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Abstract: Foreign flows have an economically large and statistically significant impact on long-term interest rates. Controlling for various macroeconomic factors we estimate that had there been no foreign flows into U.S. bonds over the past year, the 10-year Treasury yield would currently be 150 basis points higher; even a step-down to average inflows would imply an increase of 105 basis points. The impact of the headline-making foreign official flows—a relatively small subset of total foreign accumulation of U.S. bonds—is also significant but markedly smaller. Our results are robust to a number of alternative specifications.

Keywords: bond yields, Japan, China

JEL Codes: E43, E44, F21

I. Introduction

There is a burgeoning literature on the impact of international capital flows on emerging market economies. For example, we have learned in recent years that in emerging markets foreign flows can result in a reduction in systematic risk (Chari and Henry (2004)) and an increase in both physical investment (Henry (2000, 2003)) and economic growth (Bekaert, Harvey, and Lundblad (2005)). These positive aspects of capital flows are tempered by the role of foreign flows in spreading crises (Boyer, Kumagai, and Yuan (2005)).

In comparison, we know very little about the role of foreign flows in large developed economies. We aim to fill this gap by examining the impact of international capital flows on what is arguably the most important price in the U.S. economy—and possibly the world—that of the ten-year Treasury bond. Specifically, we ask to what extent foreign flows into U.S. bond markets can explain movements in long-term Treasury yields.

We address this issue at an important time. Two years ago, in the summer of 2003, short-term interest rates were very low and inflation was under control. Most models would have predicted very poor returns for U.S. bonds over the subsequent year or two.[1] And, over the course of 2004, as inflation picked up, the Federal Reserve began a tightening cycle that raised short rates, and economic growth strengthened, many market observers predicted an increase in long-term U.S. interest rates that would result in substantial losses on bond positions (see, for example, Roach (2005)). Long-term interest rates have, however, remained quite low, and the bond market has held up at a

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[1] See, for example, Baker, Greenwood, and Wurgler (2003). Other important work on the predictability of bond returns includes Ferson and Harvey (1991, 1993), Keim and Stambaugh (1986), Fama and French (1989), and Campbell and Shiller (1991).

time when many predicted subpar performance. The stubbornly low long rates have puzzled not only market participants and financial economists, but also policymakers. Might foreign flows help explain this puzzling behavior?

We address this question using data on the flows of two sets of foreign investors. Our first measure utilizes information on the purchases of Treasury securities by so-called foreign official institutions—prominent foreign institutions such as the Bank of Japan and the People's Bank of China. But we view a focus on foreign official flows as incomplete, in part because the behavior of foreign governments over the past few years could be characterized as stepping up purchases of U.S. bonds at times when private demand faltered (Dooley, Folkerts-Landau, and Garber, 2004). Our second measure of foreign flows combines foreign official purchases with those of private foreign investors.[2] Private foreign investors—the main actors in nearly every study of international capital flows—are in aggregate much larger than the headline-grabbing foreign official institutions (Figure 1). To be sure, foreign *official* purchases of U.S. Treasury bonds skyrocketed in 2003 and 2004, but these were only a small subset of foreign flows into all types of U.S. bonds—Treasury, corporate, and agency bonds. At their peak in the summer of 2004, foreign official inflows amounted to 2.5 percent of GDP, far below the overall foreign purchases of U.S. bonds of 7 percent.

To determine the impact foreign buying of U.S. bonds has on U.S. Treasury yields and U.S. interest rates in general, we utilize a reduced-form model, similar in spirit

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[2] Data on private foreign investor flows is publicly available but at the same time is not readily accessible to researchers; one of our contributions is to show how these data can be utilized after they are corrected for known problems.

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to that developed in Sack (2004).[3] The methodology controls for several macroeconomic factors—inflation and growth expectations, the budget deficit, the federal funds rate, and a risk premium—that normally provide a reasonable accounting of Treasury yields. As Figure 2 shows, recently these macroeconomic variables have not fared as well for long-term interest rates, as 10-year Treasury yields are substantially lower than can be explained by macroeconomic conditions. We add to the model a battery of carefully constructed capital flows series—the foreign official purchases that attract the most attention, but also *all* foreign purchases of Treasuries and, alternately, of *all* U.S. bonds. We find that these capital flows variables have different impacts, but each helps explain the surprisingly low U.S. interest rates.[4]

Specifically, we find in our sample spanning January 1984 to May 2005 that foreign inflows into U.S. bonds reduce the 10-year Treasury yield by an economically (and statistically) significant amount. For example, if foreigners did not accumulate U.S. bonds over the twelve months ending May 2005, our model suggests that the 10-year Treasury yield would currently be 150 basis points higher. No foreign accumulation, or zero inflows over the course of a full year, might seem farfetched (although not in a balanced current account scenario). But even if the United States experienced only average inflows of 2 percent of GDP, our point estimate suggests that U.S. rates would be 95 basis points higher. Other capital flows measures yield similar or even larger point

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[3] The Sack (2004) mimeo and much of the market commentary utilizes only the readily available data on foreign official inflows into Treasury securities, and finds modest results. Meyer and Sack (2004), which also focuses on foreign official flows, updates the original mimeo and finds effects as large as 50 basis points.

[4] Our work can be seen as a foreign relative of a variety of papers that have focused on domestic factors. For example, Diebold, Piazzesi, and Rudebusch (2005) and Piazzesi (2005) examine the impact of domestic macroeconomic factors on the yield curve. Brandt and Kavajecz (2004) and Green (2004), in the spirit of Evans (2002) and Evans and Lyons (2002), examine the impact of order flow on Treasury yields. See Bernanke, Reinhart, and Sack (2004) for a high frequency study of the very short-run impact of foreign official purchases.

estimates in our regressions, but because the flows are smaller, the overall impact is more muted. For example, had foreign *official* flows been zero over the last twelve months, long rates would currently be 60 basis points higher.[5]

Our results are robust to many alternative specifications. In robustness checks, we model *real* long rates; foreign flows significantly affect real rates. To eliminate the impact of short-run business cycle variations, we model future expected real rates (the real 5-year forward rate five years hence); the main results hold. We present evidence that a view currently circulating in practitioner circles—that the puzzle of low rates is solved by incorporating a measure of corporate savings (JP Morgan, 2005)—does not impact our results (nor does it appear to help explain the behavior of long rates). Our final robustness check involves rolling regressions. We present the evolution of the coefficient estimates through time; overall inflows have significantly impacted U.S. long rates for over a decade.

Our finding that foreign flows help explain the behavior of U.S. interest rates leaves unanswered one potentially interesting question: Are we, on average, capturing a switching effect, as global investors shift allocations between U.S. and foreign bonds, or a supply effect in which a global savings glut leaves global investors with more funds available? We are agnostic on this question—in large part because we believe that over time both effects are at work, perhaps with varying intensities and relative importance— but make some attempt at addressing it in order to provide the reader with guidance that might will aid in the interpretation our results. In fact, we present evidence that strongly suggests the former—the switching effect—is more prevalent. In particular, if we

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[5] This is consistent with the statement in Greenspan (2005) of a "modest" impact of official flows, later to be defined as probably less than 50 basis points.

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include a variable that measures the spread of foreign interest rates over U.S. rates, it enters into our regressions with a negative and significant coefficient. That is, when foreign rates rise relative to U.S. rates, U.S. rates fall, suggesting that investors are switching from foreign to U.S. bonds.

Finally, we also estimate models for a variety of U.S. interest rates—shorter term Treasury yields (2-year), high and lower quality corporate debt (Aaa and Baa), and long-term fixed and short-term adjustable mortgage rates. The impact of foreign inflows differs across these instruments, but it is always statistically significant and often economically large. The impact on corporate bond rates and long-term (30-year) fixed mortgage rates is very similar to that on the 10-year Treasury yield. Short-term rates are in general less affected by foreign flows, perhaps because as our models show they are more closely linked to the federal funds rate. The differential effect on the two- and ten-year Treasury yields implies that foreign flows have flattened the yield curve by about 75 basis points.

Our paper is as follows. In the next section, because there is considerable confusion about the different sources of capital flows data, we begin with a short description of the various capital flows data; show why we cannot use "off-the-shelf" flows data; and present capital flows series that are restated to eliminate known data problems. In Section III we present our main regression results of 10-year Treasury yields, as well as various robustness checks. Section IV addresses the interpretation of our results, in particular whether they appear to reflect a portfolio-switching effect or a supply effect associated with a global savings glut. Section V presents evidence on other long- and short-term interest rates. Section VI concludes.

II. U.S. Data on International Capital Flows

There are many interrelated sources of data on U.S. capital flows. In this section we discuss, in turn, weekly data from the Federal Reserve Bank of New York (FRBNY), monthly data from the Treasury International Capital Reporting System (TIC), and monthly flows implied from infrequent benchmark surveys of positions (which we call benchmark-consistent flows).[6] Because of limitations of the monthly TIC data, discussed below, our preferred measure utilizes the benchmark-consistent flows—the restated flows that incorporate information from benchmark surveys.

FRBNY Weekly Data on Foreign Official Holdings of Treasury Securities

The weekly FRBNY custodial data are the most timely data available for the holdings of U.S. Treasury securities by foreign *official* institutions (central banks and finance ministries). They are easily obtained[7] and of high quality; mistakes in FRBNY data are similar to a bank recording the wrong amount for an account balance, infrequent and likely quickly corrected. Although the FRBNY is just one of many custodians, it is the U.S. custodian of choice for many of the world's central banks and finance ministries; at the end of June 2003, 88 percent of foreign official holdings of long-term Treasury securities were held in custody at the FRBNY.[8]

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[6] Another important source, quarterly balance of payments (BOP) data from the Bureau of Economic Analysis (BEA), will be mentioned only briefly.

[7] A memo item at the bottom of the first page of the H.4.1 release (www.federalreserve.gov/releases/h41/) shows foreign official holdings at the FRBNY. The Treasury and FRBNY data are not directly comparable for a number of reasons; see question C10 on Treasury's FAQ site (www.treas.gov/tic/faq1.html).

[8] From Table 10 of Treasury et al (2004) and the historical Major Foreign Holders table (available at www.treas.gov/tic/mfhhis01.txt), foreign official holdings at all U.S. custodians totaled $864 billion ($653 billion in long-term Treasury securities and another $211 billion in short-term Treasury bills), of which $757 billion were held in custody at FRBNY.

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The weekly FRBNY data are the best source of foreign official flows into U.S. securities. However, foreign official purchases are often dwarfed by inflows from *private* foreigner investors. For private flows, we must utilize data from the monthly TIC reports.

Monthly TIC Data

The TIC system reports monthly data on the purchases and sales of all types of long-term securities (equities as well as corporate, agency, and Treasury bonds) by all foreigners (that is, foreign officials and private investors).[9] As such, the TIC data gives a much fuller picture of international flows into U.S. securities. It is, however, less timely than the FRBNY data, being released six weeks after month's end.

While the TIC system is more comprehensive than FRBNY's custodial reports, for at least two reasons TIC data are not as accessible to most data users. First, the data presentation is much more complicated; FRBNY publishes a single holdings number per week, whereas the TIC system publishes a myriad of time series each month. Second, the TIC transactions data are *by design* less accurate than FRBNY's custodial data. Rather than directly accessing investors' accounts to collect transactions data, the TIC system relies on market participants—primarily banks and broker dealers—to enter on reporting forms the amount of gross purchases and gross sales between U.S. and foreign residents. The aggregate nature of the TIC transactions data does not allow for the detailed editing and checking that is possible with security- or account-level data. This, coupled with the

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[9] The TIC data also include data on short-term instruments and on U.S. investors trading in foreign securities. We do not focus on these data in this paper.

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ever-increasing complexity of international financial systems, makes maintaining high quality data no small feat.

That said, we have no direct way of knowing whether the TIC capital flows data are accurate, in part because benchmark surveys of capital *flows* do not exist. However, high quality security-level benchmark surveys of foreigners' *holdings* of U.S. securities—surveys that recently have been conducted annually—can be used to gauge whether recorded capital flows data are reasonably accurate. Specifically, one can form flows-based *holdings* estimates and compare them with known *holdings* from the benchmark surveys. The comparison is not perfect, because unknown valuation adjustments are incorporated into the marked-to-market positions data, but large discrepancies between holdings given by the comprehensive benchmark surveys and holdings implied from capital flows data would indicate a problem with the flows data.

Figure 3 shows flows-based holdings estimates (the solid lines) and benchmark amounts (the dots) for foreigners' positions in Treasury, corporate, and agency bonds; complete details on the methodology for forming the flows-based holdings estimates are presented in the appendix. For Treasury bonds, reported TIC flows appear to have been running a bit high in the late 1990s; the March 2000 estimate of $1,063 billion is almost $200 billion higher than the amount collected through the benchmark survey. Since then, however, there is no evidence that TIC flows for Treasury bonds are inaccurate, as estimated holdings are right in line with benchmark amounts. For corporate bonds, flows appear to have been slightly overstated at times, but the discrepancies are not egregious.

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Agency bonds are another story: The TIC system consistently overestimates foreigners'

purchases of agency bonds.[10]

The discrepancy between flows implied from high-quality benchmark surveys and

TIC reported flows makes it difficult for market participants to interpret and use the TIC

transactions data. We present a solution in the appendix. Briefly, we can utilize the

benchmark survey data to guide a restatement of monthly TIC flows. The resulting

series, which we call benchmark-consistent flows, will be quite similar to reported TIC

flows when TIC flows are in line with the surveys. But where there is a wide discrepancy

between TIC flows and benchmark surveys--as with agency bonds--our benchmark-

consistent flows will differ substantially from reported TIC flows.

Because the TIC data appear to overstate foreign flows into U.S. bonds (Figure 3),

our adjustments will generally reduce reported flows. This is especially true for agency

bonds. For example, in the 12-month period from July 2001 to June 2002, the TIC

system reported that foreigners purchased on net $206 billion in agency bonds, whereas

our monthly benchmark-consistent flows totaled only $68 billion for the same period. In

the empirical work that follows, we utilize benchmark-consistent flows.[11]

III. The Impact of Foreign Inflows on U.S. Long-Term Interest Rates

Our basic approach follows Sack (2004): Estimate a reduced-form model of long-

term nominal interest rates that includes standard (but well thought-out) macroeconomic

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[10] This owes to an inability of the TIC system to cost-effectively collect data on the periodic principal payments on mortgage-backed securities—which should be recorded as capital outflows. The TIC web site (www.treas.gov/tic/absprin.html) describes the issue and provides adjustments; however, those adjustments appear to be far too small to eliminate the discrepancy.
[11] The BEA also publishes international flows data in their quarterly BOP release. For long-term securities, the quarterly BOP data is formed essentially by summing the monthly TIC data. However, BEA adjusts reported TIC data if they feel it is warranted. BEA's determines whether TIC flows data should be altered by consulting the infrequent benchmark positions data, so their adjustment is similar in spirit to ours.

variables, show that the model performs reasonably well in normal times but less so

recently, and then augment the model using various measures of foreign inflows into U.S.

bonds. We focus on the 10-year Treasury yield. In Section V we also analyze other long

rates (Aaa and Baa corporate bond yields and 30-year fixed mortgage rates) as well as

two short rates (2-year Treasury yield and one-year adjustable mortgage rates).

III.A. Domestic Model of 10-year Treasury Yields

The fact that in 2004 and the first half of 2005 long-term Treasury yields have

remained so low is considered puzzling, largely because conventional models have

predicted far higher rates. In this subsection we lay out an example of a typical reduced-

form model. The model is relatively standard, controlling for the influence of

macroeconomic conditions and the monetary policy setting on Treasury yields. Because

the Treasury yield is a forward-looking asset price, we try to rely on variables that

encompass forward-looking expectations. Specifically, we assume that the 10-year

Treasury yield is a function of expected growth, expected inflation, a risk premium, and

monetary and fiscal policy. We briefly discuss each variable.

(1) Expected Growth and Expected Inflation

Nominal long-term interest rates are, from the Fisher Equation, a function of real

interest rates and expected inflation. For expected inflation, we use both a long-term

(10-year) measure, denoted π_{t+10}^{e}, and a shorter-term (one-year) one that we express

relative to long-term expectations ($\pi^e_{t+1} - \pi^e_{t+10}$).[12] Expected GDP growth over the

subsequent year (denoted y^e_{t+1}) helps capture factors that impact real interest rates.

(2) Risk Premium

Investors must be compensated for bearing risk. While U.S. Treasury bonds—the

world's risk-free rate—should be free of default risk, investors are nevertheless

subject to interest rate risk. As interest rates rise and fall, investors' holdings of

existing Treasury bonds become less (or more) valuable. To proxy for an interest rate

risk premium (rp_t), we use the volatility of long-term interest rates, calculated as the

rolling 36-month standard deviation of changes in long rates.

(3) Monetary and Fiscal Policy

Current monetary policy, captured by the target federal funds rate (ff_t), has a direct

impact on the short end of the yield curve and thus, based on the expectations theory

of the term structure, also impacts long rates. Fiscal policy, which should impact real

rates, is a bit trickier to capture. Because long rates are forward looking, best for our

purposes would be to follow Laubach (2003) and utilize the long-dated budget

projections of the Congressional Budget Office (CBO) or Office of Management and

Budget (OMB). However, these projections are available only infrequently. Instead,

we use a readily available measure, the structural budget deficit ($deficit_{t-1}$) expressed

as a percent of lagged GDP. Our measure has one thing in common with the long-

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[12] Ang, Bekaert, and Wei (2005) show that surveys forecast inflation quite well.

dated projections; being structural, it abstracts from current business cycle

conditions.[13]

The variables included are intended to provide an effective summary of economic

and policy conditions that might influence Treasury yields through their implications for

policy expectations and term premiums. Many of the regressors are based on survey data

rather than realized outcomes, since expectations of future developments should be the

primary driver of Treasury yields.[14]

Two econometric issues arise in estimating this regression; both are addressed in

robustness checks presented in a later subsection. The first issue is the potential

endogeneity of the regressors. We are assuming that the right-hand side variables do not

respond contemporaneously to innovations to the interest rate. This assumption seems

reasonable (and is widely used) with regard to macroeconomic variables, which tend to

be sluggish. The assumption is somewhat less convincing, but is still maintained, with

regard to survey expectations of macroeconomic variables and the current federal funds

rate. As a robustness check, presented later in this section, we alleviate this concern by

modeling long-dated forward rates using only longer-term explanatory variables; our

main results hold.

The second econometric issue concerns the stationarity of the dependent variable.

Over the past twenty years, U.S. interest rates and inflation expectations have drifted

lower, with no apparent tendency to revert to some stable average level. That is, they

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[13] Moreover, as we will show, our estimates of the impact of budget deficits on interest rates are not dissimilar from those in Laubach (2003) or, by extension, Engen and Hubbard (2004).
[14] Short-term GDP growth and inflation expectations are from the Blue Chip survey; long-term inflation expectations are from the Philadelphia Fed's Survey of Professional Forecasters and are interpolated to monthly figures.

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appear to be nonstationary. If they are indeed nonstationary and cointegrated, an unrestricted regression would pick up only the long-term relationship and not the shorter-term dynamics that we are interested in. Thus, to accurately estimate the impact of other regressors, we impose an assumption about the long-run relationship between interest rates and inflation expectations that is consistent with the work of Mehra (1998). In particular, we assume that Treasury yields are non-stationary and are cointegrated with the federal funds rate and expected inflation by imposing that the coefficients on those two variables sum to one.[15] As a robustness check, we avoid this issue by modeling real interest rates, which are stationary. Our main results hold (and those regressions provide additional analysis of the impact of flows on real rates).

Table 1 presents regression results—using only domestic explanatory variables—for the nominal 10-year Treasury yield estimated using month-average data from January 1984 to May 2005. In this specification, the most significant drivers of long-term Treasury yields are expected long-run inflation, the risk premium, the size of the budget deficit, and the level of the federal funds rate. Declining interest rate volatility lowers long rates, and, in line with the results in Laubach (2003), a one-percentage-point increase in the deficit-to-GDP ratio increases long rates by 24 basis points. A one-percentage-point increase in long-term inflation expectations tends to increase nominal long rates by 57 basis points, and one percentage point of Fed tightening results in a 43 basis point increase. The usual relationship between Fed tightening and the long rate is

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[15] This restriction assumes that real interest rates are stationary. It can be shown that imposing this restriction is identical to estimating the regression on the yield curve slope, with one of the regressors equal to the deviation of the federal funds rate from the long-run inflation rate. One could argue that all of the variables from this alternative regression are stationary. Moreover, if this restriction were not imposed, the impact of long-run inflation expectations would become implausibly large.

shown clearly in Figure 4: Every time the Fed embarked on a tightening cycles long-term rates increased substantially. Until recently, that is.

The fit of the equations is generally good, with an adjusted R^2 of about 0.90. Figure 2 shows the fit, but also apparent is the puzzle: Given current macro and policy conditions, the domestic model predicts that the long rate should be roughly 100 basis points higher than it currently is.

III.B. Foreign Inflows and Long-term Treasury Yields

Whether the recent large foreign inflows are behind the lower than expected long-term Treasury yields is a open question. Moreover, to our knowledge, little if any academic work has been done on this topic, perhaps because capital flows data are not easily interpretable.[16]

In this section we present our regression model, which uses (alternately) three measures of capital flows that are intended to capture any systematic effects of inflows on Treasury yields. The first measure is the headline-grabbing foreign *official* purchases of Treasury securities, which, as we have shown, is just one component of the recent large inflows. The second and third measures more broadly capture the foreign flows into U.S. fixed-income markets. The second, like the foreign official flows, focuses on the Treasury market: *overall* (that is, both foreign official and private foreign) purchases of Treasury bonds.[17] The third is the broadest measure of foreign flows into U.S. bonds: our benchmark-consistent series of overall foreign purchases of *all types* of U.S. bonds

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[16] Chinn and Frankel (2005) speculate that recent capital flows might be diluting traditional interest rate relationships.

[17] Benchmark-consistent flows for the component of overall bond inflows are not available prior to 1994, so for this second measure we utilize reported TIC data. Figure 3 showed that for Treasuries reported data are rather accurate.

(agency, corporate, and Treasury). In each case, the foreign flow variable is constructed as twelve-month flows scaled by lagged GDP.[18]

Regression results for the "global" model of 10-year yield that includes foreign flows are presented in Table 2. As in the domestic model, the coefficients on expected inflation, the risk premium, the size of the budget deficit, and the level of the federal funds rate are highly significant. In addition, expected growth becomes significant in these models. Because the coefficients on ($\pi_{t+1}^e - \pi_{t+10}^e$) and π_{t+10}^e are of similar magnitudes, in these specifications short-term inflation expectations appear to be substantial drivers of nominal long rates (perhaps because they adjust more rapidly). Notably, all three foreign flow variables exhibit a significant negative impact on long rates. Just as importantly, a comparison of Figure 5 with Figure 2 indicates that including a foreign flow variable eliminates the puzzle. The global model tracks long-run rates well, and recent long-term rates are right in line with fundamentals.

Foreign flows are not only significant in a statistical sense, but their impact is also economically important. Figure 6 shows the impact on the 10-year yield of total bond inflows and foreign official inflows. Note that the graph is constructed to show how much lower U.S. rates are in comparison with the case of zero inflows. Zero inflows over the course of an entire year are common enough for foreign official flows (see Figure 1), but are infrequent events for overall bond inflows. That said, had the last twelve months seen zero foreign purchases of foreign bonds, our estimates suggest that U.S. long rates would be 150 basis points higher. Foreign official accumulation, at its

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[18] Foreign official is actually the 12-month change in positions, which are measured by FRBNY at face value (i.e., they do not include valuation adjustments). We do not use changes in positions for our other flow variables because in those cases positions are marked-to-market every month. Doing so would incorporate valuation changes into the flow variable and, because these valuation changes owe to interest rate movements, would hardwire results. Our flows variables do not suffer from this feature.

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summer 2004 peak, depressed U.S. long rates by 100 basis points. For overall flows, a return to "average" inflows is perhaps a better benchmark; had the U.S. attracted only average overall bond inflows (2 percent of GDP) long rates would be 105 basis points higher.

At first glance, our results appear to be large; in no way can 150 basis points be considered a small effect. But recall that foreigners are major participants in U.S. bond markets. They are most conspicuous in the Treasury market, where as of June 2004 they held 50 percent of outstanding tradable bonds, but they are also important players in all U.S. markets, holding 20 percent of the overall U.S. bond market (Treasury et al., 2005). The U.S. bond market is expanding by roughly $2 trillion per year. One way to gauge the size of our estimates is to ask the following: If 20 percent of the market sat on the sidelines while $2 trillion in new bonds were issued, is a 150-basis-point increase implausibly large?

Another way to put our results in perspective is to compare them to other studies of interest rates. For example, Laubach (2003) found that a one-percentage-point increase in the budget deficit would increase long rates by 25 basis points. Over the course of 2002 and 2003 the budget deficit increased from near zero to 4 percent of GDP, which, according to the Laubach estimates, would imply a 100-basis-point impact on long rates. If we witnessed a similarly dramatic movement in foreign flows, our results would imply a similar impact on long rates.

Finally, the finding of a relatively large foreign official effect on long-term Treasuries may seem puzzling, considering that foreign official institutions have traditionally preferred securities with short maturities. However, indirect bidding activity

from Treasury auctions suggests that these institutions have moved fairly aggressively

into longer maturities. This is corroborated by evidence from benchmark survey data,

which indicates that as of mid-2004 more than one-third of foreign official holdings had a

remaining maturity of more than four years (Treasury et al., 2005). In addition, dollar for

dollar, there may be greater scope for price effects on longer-term instruments; effects in

the deeper markets for shorter maturities may be limited because there are large amounts

of private assets available as substitutes and because prices of those securities are more

strongly anchored by monetary policy instruments (as shown below).

III. C. Robustness Checks

In this subsection we present a number of robustness checks. To address any

potential concerns about the non-stationarity of nominal interest rates over our sample

and about the impact of short-run dynamics and business cycle fluctuations on our

regressions, we analyze real rates and long-dated forward rates. We estimate rolling

regressions that depict the evolution of coefficient estimates over time to ascertain

whether the significant effect of foreign flows on U.S. interest rates owes solely to the

recent period of record inflows. Finally, we bring corporate savings into the model to see

if it, rather than foreign flows, is driving interest rate movements.

Modeling Real Rates

We believe our main model is well specified, but recognize that in small samples

issues of non-stationarity are difficult to convincingly address. But real interest rates are

clearly non-stationary, so we next examine real long-term interest rates ($i_{10} - \pi^e_{t+10}$). As

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Panel A of Table 3 shows, our main results hold. Compared to the estimates in Table 2, the coefficient estimates on the foreign flows variables are smaller, but foreign flows significantly impact real long-term rates.

Eliminating Effect of Short-run Business Cycle Variations

Any minor event that changes expectations should immediately impact the long rate; one cannot be certain that we accounted for every short-run variable that can impact Treasury yields. To eliminate the impact of short-run business cycle fluctuations, we model an expected future real long rate, the real 5-5 forward rate (i.e., the five-year rate five years hence), using only long-term variables.[19] The results are presented in Panel B of Table 3. Abstracting from business cycle considerations, real long-term forward rates are lower when risk premiums decrease and budget deficits are smaller. Moreover, the coefficient estimates on the foreign flows variables are consistent with our main results. Even abstracting from the potentially confounding effects of business cycle fluctuations, foreign flows have a statistically and economically significant impact on U.S. interest rates. In all, Table 3 shows that non-stationarity and business cycle fluctuations are unlikely to adversely affect our main regressions of Table 2.

Do the Results Owe Solely to the Most Recent Period?

To determine whether our results owe solely to the most recent period of very large foreign inflows, we estimate rolling regressions of the 10-year yield. Specifically, we re-estimate the regressions in Table 2 with the first re-estimation ending at January

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[19] Because data on 5-5 forward rates do not extend back to January 1984, we form these rates using the standard technique of Shiller, Campbell, and Schoenholtz (1983).

1994 and each subsequent regression extending the sample by one month; the start date is always locked at January 1984. The evolution of the coefficients on the foreign flows variables are presented in Figure 7. The figure indicates that for Total Bond Inflows (Fig. 7(a)), the estimate on the flow coefficient has been negative and significant for over a decade. For the other types of flows, the current period has indeed played an important role. Prior to the surge in inflows over the past few years, the coefficients on foreign official and flows into Treasuries were not significantly different from zero, although prior to the late 1990s these were negative and significant.

Do Corporate Savings Solve the Puzzle?

JPMorgan (2005) is a well-publicized piece that claims to solve the puzzle of low long rates by including a measure of corporate savings.[20] The logic is that as the corporate sector moved from a net borrower in 2000 (with a financing gap of about 3 percent of GDP) to a net saver by 2004 (a slightly negative financing gap), their reduced demand for capital should have put downward pressure on interest rates.

To test whether corporate savings, rather than foreign flows, helps explain the puzzle, we include a measure of the corporate financing gap (scaled by GDP). Because the financing gap is available only quarterly, for this test we utilize a quarterly model. The results are presented in Table 4. We find no evidence that the increased corporate savings has put downward pressure on U.S. interest rates; indeed, the sign on the

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[20] See the write up in the July 9, 2005 Economist article, "The corporate savings glut."

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(insignificant) coefficient would suggest the opposite. As in previous tables, in all three models foreign flows are economically and statistically important.[21]

IV. Interpretation of Our Main Results

The finding that the large foreign flows into U.S bonds has kept U.S. interest rates low leaves an interesting question unanswered. Do foreign purchases represent a portfolio shift from foreign to U.S. bonds? Or is the foreign accumulation part of a global savings glut in which bonds of all countries are being purchased at elevated amounts?

We suspect that over time both effects are at work, perhaps with varying intensities and relative importance. Unfortunately, a rigorous examination is hampered in part by lack of data, as sufficient time series of capital flows are available for surprisingly few countries. For example, Warnock (2003) and Tesar and Werner (1995) were able to locate reasonable capital flows data for only a few countries. We can, however, rely on price data to shed some light on this question. In particular, if the decline in U.S. interest rates is being driven by a global trend, we should see evidence that U.S. rates are being dragged down by foreign rates. That is, in our framework, a foreign spread variable, calculated as foreign rates less U.S. rates, should be positively related to U.S. long rates if a global savings glut is driving foreign and U.S. rates lower. In contrast, if the large capital flows into U.S. bonds represent the shifting of global portfolios from foreign

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[21] We were surprised to find results that differed so greatly from those in JPMorgan (2005), so we investigated further. We utilized, as they did, data on non-financial firms' financing gap from the Federal Reserve's Flow of Funds Accounts (Table F.102 line 59). JPMorgan appends a measure for financial firms, although no such measure exists. But their appended series is too similar to the reported one to explain the difference in results, which appears to owe to the sample; their sample extends back to 1959, and the few-year period ending 1984:Q1 experienced very high interest rates and a very high financing gap.

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bonds into U.S. bonds, the foreign spread variable should be negatively related to U.S. rates—when foreign rates rise relative to U.S rates, U.S. rates fall.

Table 5 provides evidence suggestive of the portfolio switching effect. The foreign spread variable is not positive, but rather is negative and significant. When foreign rates rise relative to U.S rates, U.S. rates are falling, suggesting that the inflows are the result of portfolio-switching by global bond investors.

Our intent is not to use the regressions presented in this subsection to rule out the global savings glut story, but to provide further evidence to guide the interpretation of our results. In fact, it is likely that at times excess global savings pushes down U.S. rates. However, the long-term evidence is more supportive of a switching effect.

V. The Impact of Foreign Inflows on Other U.S. Interest Rates

While the focus of our paper is on long-term Treasury yields, for further investigation we present results for other long-term interest rates as well as short-term rates. Our regression specifications are as in the previous section, although we include one extra variable, $cycle_t$, a real-time indicator of the state of the business cycle.[22] The business cycle variable plays two roles in what follows. When employment growth is very weak, risk premiums on some of the riskier bonds we consider below might widen, so *Cycle* may capture a risk premium effect (separate from the interest rate risk premium). Also, when we turn to shorter rates that adjust very quickly, there is a chance

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[22] Using real-time data from the Philadelphia Fed, we compute $cycle_t$ as the deviation of current real-time employment growth from its 36-month average. There is a potential role for $cycle_t$ in our main regressions, as Gurkaynak, Sack, and Swanson (2005) show that long-term rates adjust to employment reports. But including $cycle_t$ in our regressions for the 10-year Treasury yield would not alter our results, perhaps because Gurkaynak et al. argue that surprises from employment reports impact long rates through changes in inflation expectations (for which we control).

that our expectations data are sluggish. If so, the real-time business cycle variable could

pick up instantaneous adjustments in expectations.

V. A. Results for Other Long-Term Rates

To see if our results also hold for a broader set of U.S. long-term interest rates, we

re-estimate the regressions for corporate bond yields (for both Moody's Aaa and Baa) as

well as a 30-year fixed mortgage rate.[23] The results are presented in Table 6. While the

coefficient estimates for some variables differ somewhat from those in our benchmark

regressions, the drivers are similar. In particular, these other long rates tend to be driven

by inflation and growth expectations as well as risk premiums and policy variables.

Moreover, foreign flows exhibit a substantial impact on these markets.

V. B. Results for Short-Term Rates

Short-term interest rates are more closely tied to the federal funds rate, so we

expect the impact of foreign flows to be more muted. Table 7 confirms this for both the

2-year Treasury yield and the 1-year adjustable rate mortgage (ARM). For both, the

coefficient on the foreign flows variable is about half those in previous tables, while the

coefficient on the federal funds rate has increased substantially. Note too that the

coefficient on the business cycle indicator plays different roles in these regressions. For

ARMs, cyclical weakness is associated with higher rates, perhaps this owes to greater

demand for the lower rates of ARMs when unemployment is temporarily high. In

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[23] The corporate bond rate data is from the Federal Reserve Board H.15 statistical release
(www.federalreserve.gov/releases/h15/). Mortgage rate data are from Freddie Mac's Primary Mortgage
Market Survey (www.freddiemac.com/pmms/pmms_archives.html).

contrast, for short-term Treasury yields, the coefficient on the business cycle indicator is positive; cyclical weakness is associated with a decrease in short rates.

A comparison of the coefficients on the foreign flows variables in Table 7A and Table 2 suggests that foreign flows can explain at least some of the recent flattening of the yield curve. In the last year and a half of our sample, the 10-year minus 2-year spread decreased by 185 basis points. Our regressions suggest that the differential impacts of foreign flows on these rates are associated with 75 basis point of this flattening.

VI. Conclusion

This paper represents a first attempt at analyzing the impact of foreign flows on a large developed economy. Past work has taught us much about the role of foreign investors in emerging market. We can now add our results to this literature: Foreign flows have an economically large and statistically significant impact on long-term U.S. interest rates.

Our work also appears to eliminate a current puzzle. Long rates are indeed low, but not surprisingly so. The results in this paper suggest that large foreign purchases of U.S. bonds have contributed importantly to the low levels of U.S. interest rates observed over the past two years. We present a range of estimates of the impacts of foreign flows, depending on different assumptions of what the "normal" level of flows is. The most extreme comparison is with the hypothetical case of zero foreign accumulation of U.S. bonds over the course of an entire year, which we show would leave long rates 150 basis points higher.

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We caution that although we present a multitude of robustness tests, it is possible that our results overstate the effects of foreign flows. One might suspect that other factors not completely captured by the regressors were putting downward pressure on interest rates over this period. Those other factors include FOMC statements suggesting that policy accommodation would be removed only slowly, worries about the risk of deflation, or a generally more benign outlook for inflation than suggested by the Philadelphia Fed's surveys (which have long-run inflation expectations as essentially flat since the middle of 1998). Still, the facts we present are suggestive of sizeable effects: Interest rates appear to be somewhat low, our regressions attribute a substantial portion of this behavior to foreign purchases, and the fit of our "global" model tracks actual Treasury yields quite well.

Foreign buying of U.S. bonds has clear benefits for the U.S. economy. For example, by helping to keep interest rates relatively low, foreign buying has lowered borrowing costs and spurred economic activity. Consumers benefit because, for example, the monthly mortgage payment on a 30-year fixed mortgage is $158 less at a 6 percent rate compared to the zero-inflow case of 7.2 percent rate. Future work might provide a more detailed exploration of the implications of foreign flows for the real side of the U.S. economy.

The reader might ask whether a retreat of foreign investors from U.S. bond markets is likely imminent. Not necessarily. To be sure, as we showed in Figure 1, foreign official inflows are currently slowing, as they have many times in the past. East Asian countries' exchange rate management has been one major source of the recent official demand (Dooley, Folkerts-Landau, and Garber (2004)), and whether these

countries will continue to acquire large amounts of U.S. securities is in question. The

future demand from foreign officials is difficult to predict with any certainty—it is safe to

say that their objective functions are sufficiently complex and include much more than

just a desire for high risk-adjusted portfolio returns. But with U.S. bonds comprising

roughly half the global bond market, other international investors—be they speculators or

institutions such as pension funds—are not likely to completely abandon the U.S. market.

Indeed, zero net inflows into U.S. bonds over a sustained period has not occurred in at

least 20 years. Even during the 1990-1991 recession, when the U.S. current account was

temporarily balanced (and thus net capital inflows were not required), annual foreign

purchases of U.S. bonds still totaled about one percent of GDP (compared to the current

record annual bond inflows of roughly 6 percent of GDP). This is not to say that a retreat

could not occur, just that a complete and sustained retreat is unlikely.

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Appendix. Creating Benchmark-Consistent Capital Flows Data

To create benchmark-consistent capital *flows* data, we restate monthly TIC flows so that flows-based *holdings* estimates are consistent with *holdings* reported in periodic benchmark surveys.

Data Requirements

Bilateral capital flows. Foreigners' transactions in U.S. securities are reported monthly to the TIC System, mainly by brokers and dealers. For U.S. long-term debt securities (with original maturity greater than one year), these mandatory reports contain information on gross purchases and gross sales (at market value) and the country of the foreign counterparty to the transaction. The TIC data are available at www.treas.gov/tic.

Benchmark liabilities surveys. Data on foreign holdings of U.S. securities, available at www.treas.gov/fpis, are collected in detailed but infrequent security-level benchmark liabilities surveys conducted in December of 1978, 1984, 1989, and 1994; March 2000; and June of 2002, 2003, and 2004.[24] Reporting to the surveys is mandatory, with penalties for noncompliance, and the data received are subjected to extensive analysis and editing. For liabilities surveys (of foreign holdings of U.S. securities), the reporters consist primarily of large custodians (banks and broker-dealers). U.S. firms that issue securities are also included in the survey, but they typically have little information about the actual owners of their securities because U.S. securities are typically registered on their books in "street name"—that is, in the name of the custodian, not of the ultimate investor.

Valuation adjustments. We utilize three Lehman Brothers indexes: Lehman Brothers US Treasury Index, Lehman Brothers US Agency Index, and Lehman Brothers US Corporate Investment Grade Index.

Transaction costs. The TIC data are reported gross at cost including commissions and taxes, so to compute the value of securities bought or sold, an adjustment for transaction costs must be made. For round-trip transaction costs in U.S. debt securities, we rely on rough estimates of bid-ask spreads provided by market participants of 5 basis points on US Treasury debt, 10 basis points on US agency debt, and 25 basis points on US corporate debt.

Methodology

To form benchmark-consistent capital flows data, we first form monthly benchmark-consistent holdings. The restated flows consistent with those holdings estimates are our benchmark-consistent flows. We form separate estimates for agency, corporate, and Treasury bonds. All that follows is for a particular type *i* of long-term debt security (*i=agency, corporate, Treasury*); we omit the subscript *i* in the equations below.

We begin by forming naive baseline estimates. End-of-month holdings are formed by adjusting the previous month's holdings for estimated price changes and adding the current month's (transaction cost-adjusted) net purchases. Specifically, we use the following formula to form naive estimates of foreign investors' holdings of U.S. debt securities at the end of period *t*:

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[24] Details of the 2004 liabilities survey, including findings and methodology, are discussed in Treasury Department et al. (2005). Griever, Lee, and Warnock (2001) is a primer on the surveys. The recent annual surveys are "mini" surveys that serve to supplement the quinquennial full benchmarks.

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$$nh_t = nh_{t-1}(1 + r_t) + gp_t(1 - tc) - gs_t(1 + tc) \tag{A1}$$

where
nh_t naive estimates of foreign holdings of U.S. bonds at the end of month t
r_t returns from period t-1 to t, computed from appropriate price indices
gp_t foreigners' gross purchases of U.S. bonds during month t
gs_t foreigners' gross sales of U.S. bonds during month t
tc a constant adjustment factor for transaction costs

We then combine the naive baseline estimates with holdings from the infrequent benchmark surveys (conducted at time T) to form benchmark-consistent holdings estimates. For example, to form estimates for the January 1995 - March 2000 inter-survey period, we start from the December 1994 benchmark survey amount and apply equation (A1) to form estimates to March 2000. Doing so results in a naive estimate of holdings as of March 2000 (nh_T) that differs from holdings as given by the benchmark survey (bh_T) by an amount, gap_T:

$$gap_T = bh_T - nh_T \tag{A2}$$

One possible cause for the gap is errors in the capital flows data. Assuming that such errors are larger in months with greater trading activity, we add to each inter-survey month an amount that is a function of the gap and the proportion of inter-survey trading activity that occurred in that month. That is, we add to month t's net purchases of U.S. bonds an adjustment given by:

$$adj_t = gap_T * adjfactor * \frac{gp_t + gs_t}{\displaystyle\sum_{k=1}^{T} gp_k + gs_k} \tag{A3}$$

where periods 1 and T span the entire inter-survey period. For each inter-survey period, everything on the right side of (A3) is given except *adjfactor*, which we choose to minimize the distance at time T between benchmark holdings and our adjusted holdings estimates:

$$\min|bh_T - h_T| \tag{A4}$$

where our adjusted holdings estimates, h_t, evolve according to

$$h_t = h_{t-1}(1 + r_t) + gp_t(1 - tc) - gs_t(1 + tc) + adj_t \tag{A5}$$

and, for all t, we impose a non-negativity constraint on our holdings estimates:

$$h_t \geq 0 \tag{A6}$$

Because the adjustment for any period t must be part of the revaluation that produces period $t+1$ holdings (and so on), this is not a simple linear problem and, accordingly, we employ a grid-search method to solve for the adjustment factor. Once the adjustment factor is determined and applied to (A3), our benchmark-consistent flows, or net purchases (np_t), are given by

$$np_t = gp_t(1 - tc) - gs_t(1 + tc) + adj_t \tag{A7}$$

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Note three features of our adjustment factor. First, *adjfactor* can differ across inter-survey periods. Second, *adjfactor* is constant within an inter-survey period, but the adjustment itself, adj_t, is time-varying. Third, for the period after the last survey we cannot form adjustment factors and so apply *adjfactor* from the previous inter-survey period. To the extent that the relationship between TIC-reported flows and benchmark surveys will change in the future, our estimates that post-date the most recent survey should be considered preliminary.

Table 1: Domestic Model of Ten-Year Treasury Yield

OLS regressions explaining the 10-year Treasury yield, $i_{t,10}$, using domestic variables only. The specification is as follows:

$$i_{t,10} = a + b\pi^e_{t+10} + (1-b)ff_t + c(\pi^e_{t+1} - \pi^e_{t+10}) + d(rp_t) + e(y^e_{t+1}) + f(deficit_{t-1}) + \varepsilon_t$$

where π^e_{t+10} and π^e_{t+1} are 10-year- and 1-year-ahead inflation expectations; ff_t is the federal funds rate; rp_t is an interest rate risk premium; y^e_{t+1} is expected real GDP growth over the next year; and $deficit_{t-1}$ is the structural budget deficit. Standard errors are reported in parentheses (robust to heteroskedasticity and serial correlation). Highly significant coefficients (at the 1% level) are shown in bold; [a] and [b] denote significance at the 5% and 10% levels, respectively. Constants included but not reported. The sample is monthly from January 1984 to May 2005. Yields are measured in percentage points.

Dependent Variable: 10-Year Yield	
π^e_{t+10}	**0.57 (0.03)**
$\pi^e_{t+1} - \pi^e_{t+10}$	0.22 (0.19)
y^e_{t+1}	0.07 (0.07)
rp_t	**5.37 (0.64)**
ff_t	**0.43 (0.03)**
$deficit_{t-1}$	**0.24 (0.03)**
R^2	0.89

Table 2: Global Model of Ten-Yield Treasury Yield

OLS regressions explaining the 10-year Treasury yield, $i_{t,10}$, using domestic variables and a global foreign flows variable. The specification is as follows:

$$i_{t,10} = a + b\pi^e_{t+10} + (1-b)ff_t + c(\pi^e_{t+1} - \pi^e_{t+10}) + d(rp_t) + e(y^e_{t+1}) + f(deficit_{t-1}) + g(foreign_t) + \varepsilon_t$$

where π^e_{t+10} and π^e_{t+1} are 10-year- and 1-year-ahead inflation expectations; ff_t is the federal funds rate; rp_t is an interest rate risk premium; y^e_{t+1} is expected real GDP growth over the next year; $deficit_{t-1}$ is the structural budget deficit (scaled by lagged GDP); and $foreign_t$ are 12-month foreign flows in U.S. bonds (scaled by lagged GDP) . There are three alternative definitions of $foreign_t$: Total Bonds are the benchmark-consistent flows from all foreign investors into all U.S. bonds (Treasury, agency, and corporates); Treasury Bonds are reported foreign flows into Treasury bonds; and Foreign Official are foreign governments' purchases of Treasury securities. Standard errors are reported in parentheses (robust to heteroskedasticity and serial correlation). Highly significant coefficients (at the 1% level) are shown in bold; [a] and [b] denote significance at the 5% and 10% levels, respectively. Constants included but not reported. The sample is monthly from January 1984 to May 2005. Yields are measured in percentage points.

DepVar: 10-year yield	Foreign Flow Variable:		
	Total Bonds	Treasury Bonds	Foreign Official
π^e_{t+10}	**0.70 (0.03)**	**0.60 (0.03)**	**0.68 (0.03)**
$\pi^e_{t+1} - \pi^e_{t+10}$	**0.90 (0.19)**	**0.50 (0.18)**	**0.80 (0.20)**
y^e_{t+1}	**0.35 (0.07)**	**0.21 (0.07)**	0.17[a] (0.07)
rp_t	**5.94 (0.63)**	**4.50 (0.65)**	**5.76 (0.64)**
ff_t	**0.30 (0.03)**	**0.40 (0.03)**	**0.32 (0.03)**
$deficit_{t-1}$	**0.13 (0.03)**	**0.25 (0.03)**	**0.28 (0.03)**
$foreign_t$	**-0.23 (0.02)**	**-0.23 (0.03)**	**-0.43 (0.06)**
R^2	0.91	0.90	0.89

Table 3: Global Model of Real Long Rates

Panel A: OLS regressions explaining the real 10-year Treasury yield, $r_{t,10}$, using domestic variables and a global foreign flows variable. The specification is as follows:

$$r_{t,10} = a + b(\mathit{ff}_t) + c(\pi_{t+1}^e - \pi_{t+10}^e) + d(rp_t) + e(y_{t+1}^e) + f(\mathit{deficit}_{t-1}) + g(\mathit{foreign}_t) + \varepsilon_t$$

where $r_{t,10}$ is calculated as $i_{t,10} - \pi_{t+10}^e$; π_{t+10}^e and π_{t+1}^e are 10-year- and 1-year-ahead inflation expectations; ff_t is the federal funds rate; rp_t is an interest rate risk premium; y_{t+1}^e is expected real GDP growth over the next year; $\mathit{deficit}_{t-1}$ is the structural budget deficit (scaled by lagged GDP); and $\mathit{foreign}_t$ are 12-month foreign flows in U.S. bonds (scaled by lagged GDP) . There are three alternative definitions of $\mathit{foreign}_t$: Total Bonds are the benchmark-consistent flows from all foreign investors into all U.S. bonds (Treasury, agency, and corporates); Treasury Bonds are reported foreign flows into Treasury bonds; and Foreign Official are foreign governments' purchases of Treasury securities.

Panel B: OLS regressions explaining future expected long rates—specifically, the real 5-5 forward rate, $r_{t,5-5}$—using only longer-term domestic variables and a global foreign flows variable. The specification is as follows:

$$r_{t,5-5} = a + b(rp_t) + c(\mathit{deficit}_{t-1}) + d(\mathit{foreign}_t) + \varepsilon_t$$

For both panels, standard errors are reported in parentheses (robust to heteroskedasticity and serial correlation). Highly significant coefficients (at the 1% level) are shown in bold; [a] and [b] denote significance at the 5% and 10% levels, respectively. Constants included but not reported. The sample is monthly from January 1984 to May 2005. Yields are measured in percentage points.

Panel A: DepVar: Real 10-year yield	Foreign Flow Variable:		
	Total Bonds	Treasury Bonds	Foreign Official
$\pi^e_{t+1} - \pi^e_{t+10}$	0.40[b] (0.21)	0.07 (0.19)	0.12 (0.22)
y^e_{t+1}	**0.35 (0.07)**	**0.29 (0.07)**	**0.26 (0.07)**
rp_t	**4.01 (0.71)**	**2.79 (0.69)**	**3.25 (0.71)**
ff_t	**0.35 (0.03)**	**0.42 (0.03)**	**0.41 (0.03)**
$deficit_{t-1}$	0.06[a](0.02)	**0.11 (0.02)**	**0.13 (0.03)**
$foreign_t$	**-0.14 (0.02)**	**-0.11 (0.03)**	**-0.18 (0.07)**
R^2	0.92	0.91	0.91

Panel B: Real 5-5 Forward Rate	Foreign Flow Variable:		
	Total Bonds	Treasury Bonds	Foreign Official
rp_t	**11.02 (0.57)**	**10.55 (0.60)**	**11.01 (0.53)**
$deficit_{t-1}$	**0.11 (0.02)**	**0.23 (0.02)**	**0.28 (0.03)**
$foreign_t$	**-0.27 (0.02)**	**-0.35 (0.03)**	**-0.61 (0.06)**
R^2	0.88	0.85	0.84

Table 4: Global Model Including Corporate Savings

OLS regressions explaining the 10-year Treasury yield, $i_{t,10}$, using domestic variables (including corporate savings) and a global foreign flows variable. The specification is as follows:

$$i_{t,10} = a + b\pi^e_{t+10} + (1-b)ff_t + c(\pi^e_{t+1} - \pi^e_{t+10}) + d(rp_t) + e(y^e_{t+1}) + f(deficit_{t-1}) + g(foreign_t) + h(fingap_t) + \varepsilon_t$$

where π^e_{t+10} and π^e_{t+1} are 10-year- and 1-year-ahead inflation expectations; ff_t is the federal funds rate; rp_t is an interest rate risk premium; y^e_{t+1} is expected real GDP growth over the next year; $deficit_{t-1}$ is the structural budget deficit (scaled by lagged GDP); $foreign_t$ are 12-month foreign flows in U.S. bonds (scaled by lagged GDP); and $fingap_t$ is the financing gap (from Federal Reserve Flow of Funds (Table F. 102, line 59)), scaled by GDP. There are three alternative definitions of $foreign_t$: Total Bonds are the benchmark-consistent flows from all foreign investors into all U.S. bonds (Treasury, agency, and corporates); Treasury Bonds are reported foreign flows into Treasury bonds; and Foreign Official are foreign governments' purchases of Treasury securities. Standard errors are reported in parentheses (robust to heteroskedasticity and serial correlation). Highly significant coefficients (at the 1% level) are shown in bold; [a] and [b] denote significance at the 5% and 10% levels, respectively. Constants included but not reported. Unlike other regressions in this paper, the sample here is quarterly (1984:Q1 – 2005:Q1). Yields are measured in percentage points.

DepVar: 10-year yield	Foreign Flow Variable:		
	Total Bonds	Treasury Bonds	Foreign Official
π^e_{t+10}	**0.69 (0.07)**	**0.54 (0.07)**	**0.65 (0.07)**
$\pi^e_{t+1} - \pi^e_{t+10}$	**0.87 (0.37)**	0.23 (0.34)	0.77[a] (0.37)
y^e_{t+1}	**0.38 (0.14)**	0.22[b](0.13)	0.25[b](0.13)
rp_t	**6.16 (1.02)**	**4.28 (1.06)**	**5.78 (1.03)**
ff_t	**0.31 (0.07)**	**0.46 (0.07)**	**0.35 (0.07)**
$deficit_{t-1}$	**0.13 (0.05)**	**0.21 (0.04)**	**0.25 (0.04)**
$foreign_t$	**-0.22 (0.03)**	**-0.23 (0.04)**	**-0.52 (0.10)**
$fingap_t$	-0.03 (0.09)	-0.15 (0.09)	-0.15 (0.09)
R^2	0.91	0.90	0.88

Table 5: Global Model Including Foreign Spread

OLS regressions explaining the 10-year Treasury yield, $i_{t,10}$, using domestic variables, a global foreign flows variable, and a foreign spread variable. The specification is as follows:

$$i_{t,10} = a + b\pi_{t+10}^e + (1-b)ff_t + c(\pi_{t+1}^e - \pi_{t+10}^e) + d(rp_t) + e(y_{t+1}^e) + f(deficit_{t-1}) + g(foreign_t) + h(spread_t) + \varepsilon_t$$

where π_{t+10}^e and π_{t+1}^e are 10-year- and 1-year-ahead inflation expectations; ff_t is the federal funds rate; rp_t is an interest rate risk premium; y_{t+1}^e is expected real GDP growth over the next year; $deficit_{t-1}$ is the structural budget deficit (scaled by lagged GDP); $foreign_t$ are 12-month foreign flows in U.S. bonds (scaled by lagged GDP); and $spread_t$ is the spread of foreign interest rates over U.S. rates, where foreign rates are a simple average of long rates in Germany, Japan, and the UK. There are three alternative definitions of $foreign_t$: Total Bonds are the benchmark-consistent flows from all foreign investors into all U.S. bonds (Treasury, agency, and corporates); Treasury Bonds are reported foreign flows into Treasury bonds; and Foreign Official are foreign governments' purchases of Treasury securities. Standard errors are reported in parentheses (robust to heteroskedasticity and serial correlation). Highly significant coefficients (at the 1% level) are shown in bold; [a] and [b] denote significance at the 5% and 10% levels, respectively. Constants included but not reported. Yields are measured in percentage points.

DepVar: 10-year yield	Foreign Flow Variable:		
	Total Bonds	Treasury Bonds	Foreign Official
π_{t+10}^e	**0.80 (0.03)**	**0.75 (0.03)**	**0.73 (0.03)**
$\pi_{t+1}^e - \pi_{t+10}^e$	**1.14 (0.19)**	**1.09 (0.18)**	**1.11 (0.18)**
y_{t+1}^e	**0.15 (0.06)**	-0.01 (0.06)	0.00 (0.05)
rp_t	**3.50 (0.50)**	**1.78 (0.51)**	**3.18 (0.50)**
ff_t	**0.20 (0.03)**	**0.25 (0.03)**	**0.27 (0.03)**
$deficit_{t-1}$	**0.13 (0.02)**	**0.25 (0.02)**	**0.25 (0.02)**
$foreign_t$	**-0.23 (0.02)**	**-0.32 (0.03)**	**-0.32 (0.05)**
$spread_t$	**-0.38 (0.04)**	**-0.43 (0.04)**	**-0.29 (0.04)**
R^2	0.93	0.92	0.91

Table 6: Global Models of Other Long-Term Interest Rates

OLS regressions explaining the Aaa corporate bond rate (Panel A), Baa corporate bond rate (Panel B), and the 30-year fixed mortgage rate (Panel C). The general specification is as follows:

$$i_t = a + b\pi_{t+10}^e + (1-b)ff_t + c(\pi_{t+1}^e - \pi_{t+10}^e) + d(cycle_t) + e(rp_t) + f(y_{t+1}^e) + g(deficit_{t-1}) + h(foreign_t) + \varepsilon_t$$

where i_t is the nominal interest rate (Aaa, Baa, or 30-year fixed); π_{t+10}^e and π_{t+1}^e are 10-year- and 1-year-ahead inflation expectations; $cycle_t$ is a business cycle indicator computed as the real-time change in employment relative to its 36-month average; ff_t is the federal funds rate; rp_t is an interest rate risk premium; y_{t+1}^e is expected real GDP growth over the next year; $deficit_{t-1}$ is the structural budget deficit (scaled by lagged GDP); and $foreign_t$ are 12-month foreign flows in U.S. bonds (scaled by lagged GDP).

There are three alternative definitions of $foreign_t$: Total Bonds are the benchmark-consistent flows from all foreign investors into all U.S. bonds (Treasury, agency, and corporates); Treasury Bonds are reported foreign flows into Treasury bonds; and Foreign Official are foreign governments' purchases of Treasury securities. Standard errors are reported in parentheses (robust to heteroskedasticity and serial correlation). Highly significant coefficients (at the 1% level) are shown in bold; [a] and [b] denote significance at the 5% and 10% levels, respectively. Constants included but not reported. The sample is monthly from January 1984 to May 2005. Yields are measured in percentage points.

Panel A: Aaa Corporate	Foreign Flow Variable:		
	Total Bonds	Treasury Bonds	Foreign Official
π_{t+10}^e	**0.80 (0.03)**	**0.75 (0.02)**	**0.82 (0.03)**
$\pi_{t+1}^e - \pi_{t+10}^e$	**0.42 (0.14)**	0.24[b] (0.14)	**0.60 (0.16)**
y_{t+1}^e	**0.30 (0.06)**	0.14[a] (0.06)	**0.18 (0.06)**
$cycle_t$	-0.05 (0.16)	0.01 (0.16)	-0.24 (0.16)
rp_t	**5.94 (0.56)**	**5.01 (0.53)**	**5.50 (0.53)**
ff_t	**0.20 (0.03)**	**0.25 (0.02)**	**0.18 (0.03)**
$deficit_{t-1}$	-0.05[a](0.02)	**0.06 (0.02)**	**0.09 (0.02)**
$foreign_t$	**-0.24 (0.02)**	**-0.30 (0.03)**	**-0.50 (0.05)**
R^2	0.93	0.92	0.91

Panel B: Baa Corporate	Foreign Flow Variable:		
	Total Bonds	Treasury Bonds	Foreign Official
π^e_{t+10}	**0.87 (0.03)**	**0.82 (0.03)**	**0.90 (0.03)**
$\pi^e_{t+1} - \pi^e_{t+10}$	0.33[a](0.15)	0.15 (0.15)	**0.52 (0.17)**
y^e_{t+1}	**0.25 (0.07)**	0.09 (0.06)	0.11[b] (0.06)
$cycle_t$	**-0.47 (0.18)**	-0.36[a] (0.18)	**-0.62 (0.18)**
rp_t	**9.06 (0.63)**	**7.98 (0.57)**	**8.25 (0.57)**
ff_t	**0.13 (0.03)**	**0.18 (0.03)**	**0.10 (0.03)**
$deficit_{t-1}$	-0.07[a](0.03)	**0.06 (0.02)**	**0.10 (0.02)**
$foreign_t$	**-0.27 (0.02)**	**-0.37 (0.03)**	**-0.63 (0.05)**
R^2	0.93	0.93	0.92

Panel C: 30-year Fixed Mortgage Rate	Foreign Flow Variable:		
	Total Bonds	Treasury Bonds	Foreign Official
π^e_{t+10}	**0.64 (0.03)**	**0.60 (0.03)**	**0.66 (0.03)**
$\pi^e_{t+1} - \pi^e_{t+10}$	0.32[a] (0.15)	0.10 (0.14)	0.35[b] (0.16)
y^e_{t+1}	**0.31 (0.06)**	**0.16 (0.06)**	**0.16 (0.06)**
$cycle_t$	-0.21 (0.17)	-0.10 (0.17)	-0.42[b] (0.17)
rp_t	**6.13 (0.63)**	**5.31 (0.59)**	**5.87 (0.59)**
ff_t	**0.36 (0.03)**	**0.40 (0.03)**	**0.34 (0.03)**
$deficit_{t-1}$	**0.08 (0.03)**	**0.18 (0.02)**	**0.20 (0.02)**
$foreign_t$	**-0.20 (0.02)**	**-0.29 (0.03)**	**-0.46 (0.05)**
R^2	0.94	0.94	0.93

Table 7: Regression Results for Short-Term Rates

OLS regressions explaining the 2-year Treasury yield (Panel A) and the 1-year ARM (Panel B). The general specification is as follows:

$$i_t = a + b\pi^e_{t+10} + (1-b)ff_t + c(\pi^e_{t+1} - \pi^e_{t+10}) + d(cycle_t) + e(rp_t) + f(y^e_{t+1}) + g(deficit_{t-1}) + h(foreign_t) + \varepsilon_t$$

where i_t is the nominal interest rate (2-year Treasury or 1-year ARM); π^e_{t+10} and π^e_{t+1} are 10-year- and 1-year-ahead inflation expectations; $cycle_t$ is a business cycle indicator computed as the real-time change in employment relative to its 36-month average; ff_t is the federal funds rate; rp_t is an interest rate risk premium; y^e_{t+1} is expected real GDP growth over the next year; $deficit_{t-1}$ is the structural budget deficit (scaled by lagged GDP); and $foreign_t$ are 12-month foreign flows in U.S. bonds (scaled by lagged GDP).

There are three alternative definitions of $foreign_t$: Total Bonds are the benchmark-consistent flows from all foreign investors into all U.S. bonds (Treasury, agency, and corporates); Treasury Bonds are reported foreign flows into Treasury bonds; and Foreign Official are foreign governments' purchases of Treasury securities. Standard errors are reported in parentheses (robust to heteroskedasticity and serial correlation). Highly significant coefficients (at the 1% level) are shown in bold; [a] and [b] denote significance at the 5% and 10% levels, respectively. Constants included but not reported. The sample is monthly from January 1984 to May 2005. Yields are measured in percentage points.

Panel A: 2-year Treasury	Foreign Flow Variable:		
	Total Bonds	Treasury Bonds	Foreign Official
π^e_{t+10}	**0.22 (0.03)**	**0.17 (0.03)**	**0.19 (0.03)**
$\pi^e_{t+1} - \pi^e_{t+10}$	**0.48 (0.16)**	0.36[a] (0.16)	0.40[a] (0.17)
y^e_{t+1}	**0.20 (0.06)**	0.15[a] (0.06)	0.12[a] (0.06)
$cycle_t$	**0.86 (0.19)**	**0.75 (0.19)**	**0.51 (0.17)**
rp_t	**1.91 (0.60)**	1.48[a] (0.60)	**1.98 (0.61)**
ff_t	**0.78 (0.03)**	**0.83 (0.03)**	**0.81 (0.03)**
$deficit_{t-1}$	0.07[a] (0.03)	**0.09 (0.03)**	**0.14 (0.03)**
$foreign_t$	**-0.11 (0.02)**	**-0.09 (0.03)**	-0.09[b] (0.06)
R^2	0.95	0.95	0.94

Panel B: 1-year ARM	Foreign Flow Variable:		
	Total Bonds	Treasury Bonds	Foreign Official
π^e_{t+10}	**0.45 (0.03)**	**0.45 (0.03)**	**0.50 (0.02)**
$\pi^e_{t+1} - \pi^e_{t+10}$	-0.16 (0.13)	-0.23[b] (0.12)	-0.03 (0.14)
y^e_{t+1}	**0.42 (0.06)**	**0.35 (0.05)**	**0.34 (0.05)**
$cycle_t$	**-0.97 (0.17)**	**-0.78 (0.16)**	**-0.92 (0.16)**
rp_t	**5.51 (0.61)**	**5.13 (0.56)**	**5.38 (0.53)**
ff_t	**0.55 (0.03)**	**0.55 (0.02)**	**0.50 (0.02)**
$deficit_{t-1}$	**-0.09 (0.02)**	**-0.06 (0.02)**	-0.03[b] (0.02)
$foreign_t$	**-0.08 (0.02)**	**-0.19 (0.02)**	**-0.36 (0.05)**
R^2	0.96	0.96	0.96

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Figure 1. Foreign Inflows into U.S. Bonds
Both variables are 12-month flows scaled by lagged GDP. Data on foreign official purchases of Treasuries are from FRBNY's H.4.1 release. Data of total foreign purchases of U.S. bonds are our benchmark-consistent flows, which are described in detail in the appendix.

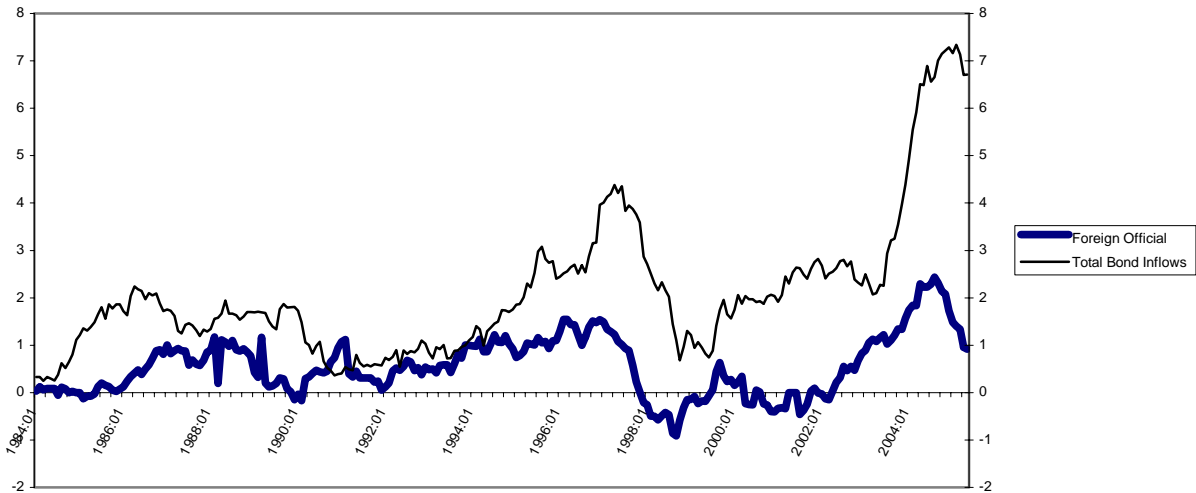**Foreign Official Purchases of US Treasuries and Total Foreign Purchases of US Bonds (as a percent of lagged GDP)**

Figure 2. Long-Term Treasury Yield: Actual vs. Fitted using domestic variables
Fitted uses the domestic model of Table 1.

10-year Treasury Yield (%)

42
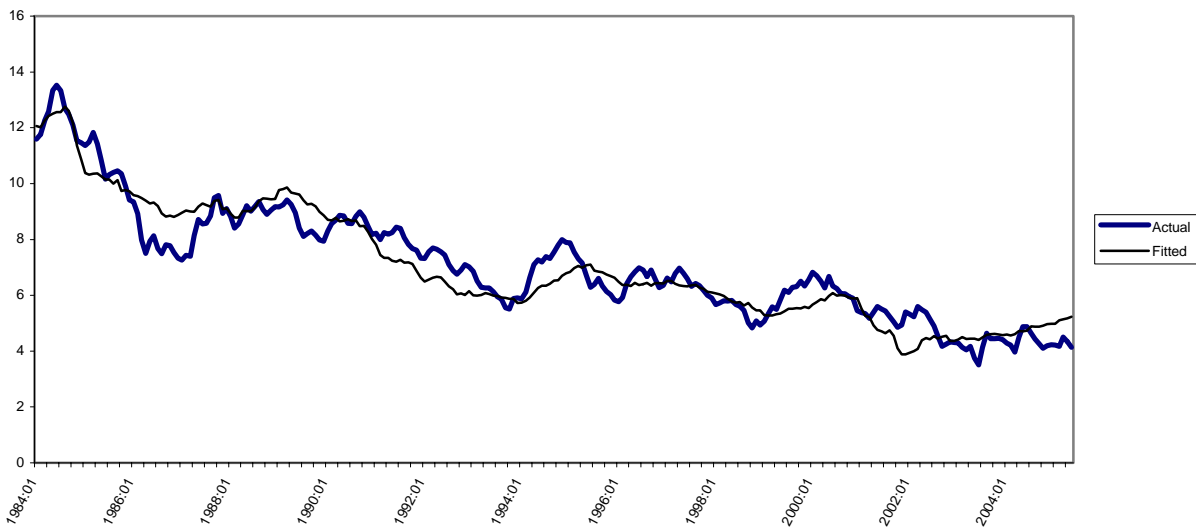
Figure 3. TIC-based Estimates of Foreign Positions in U.S. Bonds

TIC-based estimates start from benchmark survey amounts, shown by the large circles, and are formed by applying equation (A1); see the appendix for details. Major discrepancies in TIC-based estimates and the benchmark surveys are indicative of problems with the TIC data. All data are in billions of dollars.
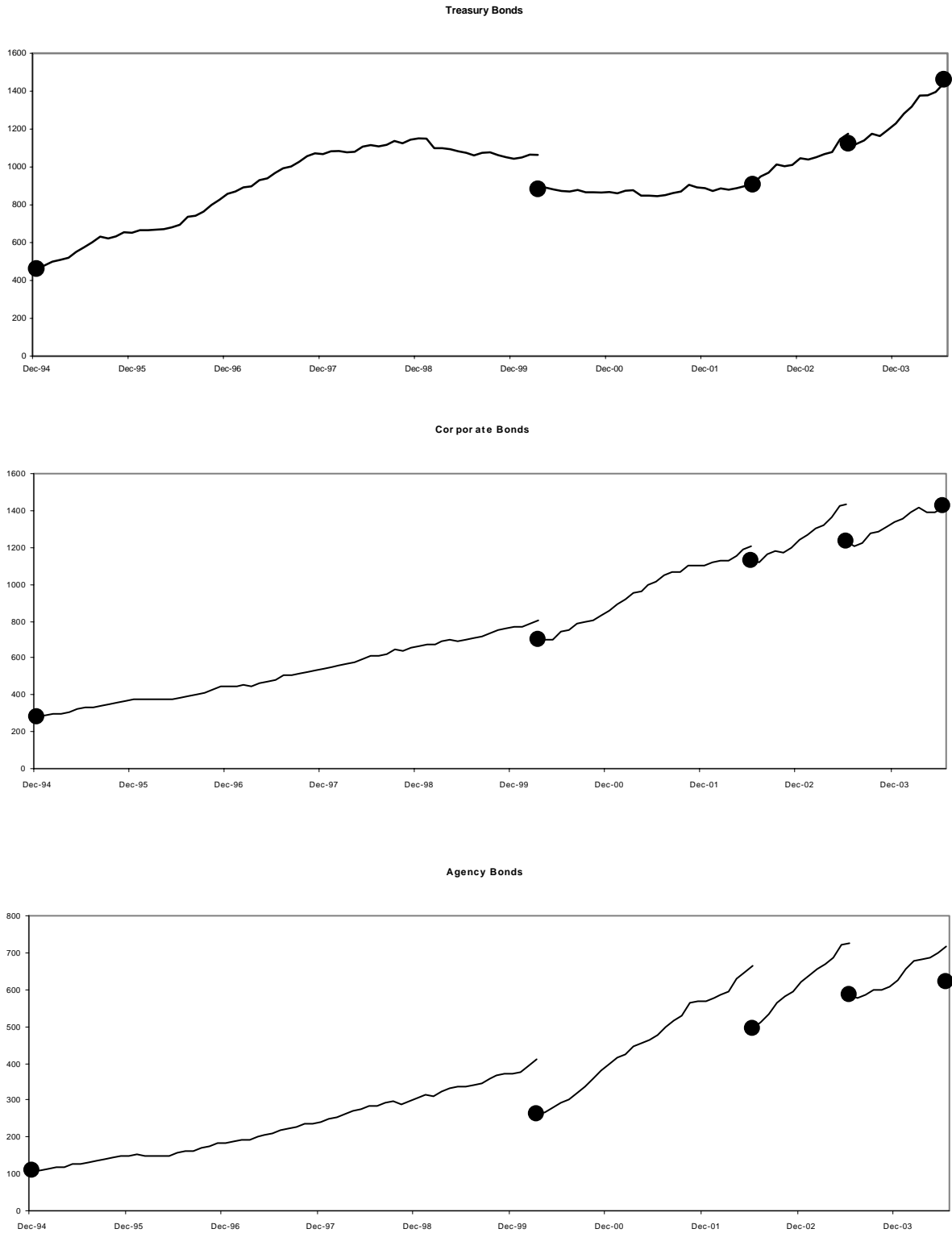
Treasury Bonds

Corporate Bonds

Agency Bonds

43

Figure 4. Long-Term Treasury Yield and the Federal Funds Rate

10-year Treasury Yield and the Federal Funds Rate
(%)

44
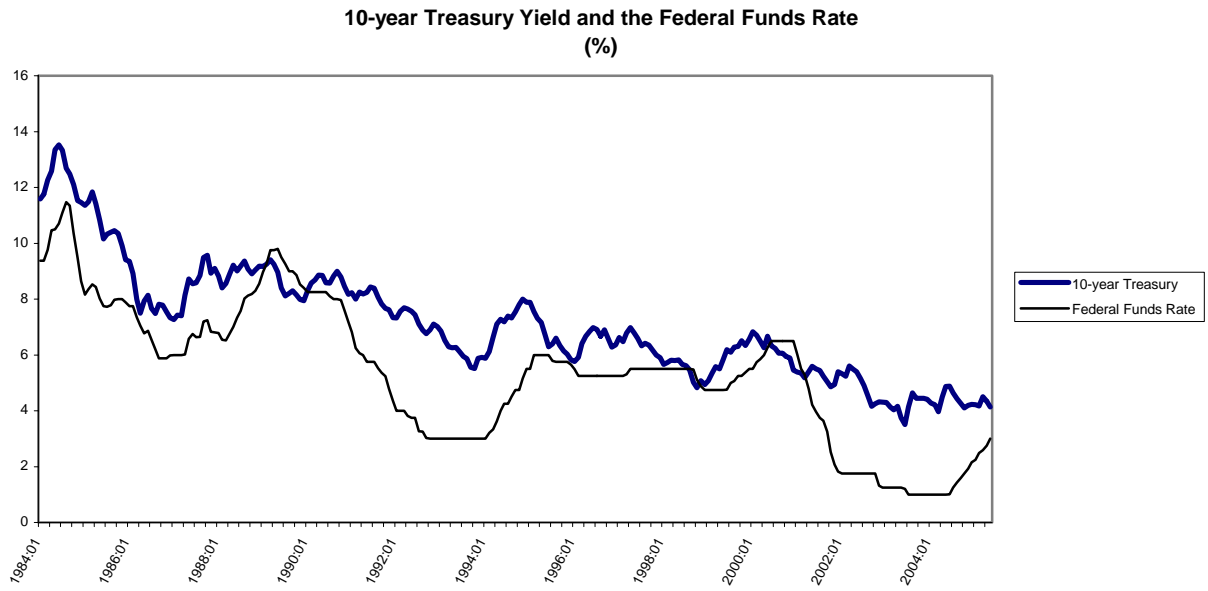
Figure 5. Long-Term Treasury Yield: Actual vs. Fitted including capital flows
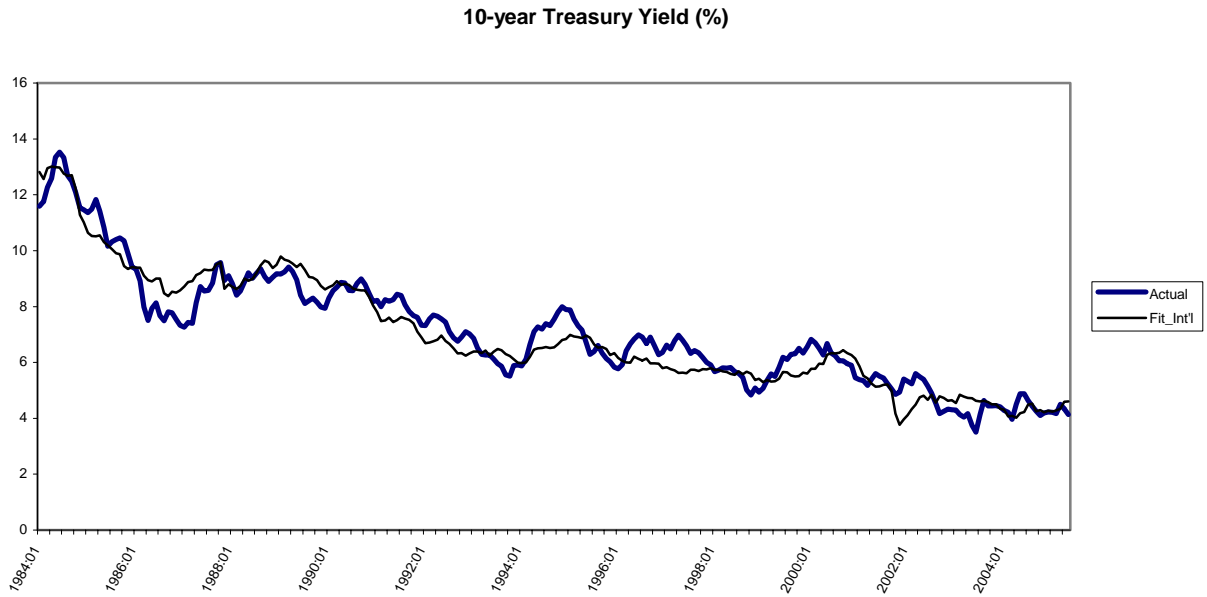Fitted uses the global model of Table 2.

10-year Treasury Yield (%)

Figure 6: Impact of Foreign Flows into US Bonds on 10-year Treasury Yields
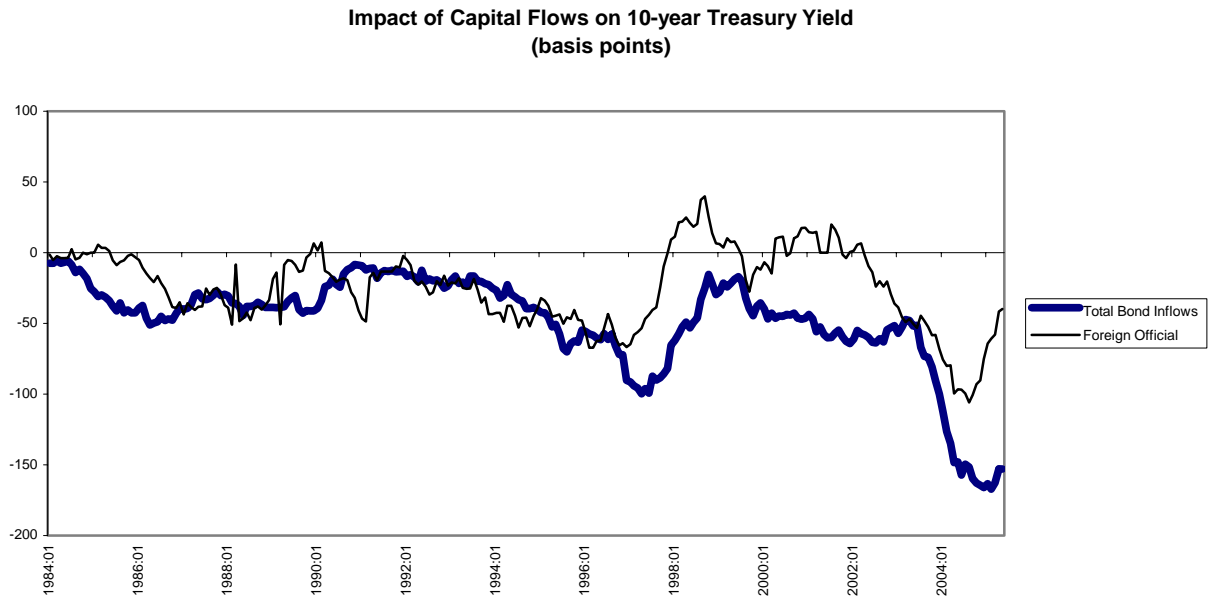Impact is calculated from the coefficient estimates in Columns 1 and 3 of Table 2.

Impact of Capital Flows on 10-year Treasury Yield
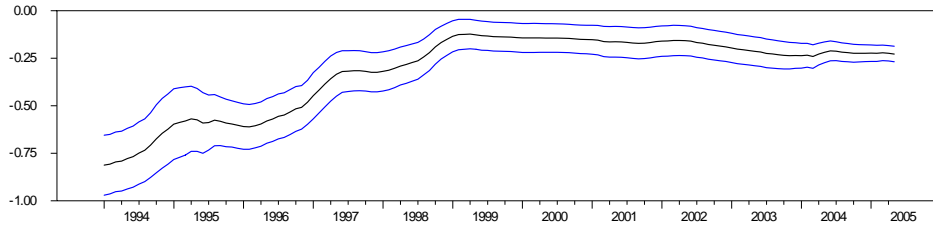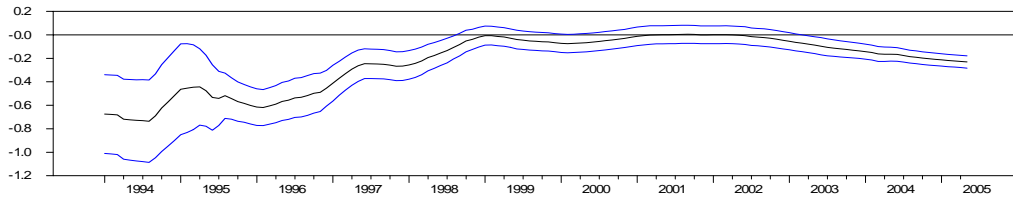**(basis points)**

Figure 7. Coefficient Estimate on Foreign Flow Variables

Coefficient estimate is from rolling regressions of the models in Table 2.

(a) Total Bonds

(b) Treasury Securities

(c) Foreign Official