

# U.S. National Debt Showing Significant Correlation to Years of Free Trade Deficits

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## Abstract

The U.S. free trade deficit has accumulated to \$6.57 trillion over the last 20 years and \$7.5 trillion since 1971. The U.S. national debt now totals around \$12.1 trillion. In fact, from 1990 to 2007 the trade deficit totaled \$5.51 trillion which was fairly close to the national debt in those years that totaled \$6.1 trillion. Thus, the trade deficit has accumulated to a sum of the same type of magnitude as the national debt. For every type of trade, whether it is an import or an export, there are tax consequences. Such consequence of a trade deficit may be correlated to the national debt. Our study in fact finds that there exists in the raw data an 87% mathematical correlation between the national debt and the free trade deficit in logically selected time periods when stable (non excessive) government spending and trading occurred. As well the X-Y relationship observed in the raw data indicates that the trade deficit is linked to approximately from \$1.7 to \$2.1 trillion of the national debt (i.e. worst case, 17% of America's current national debt).

**Key Words:** U.S. Trade Deficit, U.S. National Debt, National Debt Correlation Study

## 1. Introduction

The investigation provided here, shows a fairly strong mathematical correlation between the free trade deficit and the national debt. Correlations are sought all the time in many areas. For example in health, we know that being overweight is correlated to diabetes; smoking has been correlated to lung cancer and emphysema, and so forth.

The concern is a trade imbalance also provides tax consequences representing a combination of ways in which taxes are collected depending on the type of trade (import vs. export) for goods and services. As a simple example, the U.S. collects tax revenues on U.S. worker salaries for exported services compared to imported services for which no salary taxes are collected from foreign workers. This illustrates one simple difference in tax consequences that can occur depending on the type of trade imbalance. Other types of tax consequences are provided in Appendix A.

Despite the complex nature in interpreting the origin of the national debt data and tax consequences occurring in different types of trading, mathematically we can simply look at the raw data to see if there is in fact a correlation. Here we find that the raw data indicates a reasonably strong correlation of about 87% in select time periods between 1990 and 2008. In order to identify the possibility of a mathematical correlation, logically certain years are able to reveal the underlining relation better than other periods in the historical data set (see Table 1). For example, the two can be unrelated in certain periods. We know that the trade deficit in 1990 to about 1995 was minimal compared to the national debt (see Table 1). At this point in time where the free trade deficit was just starting to accumulate, they would be hard to identify an underlying correlation. Similarly, one would anticipate a weaker correlation in 2008 and 2009,

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since the U.S. government expenditures have been highly irregular due to the modern recession compared to the free trade deficit which has dropped dramatically due to the recession.

We would like to also mention that the author knows of no other study that has shown this correlation.

## 2. Correlation Analysis Between the National Debt and the Free Trade Deficit

To perform this analysis, we provide the trade deficit data (for U.S. Trade in Goods and Services – BOP Basis)<sup>2</sup> from the U.S. Census.gov website. This is listed in Table 1 (also see Appendix B).

Column 2 in Table 1 provides the free trade deficit data in billions of dollars while Column 3 is converted to trillions of dollars. The columns (4 and 6) showing the cumulative results are provided to illustrate the running totals of the national debt and trade deficit since inception. The total trade deficit has accumulated to \$7.51 trillion (since 1971, see Appendix B) while the national debt has now totaled to about \$12.1 trillion for the end of 2009.

**Table 1** National Debt and Free Trade Deficit Data (1990-2009)<sup>2</sup>

Year	Annual Trade Deficit in Billions \$	Annual Trade Deficit in Trillions \$	Cumulative Trade Deficit in Trillions \$	National Debt in Trillions \$	Cumulative National Debt in Trillions \$
1990	81	0.081	1.01	0.33	3.21
1991	31	0.031	1.04	0.39	3.6
1992	39	0.039	1.08	0.4	4
1993	70	0.070	1.15	0.35	4.35
1994	98	0.098	1.25	0.29	4.64
1995	96	0.096	1.35	0.28	4.92
1996	104	0.104 M1	1.45	0.26	5.18
1997	108	0.108 M1	1.56	0.19	5.37
1998	166	0.166 M1, M2	1.73	0.11	5.48
1999	265	0.265 M1, M2	1.99	0.12	5.6
2000	380	0.380	2.37	0.03**	5.63
2001	366	0.366 M1	2.74	0.14	5.77
2002	422	0.422 M1, M2	3.16	0.43	6.2
2003	495	0.495 M1, M2	3.65	0.56	6.76
2004	610	0.610 M1, M2	4.26	0.59	7.35
2005	715	0.715 M1, M2	4.98	0.56	7.91
2006	760	0.760 M1, M2	5.74	0.54	8.45
2007	701	0.701 M1	6.44	0.5	8.95
2008	696	0.696	7.14	1.04	9.99
2009	370 Est.*	0.37 Est.*	7.51 Est*	2.1 Est.*	12.1 Est.*

First we will look at the raw data in select years that make sense where we expect a correlation to occur. This will help to find the underlying relationship between the national debt and the free trade deficit. Selecting poorly correlated years distorts the relationship. Then the assumptions in providing select years are:

<sup>2</sup> Trade Def. Ref. <http://www.census.gov/foreign-trade/statistics/historical/gands.pdf>,

National Debt Ref: [www.whitehouse.gov/omb/budget/fy2010/assets/hist.pdf](http://www.whitehouse.gov/omb/budget/fy2010/assets/hist.pdf)

\*2009 Estimate from Jan to Oct. data.

\*\* Outlier point - irregular data point

1) Select a reasonable sequential time period within the normal 20 year time frame of interest. We stated earlier that from 1990 to 1995, there was a minor trade deficit and there was little correlation. We also noted that 2008 and 2009 were highly irregular in government spending. These years will be ignored in the correlation analysis.

2) We provide two Trade Deficit Tax Consequence Models (TDC-models). TDC-Model 1 (M1 in Table 1) is a set of 11 logical years from 1996 to 2007 to look for a correlation. We will ignore one irregular data point of the year 2000. TDC-Model 2 (M2 in Table 1) is a worst-case scenario. We select a set of only 7 years from 1998 to 2006 and ignore 2 irregular years 2000 (true outlier) and 2001 (a partial outlier).

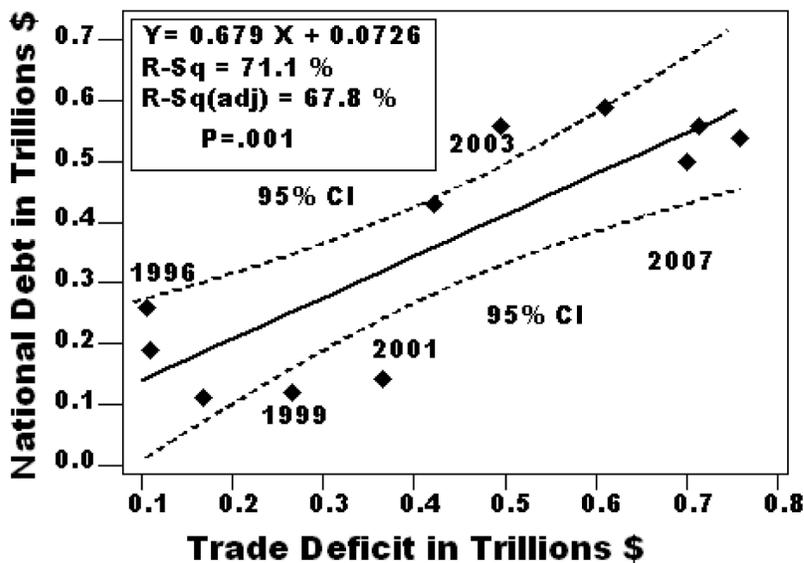


Figure 1 Model 1 of the national debt versus the trade deficit, 1996 to 2007 with outlier point 2000 removed (Column 3 vs. Column 5)

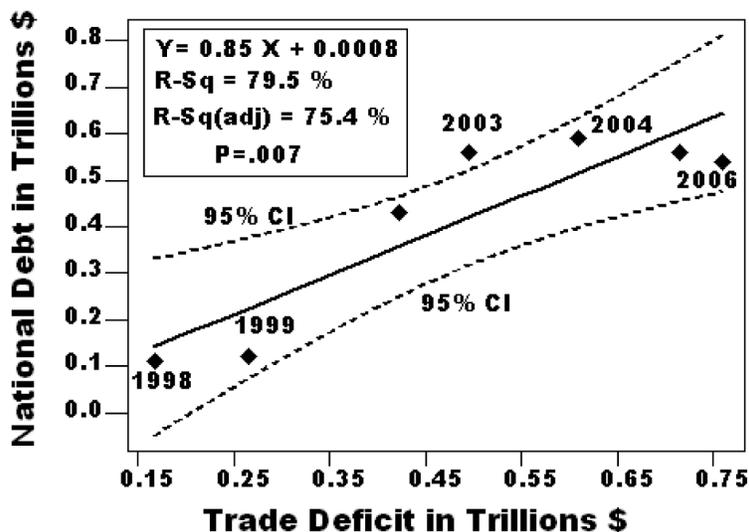


Figure 2 Model 2 of the National debt vs. the Trade Deficit (1998 to 2006, with outlier points 2000 and 2001 removed (Columns 3 vs. 5)

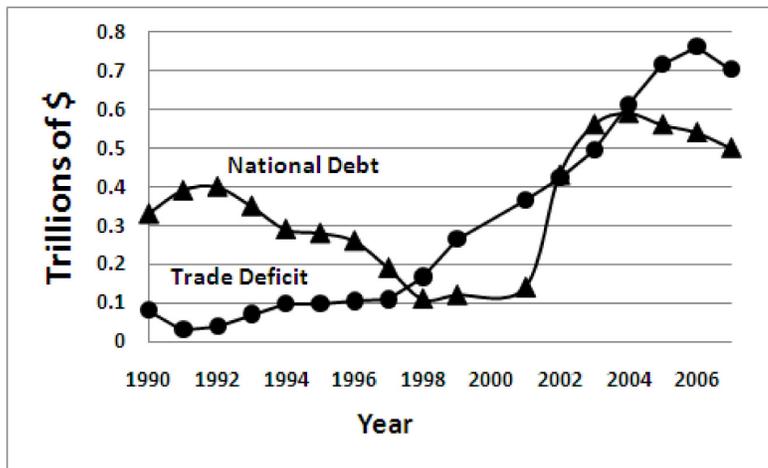
There are of course other ways to analyze the complex data set in Table 1. We selected these data points and provide the above justifications to illustrate the correlation, the sensitivity of the data, and to find a first approximation range to the relationship between free trade deficit and the national debt.

Next we provide two correlation graphs by plotting Column 3 versus Column 5 for the points we described. The result is provided in the Figure 1 and 2, respectively. Figure 1 and 2 provide estimates of how well the national debt and trade deficit can correlate. This is obtained from the  $R^2$  value of 0.711 and 0.795, respectively. The square root of each of these values is the correlation coefficient of 0.84 and 0.89 (R-value), indicating an 84% to 89% correlation, respectively out of 100% in these select time periods between 1996 and 2007. These correlations averaging 86.5%, indicate the underlying relation of the free trade deficit to mathematically correlate to our national debt.

The figures also show the 95% confidence bounds of the regression line in the figures. The P value in each regression analysis has been calculated as 0.001 and 0.007 indicating a very unlikely probability (1 or 7 in a 1000) that the correlation is by chance between the trade deficit and national debt. The "Durbin-Watson statistics for Model 1 was found to be 0.96 and for Model 2 was 1.15. These large values ( $> 0.8$ ) indicate that autocorrelation in the regression models were unlikely.

### 3. Estimate of Contributing Amount of Trade Deficit to National Debt

The next variable to assess is an estimate for what portion of the national debt is related to the trade deficit. We would like to assess a reasonable time series as we know historic issues can affect both. We will look at the time series from 1990 to 2007 for this complex data set which is shown in Figure 3.



**Figure 3** Time series plot of national debt and trade deficit from 1990 to 2007

In order to get a rough estimate of what portion of the national debt the trade deficit is contributing to, our strategy is to look at years when we expect very little contribution and compare it to years when we might expect a higher contribution. From Figure 3 we note that 1990 to 1993 shows minimums in the trade deficit. Thus we assume that the National debt has only small contribution from the trade deficit. Then from Table 1 we take an average over these years and find

$$\text{Average National Debt}(1990 \text{ to } 1993) = \$0.3675 \text{ Trillion} \quad (1)$$

Next we look at years when the national debt coincided and would be heavily influenced by the trade deficit. From Figure 3 and Table 1 this appears to be 2002 to 2007. We take the average value for the national debt in those years giving

$$\text{Average National Debt}(2002 \text{ to } 2007) = \$0.53 \text{ Trillion} \quad (2)$$

Subtracting Equation 2 from Equation 1 we obtain an estimate of the average amount that the trade deficit effects the national debt yielding.

$$\text{Average Trade Deficit Contribution}(2002 \text{ to } 2007) = \$0.1625 \text{ Trillion} \quad (3)$$

Taking the ratio of Eq. 3 to Eq. 2 we obtain a rough estimate of the amount of the portion of the national debt that is affected by the trade deficit

$$\text{Average Trade Deficit Portion to National Debt} = 30.7\% \quad (4)$$

Table 2 below now illustrates the amount with the new rough estimated national debt proportion that is due to the trade deficit in years of interest for Models 1 and 2.

**Table 2** Trade Deficit and Trade Deficit Portion of National Debt

Period	Trade Def. (TD) In Trillions \$	TD Portion National Debt x 0.307 In Trillions \$
1996 M1	0.104	0.07982
1997 M1	0.108	0.05833
1998 M1, M2	0.166	0.03377
1999 M1, M2	0.265	0.03684
2001 M1	0.366	0.04298
2002 M1, M2	0.422	0.13201
2003 M1, M2	0.495	0.17192
2004 M1, M2	0.610	0.18113
2005 M1, M2	0.715	0.17192
2006 M1, M2	0.760	0.16578
2007 M1	0.701	0.1535

Next we find the regression equations similar to Figures 1 and 2 with the new data information in Table 2. This will tell us from the X-Y relationship a rough estimate of the amount of contribution of the trade deficit to the national debt.

$$\text{Model 1: } Y=0.209X + 0.0223, R^2=0.7101, P=0.001 \quad (5)$$

$$\text{Model 2: } Y=0.26X + 0.0003, R^2=0.794, P=0.007 \quad (6)$$

Looking at both Models, we note that the Y intercept (.0223 and 0.003) are relatively small compared to the values in Column 3 from 1996-2009 (Table 1). This implies there would be little or no negative tax consequence from free trade to the National debt if the trade deficit were close to zero. It also means that we can take then the slopes as an approximate range. The upper range given by  $Y(\text{National Debt}) \sim 0.26 X(\text{Trade Deficit})$  and a lower range of  $\sim 0.209 X(\text{Trade Deficit})$ .

The range implies that between 20.9 and 26 cents of every trade deficit dollar is mathematically linked in the TDC model to the national debt according to the modeling assumptions.

We now do one-iteration for Equation 1. Taking the average of these numbers we obtain an amount of 23.45 cents. We have to subtract this amount out of the national debt for the years 1990 to 1993 that we assumed no trade deficit effect in Equation 1. This will provide a small correction as shown in the Table below.

**Table 3** Corrected Value of National Debt – Removing Trade Deficit Effect

Period	National Debt	Trade Deficit	Trade Deficit x.2345	National Debt Correction Removing Trade Deficit Effect
1990	0.33	-0.081	-0.01896	0.311
1991	0.39	-0.031	-0.0073	0.383
1992	0.4	-0.039	-0.0092	0.391
1993	0.35	-0.070	-0.01649	0.334

We then take the new average for 1990 to 1993 in column 5 of Table 3. This provides a correction to Equation 1.

$$\text{Average National Debt Correction(1990 to 1993)} = \$0.3105 \text{ Trillion} \quad (1a)$$

Subtracting Equation 2 from Equation 1a we obtain a corrected estimate of the average amount that the trade deficit effects the national debt yielding.

$$\text{Average Trade Deficit Contribution Correction (2002 to 2007)} = \$0.1755 \text{ Trillion} \quad (3a)$$

Taking the ratio of Eq. 3a to Eq. 2 we obtain a rough corrected estimate of the amount of the portion of the national debt that is effected by the trade deficit effect yielding

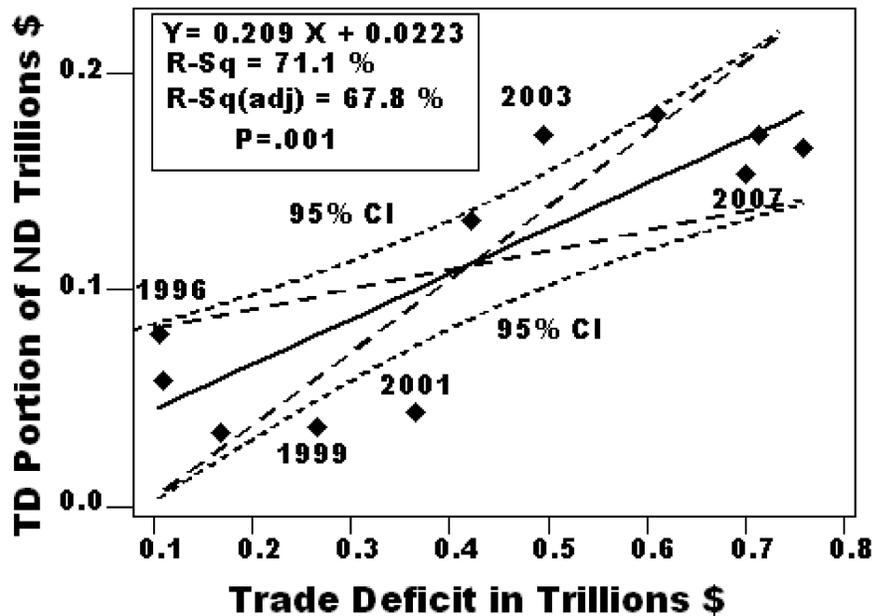
$$\text{Average Trade Deficit Portion to National Debt Corrected} = 33.1\% \quad (4a)$$

The Eq. 4a corrections to Table 2 are provided below.

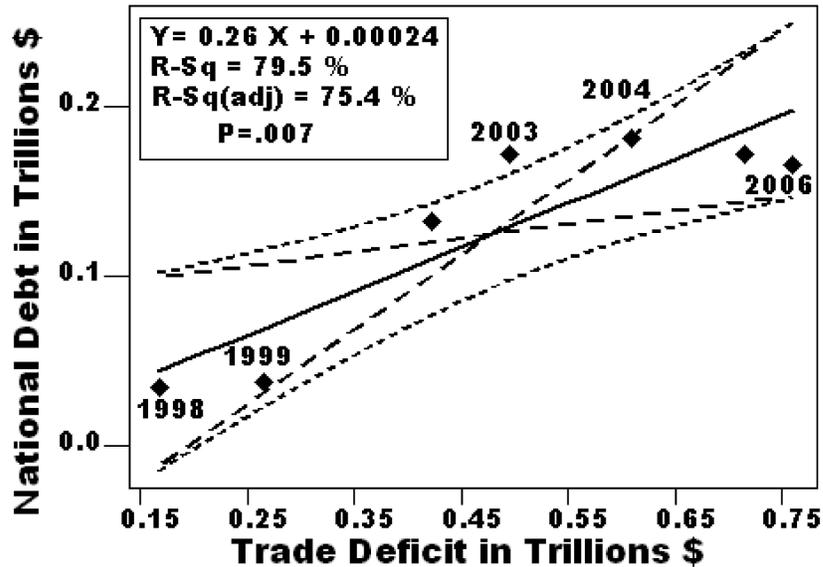
**Table 4** Trade Deficit and Trade Deficit Portion of National Debt

Period	Trade Def.	National Debt x 0.331
1996 M1	0.104	0.0861
1997 M1	0.108	0.0629
1998 M1, M2	0.166	0.0364
1999 M1, M2	0.265	0.0397
2001 M1	0.366	0.0463
2002 M1, M2	0.422	0.1423
2003 M1, M2	0.495	0.1854
2004 M1, M2	0.610	0.1953
2005 M1, M2	0.715	0.1854
2006 M1, M2	0.760	0.1787
2007 M1	0.701	0.1655

Next we provide the final regression on Table 4 results for Models 1 and 2 shown in Figures 5 and 6.



**Figure 4:** Trade deficit portion of the national debt versus trade deficit for Model 1



**Figure 5:** Trade deficit portion of the national debt versus trade deficit for Model 2

The results of course have the same statistics compared to Figure 1 and 2 for P value, the correlation coefficient and the Durbin-Watson statistics.

We next provide a third TDC model assumption that:

3) this underlying mathematical relationship is valid for any time period of trade deficit.

Under this 3<sup>rd</sup> assumption we take the free trade deficit from 1971 (see Appendix B) to present day that has accumulated to \$7.51 trillion (see Appendix A) and multiply it by 0.209 and 0.26. This yields a range from \$1.57 to \$1.95 trillion of trade deficit is correlated to the national debt. The 2009 year end national debt is \$12.1 trillion in Table 1. This rough estimate from our TDC model shows that since 1971 under the above assumptions, that between 13% and 16% of the national debt is due to the free trade deficit. This is very roughly close to 1/6 worst case of the national debt due to the free trade deficit.

From the 95% confidence intervals in Figures 5 and 6 we obtain the best and worst case estimates for the regression in the Table below:

**Table 5** Model 1 and 2 – 95% confidence interval from Figures 5 and 6

Model 1	Model 2
Upper 95% Case: $Y=0.34X-0.034$	Upper 95% Case: $Y=0.45X-0.0834$
Lower 95% Case: $Y=0.08 X + .082$	Lower 95% Case: $Y=0.06 X + .09$

We see the slopes range between 0.06 to 0.45. This variation is due to the tight 95% confidence and the amount of data points. The variation implies that compared with the above estimate that the range is between 3.7% to 28% of the national debt is due to the free trade deficit. Given the high correlation observed, it is logical to assume these best cases are less likely.

## **Summary**

We have provided the simple linear regression analysis to demonstrate the overall existence of this correlation between the national debt and trade deficit. The make-up of the data is highly complex both for the national debt sources and for the many different types of free trade effects. For our purposes here, we feel that this simple analysis is warranted and subscribe to the “law of parsimony”. The simplest theory that illustrates the facts of a problem is the one that should be selected. Complicating this analysis in our opinion will be counterproductive as we feel it would only serve for argumentative purposes and this analysis serves as reasonable first approximation for the U.S. problem. Given the highly controversial subject matter this paper presents, this basic analysis should prompt concern. Therefore, we invite and challenge other researchers to provide their models and improve upon this first assessment.

## **Appendix A**

### **Simple Examples of Tax Consequences Occurring from Different Types of Free Trade**

In this appendix we provide some discussion on possible tax collection consequences from the U.S. trade deficit to help the reader understand the correlation observed in the data. Given the complex nature of the U.S. tax collection structure, we only site simple examples.

#### **U.S. Import Related Tax Consequences:**

- 1) Imports create decreases in federal tax revenues for various reasons, (such as products made by non U.S. citizens who do not pay federal tax compared to products or services that would have created tax revenues if the products were not imported. Thus as U.S. made goods are replaced with foreign imports, so are U.S. jobs and less taxed wages that can be collected. As well, foreign companies do not pay U.S. taxes compared to U.S. companies that would have paid taxes. Foreign owned U.S. companies may find tax advantages here.
- 2) Many U.S. CEOs outsource jobs creating service trade deficits, these “imported services decrease potential tax revenues of the company’s workforce compared to non outsourcing. This also creates higher unemployment. Unemployment causes more lost tax dollars due to U.S. government subsidies. Profits of U.S. companies abroad may end up abroad decreasing potential tax revenues.
- 3) Foreign profits from the trade deficit that are reinvested typically do not provide the tax revenue that U.S. citizen reinvestments may provide. For example, currently foreign reinvestments are considerable in U.S. government obligation for the U.S. national debt and now total about \$3 trillion. This provides tax liability as the U.S. has to pay interest on this money to foreigners. On the other hand, U.S. citizens pay taxes on many of their reinvestments when owning U.S. business and equities. Foreigners who reinvest in buying U.S. business also find ways to avoid U.S. taxes. Job outsourcing often occurs once a U.S. business is take over.

#### **U.S. Export Related Tax Revenue:**

- 4) Exports create federal tax revenue gains for various reasons (products more likely made by U.S. citizens who pay income tax, U.S. companies pay taxes on profits, we export services to foreign companies and these creates tax revenue through income tax, etc.)

The above information are basic examples, but they do serve to help in understanding the reasons for the correlation observed.

**Appendix B****U.S. Trade in Goods and Services – Balance of Payments (BOP) Basis<sup>2</sup>  
1960 to 2009**

<b>Period</b>	<b>Total In Millions of Dollars</b>
1960	3,508
1961	4,195
1962	3,370
1963	4,210
1964	6,022
1965	4,664
1966	2,939
1967	2,604
1968	250
1969	91
1970	2,254
1971	-1,302
1972	-5,443
1973	1,900
1974	-4,293
1975	12,404
1976	-6,082
1977	-27,246
1978	-29,763
1979	-24,565
1980	-19,407
1981	-16,172
1982	-24,156
1983	-57,767
1984	-109,072
1985	-121,880
1986	-138,538
1987	-151,684
1988	-114,566
1989	-93,141
1990	-80,864

<b>Period</b>	<b>Total In Millions of Dollars</b>
1991	-31,135
1992	-39,212
1993	-70,311
1994	-98,493
1995	-96,384
1996	-104,065
1997	-108,273
1998	-166,140
1999	-265,090
2000	-379,835
2001	-365,505
2002	-421,601
2003	-495,035
2004	-609,987
2005	-715,269
2006	-760,359
2007	-701,423
2008	-695,937
2009	-370,000

<b>Period</b>	<b>Totals</b>
1960-2009	-7,471,584
1971-2009	-7,505,691
1990-2007	-5,508,981
1990-2009	-6,574,918