definition:

$$CA_t = GNP_t - C_t - G_t - I_t.$$

This is what many people have done in the literature. It is, however, not obvious that this method is the best way to construct the current account. This is actually an imperfect way to define it conceptually speaking. Indeed, it does not take into account the capital gains on international holdings (foreign assets owned by domestic agents and domestic assets owned by foreigners). These capital gains are made through capital gains in the local currency and/or capital gains due to exchange rate fluctuations. There are, unfortunately, little data available on these gains[26]. I will therefore follow the rest of the literature and use the traditional definition of the current account in spite of its weaknesses.

This issue may actually not matter that much in the case of the United States. Indeed, U.S. households own few foreign stocks, and the effects of potential capital gains on foreign equities are, therefore, likely to be negligible for them. And as far as the capital gains of the foreigners are concerned, the consumers should in any case not be affected by fluctuations in the value of U.S. shares owned by foreigners. So the traditional definition of the current account should, in the end, be a reasonably good proxy for our purposes in the case of the United States.

I construct Net output: $NO_t = GDP_t - I_t - G_t$[27] where I is investment, G government spending.

In doing so, I follow the rest of the literature on the fundamental equation of the current account (for a survey, see Obstfeld and Rogoff 1995 and 1997). I assume that investment and taxes are exogenously given. I also assume that the government balances its budget every

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[26] The IMF has started gathering such data (see *IMF Balance of Payments Manuel, 5th ed.*). The data are already available for some countries, but the time span is often short and quarterly data are often not available (for example, for the United States, the only available data are yearly, from 1980 to 2000).

[27] Corresponding IMF variables (and numbers) are as follows: *GNP*: gross national income (99a.c); *G*: government consumption and investment (91ff.c); *I*: sum of private gross fixed capital formation (93 eec) and increase/decrease in stocks (93i.c); *C*: private consumption (96f.c), and *GDP*: gross domestic product (99b.c). All variables are seasonally adjusted. Quarterly variables are shown at annual rates.

period and that the utility function of the agent is separable in the consumption good and in the service provided by the government. As a consequence, the money left to the agent to decide her consumption of goods after lump-sum taxes have been paid to the government and investment has been financed is: *GDP-G-I*. This is the stochastic endowment of the agent.

In the case of a model with stock markets, the same reasoning applies. The only difference is that one now has to subtract the total amount of dividends paid by domestic companies in order to avoid double counting (the dividends are already included in the gross returns on the stocks hold by consumers). This gives us net income: $NI_t = GDP_t - I_t - G_t - D_t$, where I is investment, G government spending, and D[28] the total amount of dividends paid by domestic companies.

In order to express variables in real terms, I divide them by the GDP deflator (defined as the ratio of GDP at current prices to GDP at 1996 prices). I also divide the variables by the country's population in order to express them in per capita terms.[29]

Households' risky assets holdings

The construction of financial variables is a bit trickier. For the households' portfolio holdings I use data from the Federal Reserve (Table B.100: "Balance Sheet of Households and Nonprofit Organizations").

When constructing the household's portfolio holdings (variable ω_t), I have to choose which variables to include in the equity holdings of households. There are several ways a consumer can hold stocks. The more obvious one is by direct purchase of equities. But she can also hold stocks by purchasing mutual fund shares. Also, savings put in life insurance or pension fund programs can be invested in shares. It is not clear how much the latter two influence current savings decisions. For example, although there are some constraints on using the money put in a life insurance plan, one can borrow against it. The same is true of pension plans. Moreover, there is evidence from behavioral economics that people's investment in their pension plans does not perfectly follow the predictions of a fully rational agent's model. Finally, about the mutual funds shares, there is a data issue: the variable given by the Federal Reserve is a "value based on the market value of equities held and the book value of other assets held by mutual funds." The fact that part of the variable reflects assets taken at book value rather than at market value makes imprecise the evaluation of households' wealth held through mutual funds. And, consequently, so will be the evaluation of gains on these holdings.

To deal with all these issues, I construct two different variables. The first includes only the corporate equity holdings of the households. This is a narrow definition of their total equity holdings, but it has the advantage of being a neat one, for it does not suffer from any of the

[28] The way I actually construct D_t is discussed later.

[29] Corresponding IMF variables: *GDP* in chained 1996 dollars (99b.r); population (99z).

flaws mentioned above. The second one includes all the forms of equity holdings mentioned above: it is the sum of corporate equities, mutual fund shares, life insurance reserves and pension fund reserves[30]. This aggregate combines all the weaknesses mentioned above, but it has the advantage of incorporating a broader range of the assets owned by households. In the empirical study, I do the test with both variables to check the robustness of my results. The results presented in the tables are the ones using the more restrictive definition of equity holdings. As reported, the results are usually robust to the definition of equity holdings used.[31]

More generally, it is important to note that the model could be applied to **any** risky assets, not only stocks. I chose to limit myself to stocks for two reasons. The first one is that the available data are richer, notably when it comes to assessing the returns on the assets (it is not so easy to assess the returns on houses, for example). And the second is that stocks are more liquid than most other assets, and that they therefore fit better the model of an agent optimizing her portfolio every period. To apply the model to a wider range of assets would be an interesting extension, which I leave for future research.

Financial data

Stock returns are taken from Morgan Stanley indices[32]. The indices I use measure total returns on U.S. stocks (returns that include both dividends and capital gains), as well net returns (returns not including dividends payments). I use these two returns to compute the total amount of dividends paid to households: $D_t = \left(R_t - \widetilde{R}_t\right)\omega_t^h$, where ω_t^h is the amount of domestic stocks owned by domestic agents, R_t is the gross return on stocks, and $\widetilde{R}_t$ is the net return on stocks[33]. Note that by doing so I neglect the dividends paid to foreigners (empirically they represent about 10 percent of the dividends paid to U.S. households; a robustness check would be to define the total dividends paid as a multiple, say 1.1, of the dividends paid to households. Given the small magnitude of dividends paid, this is likely not to affect the results).

The most difficult part is to define the total amount of domestic stocks available to the agents, e_t. There are two main issues associated with this.

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[30] This is what Ludvigson and Steindel (1999) use as a definition of households' equity holdings.

[31] This test of the model is consistent with limited participation in the risky assets market. Indeed, the only thing that matters is the total amount of risky assets held by domestic households, and that it is therefore not necessary to know or to assess the participation rate to do the empirical work.

[32] Extracted from DRI (variable ND@USA). The Morgan Stanley Capital International indices are also available from Morgan Stanley's website.

[33] Formally, $R_t = \frac{P_t + d_t}{P_{t-1}}$ and $\widetilde{R}_t = \frac{P_t - P_{t-1}}{P_{t-1}}$, where P_t is the stock index and d_t the dividend at time t.

At first glance, the natural choice for e_t would be the total valuation of the U.S. stock markets. The trouble is that such a variable is not, to my knowledge, available. What we do have is the valuation of very broad indices, such as the Datastream global index (which covers about 1000 stocks). Provided that these indices reflect the whole stock market well (and they probably do), they provide a good idea of how the total valuation of the market fluctuates. However, they do not tell us what this valuation is --in other words, we would like to know what percentage of the market valuation these indices represent.

Now, even if we knew the total market valuation, we would face another, subtler problem. What matters to us is the total stock of domestic stocks available to the U.S. consumers. But not all of existing stocks are available to U.S. consumers in the market. A share of them is detained by U.S. (or foreign) corporations through cross-ownerships, and those are not available to U.S. consumers for consumption smoothing. How much of the market is "locked" in cross-ownership is unclear, and even if we knew the total valuation of U.S. stock markets, it would be difficult to assess the amount of U.S. risky assets potentially available to U.S. consumers at any time.

These issues make the choice of e_t delicate. I chose two ways to estimate it.

One is to assume that e_t is a constant multiple k of the valuation of the broadest U.S. Datastream index[34]. What multiple should I use? One way to do this is to assume, as seems not unreasonable, that U.S. households have been constrained at least once in the last 30 years, in the sense that they purchased all the stocks available to them. I therefore looked at the ratio of the index value to households' equity holdings. Its average was about 1.2, with a maximum of 1.8. Following our previous line of reasoning, one would conclude that about the amount of stocks available at any time to U.S. households is roughly 1.8 times the value of the Datastream index. This, of course, is not a fully satisfactory way to define it[35]. I, therefore, did several robustness checks with values of the multiple varying between 1 and 2[36]. The results I report are for k=1.8. I will report any time the results are not robust to variations of k. **They are labeled "index based" in the tables.**

The second way I estimated e_t was to assume that U.S. household always owned a constant share of the total amount of assets available to them. One way to justify this is to use the rule of thumb suggested by Kraay and Ventura (2000) in their papers: agents invest their marginal unit of wealth as their average one. So if one assumes, for convenience, that all companies controlled by the agent grow at the same rate as the stock markets, the agent will always own

[34] This index is available only from 1973 on. This reduces the studied time span by three years when I use it.

[35] For example, following this line of reasoning, all the stocks that are available to U.S. households but not purchased by them must be purchased by foreigners. But the difference between 1.8 times the index value and the U.S. households' holdings leads to implausibly large holdings of U.S. shares by foreigners. This can of course be explained by the fact that the amount of stocks available to households is actually not a constant multiple of the index valuation over time.

[36] Values less than one would not make sense for U.S. data, given that at some periods the total amount of stocks owned by U.S. households is more than the valuation of the index.

a constant share of her domestic market valuation. Another, easier way to justify this is to say that as there is no good way to assess the amount of domestic stocks available to domestic agents at each period, a multiple of their current holdings is not a priori a worse proxy than a multiple of an arbitrary index valuation. This, therefore, constitutes a useful robustness check.

What multiple to choose? As mentioned before, most of the assets that are available to U.S. households but are not bought by them, should be purchased by foreigners. It could, therefore, be the sum of U.S. households' holdings and U.S. stocks owned by foreigners (if one neglects foreign cross-ownerships of U.S. stocks). As discussed above, the latter variable is unfortunately not available, except at annual rate and for the most recent years only[37]. We, therefore, cannot use it directly, but we can use it to assess the magnitude of U.S. shares owned by foreigners. It turns out that the value foreign-owned U.S. shares is equal to about 10-14 percent (depending on the definition of equities we use[38]) of the total amount of shares owned by American households. I therefore chose a multiple k' between 1 and 1.2. The results are reported for k'=1.1 (again, I will mention when the results are not robust to changes in k'). **The results are labeled "households based" in the tables.**

To conclude, one should also keep in mind that stocks is only one kind of the risky assets owned by agents, and that the definition of e_t is actually even more complex. One should, therefore, proceed with some caution when interpreting the results.

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[37] Available from the IMF's *International Financial Statistics*: variable B8660 (extracted using DRI).

[38] As before, I did the whole study using two definitions of equity holdings by U.S. households: the definition with equities only; and the broader definition à la Ludvigson-Steindel, which includes life insurance and mutual funds.

Appendix III. Proofs

Solution of the model

The program of the agent is the following:

$$\underset{\{c_t;\omega_{0,t};\omega_t\}_{t=0}^{+\infty}}{\text{Max}} \; U(C) = E_0\left\{\sum_{t=0}^{T}\delta^t u(c_t)\right\},$$

under the budget constraints $\mathbf{BC}_t$:

$$c_t + \omega_{0,t} + \sum_{j=1}^{J}\omega_{j,t} = NI_t + R_0\omega_{0,t-1} + \sum_{j=1}^{J}R_{j,t}\omega_{j,t-1}$$

(and we have the initial conditions: $\omega_{0,-1} = \omega_{j,-1} = 0$).

I can rewrite this program as:

$$\underset{\{\omega_{0,t};\omega_t\}_{t=0}^{+\infty}}{\text{Max}} \; U(C) = E_0\left\{\sum_{t=0}^{T}\delta^t u(NI_t + R_0\omega_{0,t-1} + \sum_{j=1}^{J}R_{j,t}\omega_{j,t-1} - \omega_{0,t} - \sum_{j=1}^{J}\omega_{j,t})\right\}.$$

Let us write the Euler equations:

$$\frac{\partial}{\partial\omega_{0,t}}: \quad \mathrm{E}_t\left\{-\mathrm{u}'(c_t) + \delta(1+r)u'(c_{t+1})\right\} = 0 \qquad \text{equation (A1)}$$

$$\frac{\partial}{\partial\omega_{j,t}}: \quad \mathrm{E}_t\left\{-\mathrm{u}'(c_t) + \delta R_{j,t+1}u'(c_{t+1})\right\} = 0 \qquad \text{equation (A2)}$$

As a beginning, let us rewrite this system of equations.

I can rewrite (A1) as: $\exp(-Ac_t) = \delta(1+r)E_t\left[\exp(-Ac_{t+1})\right]$.

Because all shocks are normally distributed by assumption, the budget constraint implies that consumption is normally distributed as well. I, therefore, have:

$$\exp(-Ac_t) = \delta(1+r)\exp\left[-AE_t(c_{t+1}) + \frac{A^2}{2}\mathrm{var}_t(c_{t+1})\right],$$

which leads to: $E_t(c_{t+1}) = c_t + \frac{A}{2}\mathrm{var}_t(c_{t+1}) + \ln\left[\delta(1+r)\right]$. equation (A3)

On the other hand, differencing (A1) and (A2) leads to:

$E_t\left[(1+r)u'(c_{t+1})\right] = E_t\left[R_{j,t+1}u'(c_{t+1})\right]$, which is equivalent to:

$E_t(X_{j,t+1})E_t\left[u'(c_{t+1})\right] + \mathrm{cov}_t\left[X_{j,t+1};u'(c_{t+1})\right] = 0$.

Since the variables are normally distributed, I can use Stein's lemma:
$\mathrm{cov}_t\left[X_{j,t+1};u'(c_{t+1})\right] = E_t\left[u''(c_{t+1})\right]\mathrm{cov}_t\left(X_{j,t+1};c_{t+1}\right)$.

Using the fact that I have an exponential utility function, this can be rearranged in:
$E_t\left(X_{j,t+1}\right) = A\,\mathrm{cov}_t\left[R_{j,t+1};c_{t+1}\right]$ equation (A4)

I will now use (A3) and (A4) to solve the model. The strategy is as follows: equation (A4) will give the risky portfolio holding expression, while the other equations will give the other variables as function of the portfolio holding. I will use a "guess and verify" method on the portfolio holding: I will "guess" its expression, then solve for all other variables as a function of portfolio holding. And finally, I will verify that equation (A4) and the expressions found for the other variables indeed result in the guessed risky portfolio allocation.

The guess for the portfolio of risky assets is: $\omega_t = \underbrace{\frac{1+r}{rA}\Sigma_{t+1}^{-1}E_tX_{t+1}}_{\text{risk premium exploitation}} - \underbrace{\Sigma_{t+1}^{-1}\beta_{t+1}}_{\text{risk hedging}}$,

where $\Sigma_t = \left[\mathrm{cov}_{t-1}(R_{i,t};R_{j,t})\right]_{i,j=1\ldots J}$ is the JxJ variance-covariance matrix of asset returns,

and $\beta_t = \left[\mathrm{cov}_{t-1}\left(NI_t,R_{j,t}\right)\right]_{j=1,\ldots,J}$ is the Jx1 matrix of covariance between net income and asset returns. Both β_t and Σ_t are exogenous in the model. They can vary over time, however.

Let us first find the expression of consumption. The consumption is found by solving the budget constraint ("BC") forward and using equation (A3): I take the sum $BC_t + E_t\sum_{i=1}^{T}\frac{1}{(1+r)^i}BC_{t+i}$ and use the fact that $E_t\left[c_{t+i+1}\right] = E_t\left[E_{t+i}\left(c_{t+i+1}\right)\right]$. Since I have assumed that the first and second moments of our exogenous random variables are bounded, each element of ω_t will be bounded, and so will be $X_{t+i}'\omega_{t+i-1}$ for all i. $\mathrm{var}_t\left(c_{t+1}\right)$ will also be bounded.

As a consequence, the series $\sum_{i=1}^{T}\frac{1}{(1+r)^i}E_t\left(X_{t+i}'\omega_{t+i-1}\right)$ and $\sum_{i=1}^{T}\frac{1}{(1+r)^i}\mathrm{var}_t\,c_{t+i}$, respectively, converge when $T\to+\infty$.

Solving forward the budget constraint will, after some straightforward algebra, leads to:[39]

[39] I also assume that $\sum_{i=0}^{+\infty}\frac{1}{(1+r)^i}E_t(NI_{t+i})$ exists, which is a natural assumption. If the sum did not converge, it would mean that the present discounted value of the agent's labor income is infinite. She would then have no intertemporal budget constraint and she would be free to consume as much as she wishes.

$$c_t = \frac{r}{1+r}\left\{ \underbrace{\sum_{i=0}^{+\infty} \frac{1}{(1+r)^i} E_t(NI_{t+i})}_{\text{(1) labor income wealth}} + \underbrace{R_0 \omega_{0,t-1} + R'_t \omega_{t-1}}_{\text{(2) current financial income}} + \underbrace{\sum_{i=1}^{+\infty} \frac{1}{(1+r)^i} E_t\left(X'_{t+i} \omega_{t+i-1}\right)}_{\text{(3) future fincial excess gains}} \right.$$
$$\left. - \underbrace{\frac{1}{r.A} Ln\left[\delta.(1+r)\right]}_{\text{(4) consumption tilting}} - \underbrace{\frac{A}{2} \sum_{i=1}^{+\infty} \frac{1}{(1+r)^i} \text{var}_t\, c_{t+i}}_{\text{(5) precautionary savings}} \right\}.$$

Let us now turn to the expression of risk-free asset holding $\omega_{0,t}$. Plugging the budget constraint at time t into equation (A3) leads to the following recursive relation:

$\omega_{0,t} = \omega_{0,t-1} + z_t$,

$$\text{with } z_t = NI_t + R_t' \omega_{t-1} - \sum_{j=1}^{J} \omega_{j,t} - \frac{r}{1+r}\left\{ \sum_{i=0}^{+\infty} \frac{1}{(1+r)^i} E_t(NI_{t+i}) + R'_t \omega_{t-1} + \sum_{i=1}^{+\infty} \frac{1}{(1+r)^i} E_t\left(X'_{t+i} \omega_{t+i-1}\right) \right\}$$

$$+ \frac{1}{r.A} Ln\left[\delta.(1+r)\right] + \frac{A}{2} \sum_{i=1}^{+\infty} \frac{1}{(1+r)^i} \text{var}_t\, c_{t+i}$$

I can now verify our guess. Using the expression I found for consumption in equation (A4) leads to:

$$E_t\left(X_{j,t+1}\right) = \frac{Ar}{1+r} \text{cov}_t\left[R_{j,t+1}; NI_{t+1} + \sum_{i=1}^{J} R_{i,t+1} \omega_{i,t} \right] \quad \forall j = 1,\ldots,J.$$

This can be rewritten in matrix form as: $\frac{Ar}{1+r}\left[\Sigma_{t+1} \omega_t + \beta_{t+1}\right] = E_t X_{t+1}$,

or $\omega_t = \underbrace{\frac{1+r}{rA} \Sigma_{t+1}^{-1} E_t X_{t+1}}_{\text{risk premium exploitation}} - \underbrace{\Sigma_{t+1}^{-1} \beta_{t+1}}_{\text{risk hedging}}$, which was our initial guess.

Transversality condition (TVC)

I also have to check that the TVC is satisfied. A sufficient condition for the TVC to be satisfied is: $\lim_{s \to +\infty} E_t\left(\frac{1}{1+r}\right)^s \left[\omega_{0,t+s} + \sum_{j=1}^{J} \omega_{j,t+s} \right] \leq 0$.

We saw that because the first and second moments of the exogenous stochastic variables are bounded $\sum_{j=1}^{J} \omega_{j,t+s}$ is bounded as well, and, therefore, $\lim_{s \to +\infty} E_t\left[\left(\frac{1}{1+r}\right)^s \sum_{j=1}^{J} \omega_{j,t+s} \right] = 0$.

We also have $\omega_{0,t+s} = \sum_{i=0}^{t+s} z_i$,

$$\text{with } z_t = NI_t + R_t'\omega_{t-1} - \sum_{j=1}^{J}\omega_{j,t} - \frac{r}{1+r}\left\{\sum_{i=0}^{+\infty}\frac{1}{(1+r)^i}E_t(NI_{t+i}) + R'_t\,\omega_{t-1} + \sum_{i=1}^{+\infty}\frac{1}{(1+r)^i}E_t\left(X'_{t+i}\omega_{t+i-1}\right)\right\}$$

$$+\frac{1}{r.A}Ln\left[\delta.(1+r)\right] + \frac{A}{2}\sum_{i=1}^{+\infty}\frac{1}{(1+r)^i}\text{var}_t\, c_{t+i}$$

From the boundedness of the variables, which has been previously discussed, it is possible to derive that there exists a constant K such that:

$$\left| R_t'\omega_{t-1} - \sum_{j=1}^{J}\omega_{j,t} - \frac{r}{1+r}\left\{R'_t\,\omega_{t-1} + \sum_{i=1}^{+\infty}\frac{1}{(1+r)^i}E_t\left(X'_{t+i}\omega_{t+i-1}\right)\right\}\right.$$

$$\left. +\frac{1}{r.A}Ln\left[\delta.(1+r)\right] + \frac{A}{2}\sum_{i=1}^{+\infty}\frac{1}{(1+r)^i}\text{var}_t\, c_{t+i}\right| \le K$$

Writing x_t the variable between the absolute value sign above, I then have:

$$\lim_{s\to+\infty} E_t\left(\frac{1}{1+r}\right)^s \sum_{i=1}^{t+s} x_i = 0\,.$$

So all I have left to show in order to verify that the TVC is satisfied is that :

$$\lim_{s\to+\infty} E_t\left[\left(\frac{1}{1+r}\right)^s \sum_{k=0}^{t+s}\left(NI_k - \frac{r}{1+r}\left\{\sum_{i=0}^{+\infty}\frac{1}{(1+r)^i}E_k(NI_{k+i})\right\}\right)\right] \le 0 \qquad \text{inequality (A5)}$$

Let us define $Z_{t+s} \equiv \left(\frac{1}{1+r}\right)^{t+s}\sum_{k=0}^{t+s} NI_k$. I will show that $\lim_{s\to+\infty} E_t Z_{t+s} = 0$.

I will do the proof in the sub case where t+s is an even number. The other sub case where t+s is odd is then straightforward. Posit $t+s \equiv 2n$, with $n \in \mathbb{N}$. We have the following:

$$E_t Z_{t+s} = \left(\frac{1}{1+r}\right)^{2n} E_t\left(\sum_{k=0}^{n} NI_k + \sum_{k=n}^{2n} NI_k\right).$$

$$E_t Z_{t+s} \le \left(\frac{1}{1+r}\right)^{n}\sum_{k=0}^{n}\left(\frac{1}{1+r}\right)^{n} E_t NI_k + \sum_{k=n}^{2n}\left(\frac{1}{1+r}\right)^{2n} E_t NI_k \text{ , which leads to:}$$

$$E_t Z_{t+s} \le \left(\frac{1}{1+r}\right)^{n}\sum_{k=0}^{n}\left(\frac{1}{1+r}\right)^{k} E_t NI_k + \sum_{k=n}^{2n}\left(\frac{1}{1+r}\right)^{k} E_t NI_k\,.$$

By assumption, $\sum_{k=0}^{n}\left(\frac{1}{1+r}\right)^{k} E_t NI_k$ converges. Therefore,

$$\left(\frac{1}{1+r}\right)^{n}\left[\sum_{k=0}^{n}\left(\frac{1}{1+r}\right)^{k} E_t NI_k\right] \to 0 \text{ when } n \to +\infty\,.$$

Moreover, $\sum_{k=n}^{2n}\left(\frac{1}{1+r}\right)^{k} E_t \mathrm{NI}_k \to 0$ when $n \to +\infty$ as part of the residual of a converging positive series. Hence, $\lim_{s\to+\infty} E_t Z_{t+s} = 0$.

This result implies that inequality (A5) is necessarily verified. Indeed, all the other terms on the LHS are negative. I, therefore, have finally proved that the TVC is verified.

No-Ponzi-Game condition

What would be a no-Ponzi-game condition for this problem? One way to think about it would be to say that the total amount of money foreigners are willing to lend to the domestic economy should not grow faster than the total stock of risky assets in the economy:

$$\lim_{s\to+\infty} E_t\left(\frac{1}{1+r}\right)^{s}\left[\omega_{0,t+s} + \sum_{j=1}^{J}\omega_{j,t+s}\right] \geq \lim_{s\to+\infty} E_t\left[\left(\frac{1}{1+r}\right)^{s} e_{t+s}\right].$$

More assumptions should be made on the model to check formally that such a condition is verified, but these new conditions would be very weak. Indeed, it is sufficient to assume, for example, that the net income follows an exponential growth path whose rate is below the risk-free rate[40], and it is possible to show that $\lim_{s\to+\infty} E_t\left(\frac{1}{1+r}\right)^{s}\left[\omega_{0,t+s} + \sum_{j=1}^{J}\omega_{j,t+s}\right] = 0$, so that the No-Ponzi-game condition is satisfied.

Proof of proposition 1. Stock market-augmented fundamental equation of the current account.

By definition, the current account is the change in net foreign assets:
$GCA_t = \omega_{0,t} + 1'\omega_t^{h,f} - 1'\omega_t^{f,h} - \left(\omega_{0,t-1} + 1'\omega_{t-1}^{h,f} - 1'\omega_{t-1}^{f,h}\right)$, where $\omega_t^{h,f}$ is the vector of foreign assets owned by domestic ("home") agents, and $\omega_t^{f,h}$ is the vector of domestic assets owned by foreign agents.

Using the fact that $\sum_{j=1}^{J}\omega_{j,t} = e_t - 1'\omega_t^{f,h} + 1'\omega_t^{h,f}$, the GCA can be rewritten as:

$$GCA_t = \omega_{0,t} + \sum_{j=1}^{J}\omega_{j,t} - \left(\omega_{0,t-1} + \sum_{j=1}^{J}\omega_{j,t-1}\right) - \left(e_t - e_{t-1}\right).$$

Using the recursive relation found above for the risk-free asset holding yields:

[40] Again, if this rate were higher, the present discounted value of the country's endowment income would be infinite. The country's representative agent would then be able to consume as much as she wanted at each period, for she would not face any intertemporal budget constraint. So the required conditions are weak indeed.

$$GCA_t = \sum_{j=1}^{J}\omega_{j,t} - \sum_{j=1}^{J}\omega_{j,t-1} + NI_t + R_t'\omega_{t-1} - \sum_{j=1}^{J}\omega_{j,t}$$

$$-\frac{r}{1+r}\left\{\sum_{i=0}^{+\infty}\frac{1}{(1+r)^i}E_t(NI_{t+i}) + R'_t\,\omega_{t-1} + \sum_{i=1}^{+\infty}\frac{1}{(1+r)^i}E_t\left(X'_{t+i}\omega_{t+i-1}\right)\right\}.$$

$$+\frac{1}{r.A}Ln\left[\delta.(1+r)\right] + \frac{A}{2}\sum_{i=1}^{+\infty}\frac{1}{(1+r)^i}\mathrm{var}_t\, c_{t+i} - \left(e_t - e_{t-1}\right)$$

Using the definition of the "future permanent level" operator

$\left(\sum_{i=0}^{+\infty}\frac{1}{(1+r)^i}Z_{t+i} = \sum_{i=0}^{+\infty}\frac{1}{(1+r)^i}Z_t^*\right)$ and rearranging the terms gives:

$$GCA_t = \underbrace{\left(NI_t - E_t NI_t^*\right)}_{\text{(1) labor income effect}} + \underbrace{\left(X_t'\omega_{t-1} - E_t\left[\left(X_t'\omega_{t-1}\right)^*\right]\right)}_{\text{(2) stock market effect}}$$

$$+ \underbrace{\frac{1}{r.A}Ln\left[\delta.(1+r)\right]}_{\text{(3) consumption tilting}} + \underbrace{\frac{A}{2}\sum_{i=1}^{+\infty}\frac{1}{(1+r)^i}\mathrm{var}_t\, c_{t+i}}_{\text{(4) precautionary savings}} - (e_t - e_{t-1})$$

Finally, note that var(c) can also be expressed as a function of the exogenous parameters:

$$\mathrm{var}(c_t) = \left(\frac{r}{1+r}\right)^2 \underbrace{(\Psi_t)^2\left[\mathrm{var}(\eta_t) - \beta_t'\Sigma_t^{-1}\beta_t\right]}_{\text{undiversifiable part of idiosyncratic risk}} + \underbrace{\frac{1}{A^2}EX_t'\Sigma_t^{-1}EX_t}_{\text{premium exploitation risk}}$$

where η_t is the innovation of net output, Ψ_t is the present value multiplier of the innovation on net output, Σ_t^{-1} is the variance-covariance matrix of the assets returns, β_t the vector of covariance of the asset returns with NI_t.

Proof of proposition 2.

To prove proposition 2, one should start with writing down the RHS of the equation to prove: $RHS \equiv -\sum_{i=1}^{+\infty}\left(\frac{1}{1+r}\right)^i\left[E_t\left(\Delta NI_{t+i}\right)\right] - \sum_{i=1}^{+\infty}\left(\frac{1}{1+r}\right)^i\left[E_t\left(\Delta f_{t+i}\right)\right]$.

Then all one has to do is to split each sum into two sums (recall that both series $\sum_{i=1}^{T}\frac{1}{(1+r)^i}E_t\left(f_{t+i-1}\right)$ and $\sum_{i=1}^{T}\frac{1}{(1+r)^i}NI_{t+i}$ converge when $T \to +\infty$). Simplifying term-by-term and rearranging then yields the stock-market-augmented equation of the current account.

Appendix IV. Summary of Main Notation

Description	Notation	Dimension
Net income	$NI_t = Y_t - I_t - G_t - D_t$	1x1
Total amount of dividends distributed by domestic companies	D_t	1x1
Risk-free interest rate	$R_0 = 1 + r$	1x1
Dividends paid by company *j*	$d_{j,t}$	1x1
Price of stock *j*	$P_{j,t}$	1x1
Gross returns	$\boldsymbol{R_t}$	*J*x1
Gross return of stock *j*	$R_{j,t} = \frac{d_{j,t} + P_{j,t}}{P_{j,t-1}}$	1x1
Excess returns	X_t	Jx1
Excess return of stock *j*	$X_{j,t} = \left(R_{j,t} - R_0\right)$	1x1
Risk free asset holding	$\boldsymbol{\omega_{0,t}}$	1x1
Risky asset holding by domestic agent	$\omega_t = \left(\omega_{j,t}\right)_{j=1}^{J}$	*J*x1
Total endowment of risky assets in the domestic economy (=stock market valuation)	e_t	1x1
Excess financial gains	$\boldsymbol{f_t} = X'_t . \omega_{t-1}$	1x1
Trade balance	$TB_t \equiv Y_t - C_t - I_t - G_t$	1x1
Rate of time preference	δ	1x1
Coefficient of absolute risk aversion	A	1x1

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