

# Estimating Capital Gains using Data at Multiple Frequencies

Emel O. Yildirim\*

November 9, 2009

## Abstract

The capital gains on US owned assets abroad and the foreign owned assets in US is important in global imbalances discussions because it is one part of the total return to be calculated along with the income received. One way to estimate the capital gain is to use the difference in change in position and the flows. This method however is shown to overestimate the capital gain due to internal inconsistency issues present in the revised data provided by BEA (Curcuro, Dvorak and Warnock 2008, see).

This paper shows that using the Kalman filter method is a simple alternative way to estimate implied capital gains and to correct for possible measurement errors and biases due to revisions. I used annually published international investment data and quarterly published international transactions data published by BEA and estimate quarterly capital gains on US asset and liabilities as well as show that equity flows are significantly undermeasured.

**Keywords:** Global Imbalances, International Investment Position

**JEL Classification:** F3

---

\*Rutgers University, Department of Economics, 75 Hamilton St. New Brunswick NJ,08904. PhD Candidate. E-mail: eyildirim@econ.rutgers.edu. I am grateful to Roberto Chang and John Landon-Lane for their valuable comments and suggestions. All mistakes are mine.

# 1 Introduction

The external asset and liability balance of United States is at the heart of the global imbalances discussions. Over the years the amount of US wealth sent abroad gets larger, however compared to the amount received from the rest of the world US is in deficit. The size of this accumulated debt over time causes discussions about its sustainability and possible effects on the dollar.

Every July, Bureau of Economics Analysis (BEA) publishes the preliminary estimation of the US assets abroad and foreign held assets in the US under International Investment Position (IIP) category. The revised results are published in the July of the following year. This estimation results report the end of the year value of the US external assets and liabilities taking possible value and currency changes into account.

Aside from the IIP, the accumulation of the net debt could be calculated using the value of the net investment flows during the year. The flows are calculated as a part of balance of payment and published under International Transactions category quarterly. Unlike IIP, this data only reflects the value invested abroad and received from the rest of the world during the period and does not include the value gains on previous investments.

The Figures 1 and 2 show two different ways to look at the US asset and liability flows: Using current account balance (outflows-inflows) and change in international investment position. The difference between the two calculation tells us about the net value gain over the year which is called implied value gain.

Figure 1: Change in External Asset Position: 1977-2007

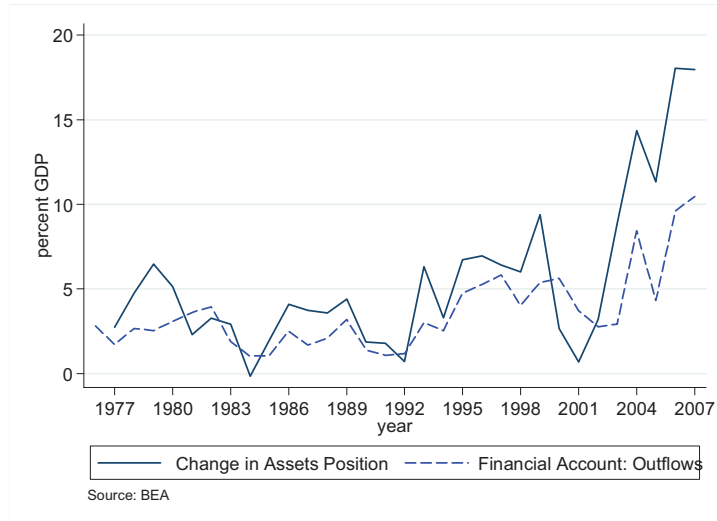
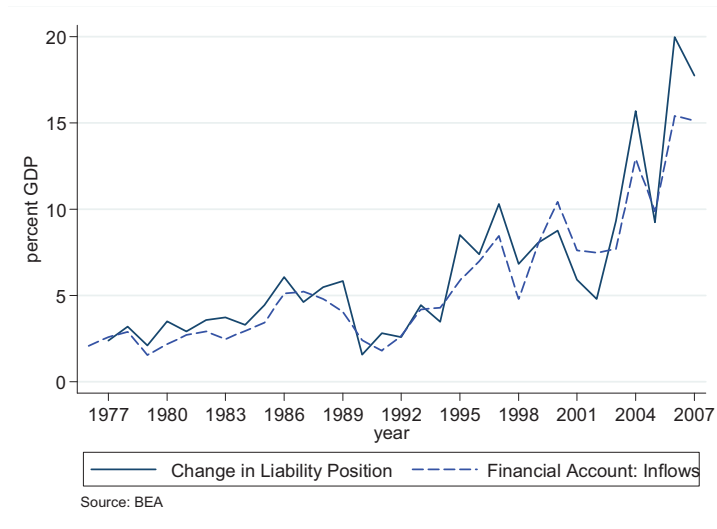


Figure 2: Change in External Liability Position : 1977-2007



The implied value gain however is subject to mis-estimation due to the fact that flows are not fully revised Curcuru, Dvorak and Warnock (2007).

Overestimated value gain leads to overestimation of total return which includes the net value gain and income yield.

This paper builds on the value gain estimation literature by suggesting the Kalman filter method as a simple alternative way to estimate implied capital gains and to correct for possible measurement errors and biases due to revisions.

Value gain calculation requires to know the weight of the countries in US portfolio for each category like FDI, portfolio investment etc. , the currency denomination of the investment, and asset prices. Curcuru et al. (2008) constructs monthly total returns on US assets and liabilities using monthly cross-border asset positions with countries that composed of th 70% of the US foreign portfolio. Similarly, Grouinchas and Rey (2007) constructs quarterly foreign asset position using the calculated value gain based on a tedious accounting exercise.

Yildirim (2009) suggests that using Kalman filter estimation it is possible to correct the data for mismeasurements and estimate the value gain. The paper uses private data constructed by Grouinchas and Rey (2007) and Bertaut and Tryon (2006) to show that even though constructed differently Kalman filter estimation yields similar rate of value gain.

This paper is similar to Yildirim (2009) however is different in two ways. Rather than using a previously constructed data sets this paper uses the data on US international investment published regularly by BEA. The fact that BEA publishes the international investment position and international transactions at different frequencies was overcome using the method suggested by Mariano and Murasawa (2003).

This rest of the paper is organized as follows: section 2 will introduce the model, section 3 will present the result, and section 4 will conclude.

## 2 The Model

This model is derived to estimate quarterly value gains using annual and quarterly data sources. The international investment position is published annually by BEA, shows the current value of the US assets held abroad and foreign-held US assets based on the surveys.

Year to year change in IIP <sup>1</sup> from the previous year can be formulated as the sum of the unobserved changes in IIP every quarter.

$$IIP_t - IIP_{t-4} = \Delta IIP_t^* + \Delta IIP_{t-1}^* + \Delta IIP_{t-2}^* + \Delta IIP_{t-3}^* \quad (1)$$

,where  $\Delta IIP_t^* = IIP_t^* - IIP_{t-1}^*$ , is the unobserved quarterly change in asset and liability positions. The change in investment position at the end of a quarter depends on flows,  $Flow_t$  and value gain,  $Val_t$ , due to price and exchange rate fluctuations.

$$\Delta IIP_t = Flow_t + Val_t \quad (2)$$

The revised international investment data,  $IIP_t$  reflects the true value of investment position however, the amount of flows during the quarter,  $Flow_t$

---

<sup>1</sup>I prefer to use one notation for both assets and liabilities. Generally, the US-owned foreign assets will be referred as "Assets" and foreign owned US assets will be referred as "Liabilities".

is mismeasured even after the revisions because of the dynamic nature of the financial transactions (Curcuro et al. 2008).

So, I will assume that the net inflows/net outflows published, ( $FL_t$ ), is a fraction of the true flows ( $Flow_t$ ) .

$$Flow_t = \beta FL_t \quad (3)$$

Change in international investment position from a year ago,  $\Delta^4 IIP_t$  has two major components; quarterly net flows,  $FL_t$ , and value gain,  $Val_t$  received during the year. Combining the equations 2 and 1 yields

$$\begin{aligned} \Delta^4 IIP_t = & \beta (FL_t + FL_{t-1} + FL_{t-2} + FL_{t-3}) + \\ & Val_t + Val_{t-1} + Val_{t-2} + Val_{t-3} \end{aligned} \quad (4)$$

To construct the measurement equation divide the equation 4 by annual GDP. Rearranging it yields;

$$\Delta iip_t = \beta F_t + w_{t,t-3}^t kg_t + w_{t,t-3}^{t-1} kg_{t-1} + w_{t,t-3}^{t-2} kg_{t-2} + w_{t,t-3}^{t-3} kg_{t-3} \quad (5)$$

$$F_t = fl_t w_{t,t-3}^t + fl_{t-1} w_{t,t-3}^{t-1} + fl_{t-2} w_{t,t-3}^{t-2} + fl_{t-3} w_{t,t-3}^{t-3} \quad (6)$$

The first part of right hand side shows the weighted average of total flows,  $F_t$  corrected for mismeasurement by  $\beta$ . If  $\beta$  is estimated as larger than 1 than the actual flows are larger than what is reported, so flows are underestimated. If it is less than one than the flows are overestimated.

Here,  $fl_t = \frac{FL_t}{GDP_t}$  denotes quarterly flows to quarterly GDP ratio. Hence

the weights,  $w_{t,t-3}^t = \frac{GDP_t}{GDP_{t,t-3}}$ , show the ratio of the GDP in a given quarter and the annual GDP,  $GDP_{t,t-3}$  of that year.

In equation 6, the latent state variable is value gain to GDP ratio,  $kg_t$ , and its four lags. The transition equation of  $kg_t$  depends on its past value and exchange rate gain/loss to GDP ratio.

$$kg_t = \alpha_0 + \alpha_1 r_{EXR,t} * iip_{t-1} + \alpha_2 kg_{t-1} + \nu_t \quad (7)$$

where  $iip_{t-1} = \frac{IIP_{t,t-3}}{GDP_{t,t-3}}$ . The last part of the right hand side will measure the value gain due to exchange rate changes.  $r_{EXR,t}$  is the percentage change in exchange from quarter  $t - 1$  to  $t$ .

This paper used trade weighted exchange rate which is a weighted average of the currencies of the major trading partners of the US. A negative change in the exchange rate means a depreciation in the US dollar. Since most of the US foreign asset is denominated in foreign currency, a depreciation in dollar should contribute to value gain positively (Gourinchas and Rey 2007). So, estimated value of  $\alpha_2$  is expected to be negative and show the contribution of the exchange rate changes to value gain.

The method suggested by (Mariano and Murasawa 2003) uses maximum likelihood estimation of factor models. The state-space formulation requires measurement and transition equation. Which can be summeried as follows:

$$y_t^+ = \beta F_t + H_t s_t \quad (8)$$

$$s_t = a_0 + a_1 * z_t + a_3 * s_{t-1} + \nu_t \quad (9)$$

where  $s_t = \begin{bmatrix} kg_t \\ kg_{t-1} \\ kg_{t-2} \\ kg_{t-3} \end{bmatrix}$  is latent state vector,  $H_t = \begin{bmatrix} w_{t,t-3}^t & w_{t,t-3}^{t-1} & w_{t,t-3}^{t-2} & w_{t,t-3}^{t-3} \end{bmatrix}$

is the weights, and  $F_t$  is weighted average of the flows as defined before.

Note that  $y_t^+$  is only observed once every four quarter. The quarters where it is missing will be replaced by iid random draws from standard normal distribution.

The list of parameters of the state-space system to be estimated are as follows:  $\Theta = \{\alpha_0, \alpha_1, \alpha_2, \beta, \sigma_{nu}\}$ . They will be estimated using the likelihood generated by the Kalman filter applied to multi frequency data described by Mariano and Murasawa (2003) .

The paper argues that aggregating data to match the lowest frequency does not yield the same results as using it at the original frequency.

### 3 Results

The estimation results are consistent with Curcuru et al. (2008) argument that the flows are under measured. Table 1 summarizes the estimated coefficients for both the US foreign assets and liabilities.

The estimated value of  $\beta$  , 1.4, is significantly different than zero as well as one in asset category. This coefficient tells us that assets flows (outflows) are under measured. The true flows are on average 1.4 times bigger than that is published. The value for liabilities is significantly different than zero. However 10% confidence interval includes 0.948. The amount of mismea-

Table 1: Estimated Coefficients

	$\beta$	$\alpha_0$	$\alpha_1$	$\alpha_2$	$\sigma_{nu}$
Assets	1.397* (0.203)	0.036 (0.329)	-0.737* (0.285)	0.638* (0.151)	1.84* (0.448)
Liabilities	1.128* (0.09)	-0.203 (0.464)	-0.306 (0.327)	0.27 (0.536)	2.308* (1.255)

Standard errors are reported under each coefficient in parenthesis.

Star (\*) shows significance at 10% level.

The data covers 1983 first quarter to 2007 fourth quarter.

surement in liability category is much less compared to the assets, which is in line with the mismeasurement calculations in the literature (Curcuro et al. 2008, Yildirim 2009).

After the data is published by BEA for the first time, in the following years the figures are updated based on updated source of data and presentations, as well as improved estimations (Bach 2008). Curcuro et al. (2008) argues that the amount of revisions done to position data far exceed the amount of revisions done to flows, due to the fact that revising the flows are quite difficult. As a result, this creates an internal inconsistency. If flows were measured correctly the value gain could be calculated using the difference between the change in the position and the flows. Now, however, the part of the flows that is not captured is attributed to value gain and the other part that is that is reported, published as "other changes" (Milesi-Ferretti and Lane 2009) .

The coefficient  $\alpha_0$  shows value gain as a rate of GDP when the effect of exchange rate is controlled. It is insignificant both for asset and liability

categories. The major source of value gain is obtained from the exchange rate fluctuations.

If all the foreign US assets are denominated in foreign currency, a 1% appreciation of the foreign currency would mean 1% value gain in dollars. The variable,  $r_{EXR,t} * iip_{t-1}$ , is value change in dollar to GDP ratio if US invests in foreign currency (assets in foreign currency) or foreign investors US assets are denominated in foreign currency .

Report on foreign portfolio holdings of US securities <sup>2</sup> show that more than 90% the foreign portfolio investment in the US is in long-term securities, 65% of which is long-term debt security and the rest is equity. The currency structure of these long-term debt is mostly (about 90%) in US dollar. So, if dollar loses value against the other currencies the value gain will not be drastically affected.

The asset side of the story, however is different. 76% of US holdings of foreign debt securities are denominated in dollar, which makes up more than half of the US portfolio investment abroad <sup>3</sup>. If the dollar loses value, the assets that are denominated in foreign currency will be more valuable in dollar terms.

Estimated value of the coefficient,  $\alpha_1$ , is significantly less than zero in the asset category. About 70% of  $r_{EXR,t} * iip_{t-1}$  is reflected to the capital gain . The coefficient of liabilities is much lower and insignificant as expected.

In the rate of return estimations the rate capital gain,  $kg_t$  is defined as a fraction of the past investment position,  $kg_t * IIP_{t-1}$ . This paper,

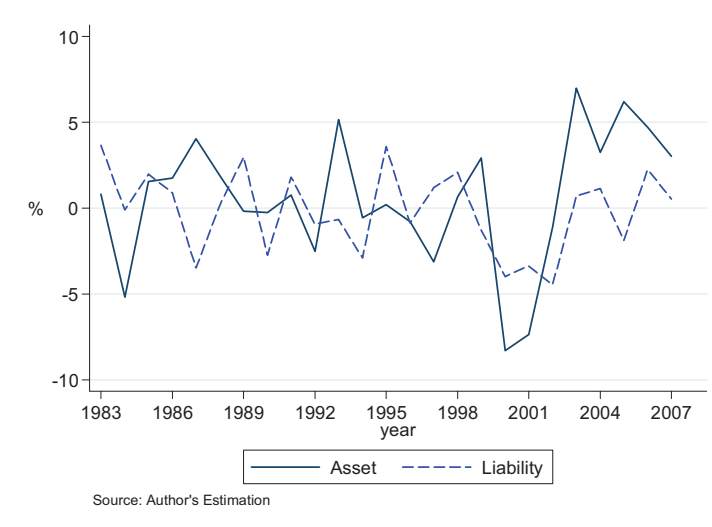
---

<sup>2</sup>Department of Treasury, Federal Reserve Bank of New York, April 2009

<sup>3</sup>Report on US Portfolio Holdings of Foreign Securities, Department of Treasury, Federal Reserve Bank of New York, October 2008

however estimated the value gain as a fraction of the GDP. Aggregating all value gain generated during the year and dividing by the previous years investment position level yields rate of capital gains.

Figure 3: Rate of Value Gains on Asset and Liability Positions : 1983-2007



The Figure 3 shows that rate of capital gain for asset and liability. The volatility of the liability side is much less compared to the asset side. After 1998 the rate of gain due to price and exchange rate fluctuations of US assets abroad fluctuates between -7% to 7%.

Next figure, Figure 4, has the estimated value gain on assets net of value gain on liabilities compared to the value gain reported by BEA under the net value adjustment category. In this figure the value gains are reported as percentage of GDP.

Under the international investment position section, BEA reports special tables which reports the selected major components of positions calculated.

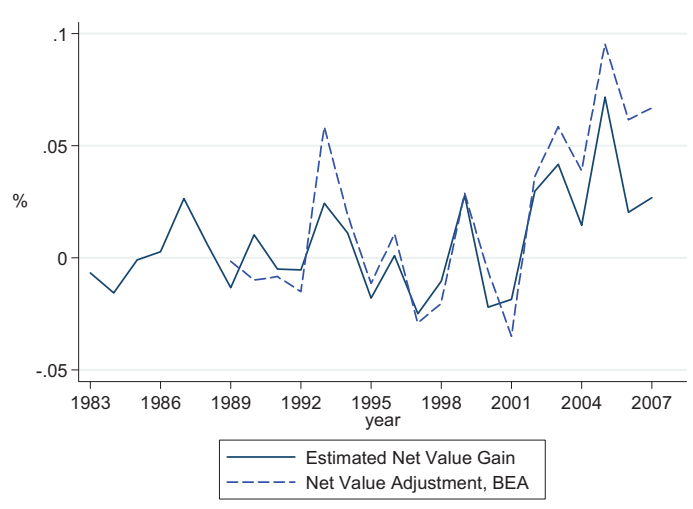


Figure 4: Estimated Net Value Gain vs. Net Value Adjustment, % GDP

These selected tables report the details of position estimates including the estimated valuation adjustments due to price and exchange rate changes <sup>4</sup>. The dashed line in the Figure 4 shows the value adjustment components of US foreign assets net of US foreign liabilities. We see that the estimated net value gain is less than the net value adjustment that BEA announces.

This difference is in line with the literature. One of the components of value adjustments is "Other Changes". The other changes category is argued to cover the part of the transactions that are not recorded under any flow category (Milesi-Ferretti and Lane 2009). So, part of the flows is captured under this category. As a result, the valuation adjustment is

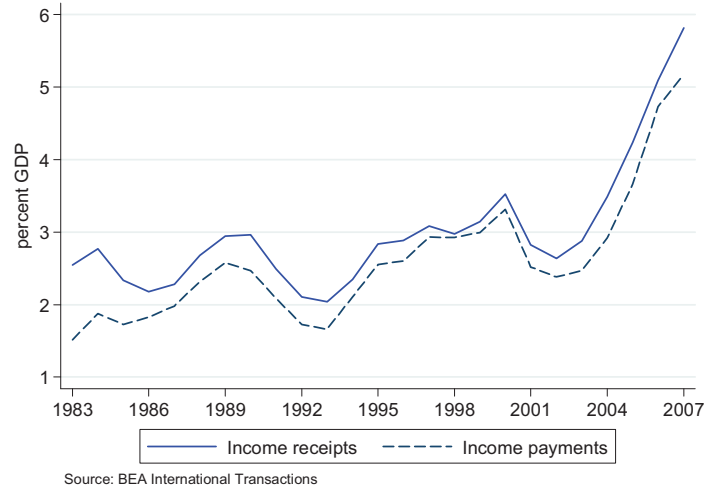
<sup>4</sup>I focus on the table: Components of Changes in the Net International Investment Position, With Direct Investment at Market Value, 1989-2008. Landefeld and Lawson (1991) shows that there is a difference between the market value method and current-cost method. The market value shows the net worth of direct investment which includes the stock value fluctuations.

overestimated and an implied capital gains calculation would yield higher rates.

$$\text{Total Return} = \frac{\text{Value Gain} + \text{Income Received}}{\text{Investment Position}} \quad (10)$$

A total return on investment position includes income received in addition to value gain. The income that foreign investors receive from investing in US has been less than the income that US receives from abroad. The data on income is published quarterly as a part of the current account balance by BEA. The Figure 5 shows the consistent positive net difference between the income that US receives and pays abroad.

Figure 5: Current Account Balance, Income Paid and Received



This graph is particularly interesting because since mid-1980s the difference between US foreign investment abroad and foreign investment in US is negative and the gap is getting larger. The preliminary estimation of this

gap for 2008 is about -3.5 trillion \$. So even though the foreigners are accumulating more and more US assets, the net income that they receive is less than what they pay to the US.

Table 2: Return on Asset vs. Liabilities

Year	Capital Gain		Total Return	
	Asset	Liability	Asset	Liability
2003	7.0	0.71	11.2	3.54
2004	3.3	1.13	7.7	4.13
2005	6.2	-1.87	11.2	1.76
2006	4.7	2.26	9.9	6.37
2007	3.0	0.53	8.2	4.59

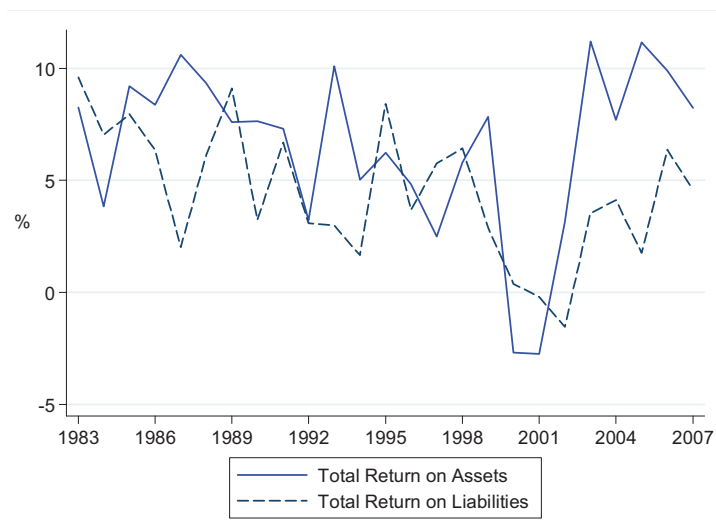
Source: Data on income and positions are taken from BEA International Transactions. Capital gain is author's estimation

The first block in Table 2, shows the estimated rate of capital gain on asset and liability positions over the last five years. The second block add the income earned abroad and reports the total returns. We see that during this period the US assets did earn significantly more than its liabilities.

The Figure 6 shows the total returns on US assets and liabilities from 1983 to 2007. We see that the total return on assets and liabilities has always been positive except the years 2000 and 2001. Even the income year during these two years were positive the capital gain especially on US foreign assets, was significantly negative.

The net return has not always been positive but positive for the most of the 24 years. On the contrary to the argument that the main contribution comes

Figure 6: Total Return on Asset and Liability Positions, 1983-2007

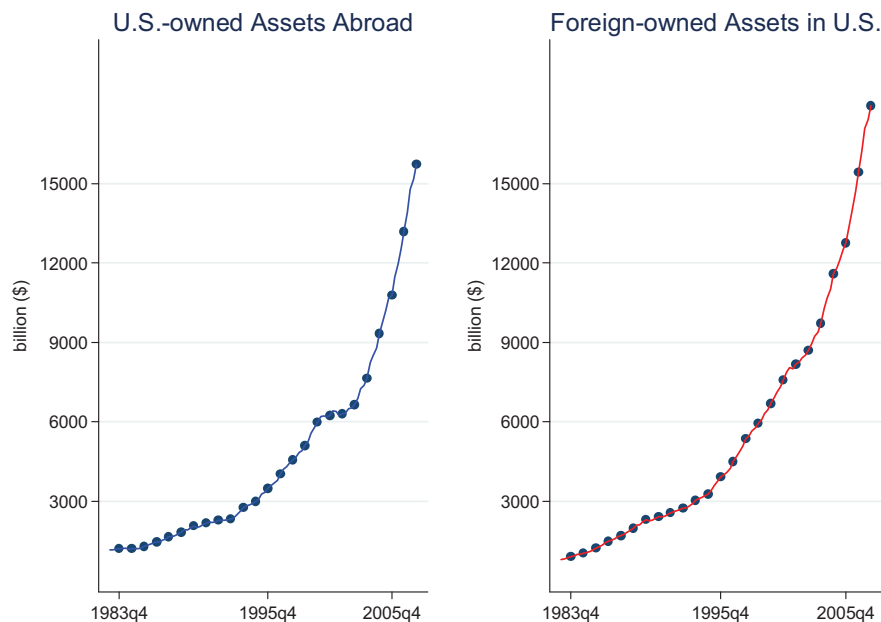


from the capital gains, my analysis shows that it actually income received abroad, mainly on FDI (Gourinchas and Rey (2007) , Cline (2005)).

The last contribution of the paper is that this method provides a simple alternative to estimate quarterly asset and liability positions. Knowing the quarterly value gains I constructed the quarterly asset and liability positions.

Figure 7 above shows the estimated quarterly levels compared with the end of year asset and liability positions published by BEA. Note that the transition of positions is modeled based on the new transactions acquired and the value gains. "Other Adjustments", as suggested by BEA, is counted as part of the value gain, once the mismeasurement in flows is taken into the account.

Figure 7: Annual vs. Quarterly Positions : 1983-2007



Note: The dots show investment position levels published by BEA

## 4 Conclusion

The capital gains on US owned assets abroad and the foreign owned assets in US is important in global imbalances discussions because it is one part of the total return to be calculated along with the income received.

One way to estimate the capital gain is to use the difference in change in position and the flows. This method however is shown to overestimate the capital gain due to internal inconsistency issues present in the revised data provided by BEA (Curcuru et al. 2008, see).

This paper shows that using maximum likelihood factor analysis with data at different frequencies capital gain can be estimated. I used annually

published international investment data and quarterly published international transactions data published by BEA, I found that the asset flows are underestimated and the true flows are on the average 1.3 times the published levels. The liability flows are however estimated as 1.1 times the published flows.

The estimated rate of capital flows fluctuates between -5% to 5% over the 24 years however there is no evidence that the gains on asset is larger than the gains on liabilities. When we include the income gain and calculated the total returns we see that the returns on US assets are larger than the ones on US liabilities, and the contribution of the returns on the asset positions goes up to 11% in some years.

## References

**Bach, Christopher**, “Annual Revisions of the U.S. International Accounts, 1974-2007,” *Survey of Current Business*, July 2008.

**Bertaut, Carol and Ralph Tryon**, “Monthly Estimates of U.S. Cross-Border Securities Position,” *Federal Reserve Board, International Finance Discussion Paper*, May 2006, pp. A59–A75.

**Cline, William R.**, *United States as a Debtor Nation: Risks and Policy Reform*, Institute for International Economics: Center for Global Development, 2005.

**Curcuru, Stephanie, Tomas Dvorak, and Francis Warnock**, “The Stability of Large External Imbalances: The Role of Returns Differentials,” *International Finance Discussion Papers*, April 2007, (894).

—, —, and —, “Cross-Border Return Differentials,” *The Quarterly Journal of Economics*, November 2008, 123 (4), 1495–1530.

**Gourinchas, Pierre-Olivier and Helene Rey**, *From World Banker to World Venture Capitalist: The U.S. External Adjustment and Exorbitant Privilege*, University of Chicago Press, 2007.

**Landefeld, Steven and Ann Lawson**, “Valuation of U.S. Net International Investment Position,” *Bureau of Economic Analysis, Survey of Current Business*, May 1991.

**Mariano, Roberto and Yasutomo Murasawa**, “A New Coincident Index of Business Cycles Based on Monthly and Quarterly Series,” *Journal of Applied Econometrics*, 2003, 18 (4), 427–443.

**Milesi-Ferretti, Gian Maria and Phillip Lane**, “Where Did All the Borrowing Go? A Forensic Analysis of the U.S. External Position,” *Journal of Japanese and International Economies*, June 2009, 23 (2), 177–199.

**Yildirim, Emel O.**, “Estimating Capital Gains on the U.S. Foreign Asset and Liability Positions,” *Rutgers University, Working Paper*, 2009.