Rensselaer

Working Papers in Economics

Department of Economics, Rensselaer Polytechnic Institute, 110 8th Street, Troy, NY, 12180-3590, USA. Tel: +1-518-276-6387; Fax: +1-518-276-2235; URL: http://www.rpi.edu/dept/economics/; E-Mail: heimj@rpi.edu

THE REAL EXCHANGE RATE AND THE U. S. ECONOMY 2000 - 2008

John J. Heim
Rensselaer Polytechnic Institute

Number 0905

August 2009

THE REAL EXCHANGE RATE AND THE U.S. ECONOMY 2000-2008

John J. Heim
Professor of Economics
Rensselaer Polytechnic Institute

ABSTRACT:

This paper is a revision of Rensselaer Polytechnic Institute's Working Papers in Economics Series, No. 803, entitled "How Falling Exchange Rates 2000 – 2007 have Affected the U.S. Economy and Trade Deficit (Evaluated Using the Federal Reserve's Real Broad Exchange Rate)". It expands the analysis to measure exchange rate effects on the U.S. economy through 2008. It also utilizes a significantly improved method for assessing the meaning of the regression coefficient on the exchange rate variable in consumption and investment functions, removing ambiguity as to whether they should be interpreted as income or substitution effects. The paper attempts econometrically, using a seven behavioral equation model, to determine the total impact during 2000-2008 of the U.S. real exchange rate's 13.8% decline. Using projections based on an econometric model of the U.S. economy 1960 – 2000, the paper suggests that the effect on demand for domestically produced consumer goods (and exports) is positive, but strongly negative for investment goods. The estimated overall negative effect of declining real exchange rates on the GDP is 1.9% over the eight years, or about a quarter percent decline a year. This revised estimate is less than half the estimated impact reported Working Paper 803. It is estimated the decline reduced the trade deficit $189 billion from what it otherwise would have been, down from $244 billion reported Working Paper 803. JEL E00, F40, F43.

***Keywords**: Macroeconomics, International Trade, Imports, Exports, Exchange Rate*

1. INTRODUCTION AND OUTLINE

1.1 INTRODUCTION

A decline in the U.S. exchange rate (XR) decreases the amount of foreign currency a dollar can buy which can increase import prices. Such a decline occurred during the 2000 – 2008 period. This made imported goods Americans purchase more expensive, thereby reducing American real incomes. This "income effect" may reduce U. S. demand for both domestic and imported goods. It may also cause a "substitution effect" by making imports more expensive, shifting demand toward cheaper American goods. Also, the cheaper U.S. dollar may have a positive income effect by increasing American exports: make U.S. exports cheaper to the rest of the world.

While all of these effects may occur to some extent or another, the real question is whether exchange rate changes bring about major differences in the demand for domestic goods and imports? Or is it possible that even major changes in America's exchange rate only bring about marginal, relatively insignificant effects because of effects offsetting the other, or only being of a small magnitude?

These are empirical questions. This study attempts to answer them using estimates of the effects of exchange rate changes on U.S. demand for both domestic and imported goods during that period 1960-2000, and applying the findings to the 2000-2008 period. Econometric estimates of the marginal impact of the exchange rate changes on U.S. demand for imports and domestic goods, controlling for important variables that affect consumer and investment demand are used. These were developed by Heim (2008a, b, c). The statistical results are used as a basis for simulating the initial impact of a change in the exchange rate, holding all other variables affecting demand constant. The exchange rate variable's regression coefficients are used as the measure of initial impact. The initial impact is then multiplied by estimates of multiplier/accelerator effects derived from the same econometric model, to get estimates of the total impact on demand. Three separate methods for calculating these effects on demand are presented. Each reaches the same conclusions about the effects of the 2000 - 2008 exchange rate changes on the U.S. economy, when the U.S. Federal Reserve's real "Broad" trade weighted exchange rate index declined 13.8%, from 104.70 to 90.27.

Finally, the paper also estimates the extent to which exchange rate – induced price increases in imports reduce the trade deficit and thereby reduce transfers of U.S. assets to other nations or their citizens, as required to pay for trade deficits.

1.2. OUTLINE

2. METHODOLOGY

This study examines how real declining exchange rates 2000 – 2008 have affected U.S. demand for domestic and imported goods. It uses a seven behavioral equation model of the U.S. economy (three consumer demand equations, three investment demand equations and an export demand equation) to estimate the GDP and its components. The three consumption equations are for total, domestically produced and imported consumer goods, the three investment equations are for total, domestically produced and imported investment goods. The seventh equation estimated export demand.

The econometric approach is patterned after the more detailed (30 behavioral equations) demand – driven econometric models of Ray Fair (2004). Fair, for example, has four separate behavioral equations for household demand; whereas the model used in this study has two consumption equations: one for domestically produced consumer goods and one for imports. Fair's model, as does this model, estimates the GDP additively, from behavioral equation estimates of consumer, investment, export and import demand. In both models, government spending on goods & services is treated as exogenous. Finally, like Fair's model, the model here is Keynesian i.e., demand driven in orientation.

There are some differences between the models aside from size. All imports in Fair's model are estimated as one variable and imports are modeled as simple functions of GDP growth. In the model used here, consumer and investment imports are modeled separately and as functions of the same large number of specific determinants of consumer and investment demand found to be important determinants of demand for domestically produced consumer and investment goods, such as wealth, profits, interest rates, depreciation, credit crowd out, etc. In Fair's model exports are exogenous, but in the model used here exports are endogenous. They are determined by the exchange rate and a proxy for our trading partners' economic growth rate. Another difference is that Fair commonly uses lagged values of an equation's dependent variable on the right hand side of an equation to explain the movement in the dependent variable; the model used here does not. Its main objective is to explain the past influence of specific variables, especially the real exchange rate, on consumption, investment and the GDP. Lagged values of dependent variables may improve the accuracy of predictions, which is a core objective of Fair's model, but tend to hide from us the underlying variables that drive them (as well as the current dependent variable). Hence, they provide an inadequate explanation of underlying structural relationships. That said, in quarterly data models, lags may be needed simply to capture lagged adjustment effects. The annual data used in this model reduces that need appreciably.

Also because of Fair's findings, equations in this model do not include variables to account for rational expectations –driven behavior, since Fair, like others before him, found little support for these issues in extensive tests in his own models, (Fernandez-Villaverde, 2008). Fair also found his own model (a Cowles – Commission type model, like the model used here) performed better than a VAR model against which he tested it, and generally better in tests against an autoregressive components (AC) model. (Fernandez-Villaverde, 2008).

A significant difference between this study and Fair's models is the way in which autocorrelation is treated. Generally, here it is dealt with by first differencing data. In Fair, it is dealt with by leaving the data in levels and using standard autocorrelation control AR(i) variables. Generally, though not always, the first differencing used here was successful in bringing Durban Watson statistics up to desirable levels. This approach also provided two critically important additional benefits:

1. First differencing significantly reduced multicollinearity between the variables thought to be determinants of consumption or investment. This provided for much more stable regression coefficients on variables in the model when changes to the model were made, and therefore, more reliable estimates of marginal impact.

2. First differencing eliminates the irrational tendency for the regression coefficients on a particular variable (e.g., the exchange rate) in imports and domestic goods demand equations not to add up to same variable's coefficient in total demand equation when using standard AR(i) controls. The two parts together (demand for imports and demand for domestically produced goods) definitionally equal total consumption or investment. Adding the estimated effects of a particular variable on import demand and domestic demand should tell us precisely how total demand is affected. Statistical results should yield the same result, assuming regression does not provide illogical results. Statistical results do equal the arithmetic sum of these two parts, unless AR(i) controls are used with any of the equations.

   For example, equations 9 -11 below provide statistical estimates of the impact of the exchange rate (and other variables) on demand for domestically produced, imported and total investment goods. Equation eleven's relatively low Durbin Watson statistic indicates possible autocorrelation. Using a standard AR(1) control raises the Durbin – Watson statistic to more acceptable levels, but at the price of changing all of other regression coefficients in that equation so that the coefficients on a variable in the domestic and imports demand equations no longer add to the total effect, as they did – exactly - before the autocorrelation control was added!. Hence, questions arise about the reliability of our estimates. The situation is not improved by adding autocorrelation controls to the other equations.

   To avoid this problem, first differencing is used here. Where first differencing is not successful in raising the Durbin Watson statistic to desired levels, the evidence suggests the coefficient is not adversely affected. For example, subtracting the (non-)autocorrelation plagued imports coefficient (eq. 10), from the (non-)autocorrelation plagued total investment coefficient for the same variable (eq. 9) yields exactly the value of a variable we find in the autocorrelation plagued domestic demand equation (eq. 11).

Arithmetic methods for estimating the effect of exchange rate changes on the GDP, consumption, investment, the trade deficit, and U.S. ownership of assets are developed and presented in sections 9-12 of this study. They depend heavily on the marginal effects of changes in exchange rates given by regression coefficients in our econometric models. The reliability of such estimates is greatly enhanced if the models have made serious efforts to control for all other major variables that effect consumption and investment. This provides better assurance that the estimated effects of the exchange rate are good estimates, and not estimates which mislead because they are also proxying for the effects of other consumption or investment determinants not controlled for in the testing process. Extensive efforts were made in Heim (2008a, b &c) to determine what theoretically – postulated variables belonged in these equations, and which lagged value of the variables was the most appropriate to use. The consumption and investment models used here utilize the findings from those studies coupled with the Federal Reserve's (Nominal) Broad exchange rate. They are described further below.

All data used in those studies was taken from the Council of Economic Advisors' statistical appendix to the *Economic Report of the President, 2002*. Data Tables B2, B3, B7, B26, B54, B60, B73, B82, B90, B95, B104, B106 and B110. However, additional multilateral trade weighted value of the dollar, i.e., the foreign exchange rate data, is taken from Table B110 of the *Economic Report of the President, 2001* and Table B108 of the 1997 *Economic Report of the President, 1997.* Exchange rate values 1960 - 1970 were assumed constant at 1970 levels, per the Bretton Woods protocols. All data are expressed in real 1996 dollars, or converted to same using the GDP deflator in Table B3.

Each regression below shows the estimated marginal effect (regression coefficient) for the explanatory variables, the t statistic associated with it, the percent of variance explained and the Durbin Watson autocorrelation statistic. Depending on the particular regression test and the number of lags used, our sample size was 36-38 observations from the 1960-2000 period. With this number of observations, throughout the remainder of the paper, marginal effects with a t-statistic of 1.8 are significant at the 8% level, 2.0 are significant at the 5% level and t-statistics of 2.7 are significant at the 1% level

Because of the simultaneity between the total consumption variable (C) in the GDP accounts, or its component part, domestic consumer goods (C_D), and income (Y) inherent in these equations, two stage least squares estimates of disposable income $\Delta(Y-T_{\mathbf{G}})_0$ were used. The remaining right hand side variables were used as first stage regressors. Newey-West heteroskedasticity corrections were also made, generally improving t - statistics. Two Stage least Squares was also used with the investment equations because of simultaneity between investment and the economy's growth rate (the accelerator variable).

There is some difficulty separating consumer imports out of total imports in the *Economic Report of the President*. This is because, as the Bureau of Economic Analysis (BEA) has confirmed, it does not categorize import and export data into same "C" and "I" and "G" categories used elsewhere in the national GDP accounts. Absent official determinations by BEA, economists must make their own evaluations of how to divide the data. It is not clear from Table 104 in the *Economic Report of the President*, for example, how much of the value of motor vehicle imports or petroleum imports are for business (inventory investment) vs. consumer use. Data on imported services (Table B-106) does not distinguish between imports of services by businesses and consumers, though one might suspect the former dominate. Nor do the services data extend back beyond 1974, so no deduction from total imports for business services imports could be made in calculating consumer imports.

Following Heim (2007), we then take as our definition of consumer goods and services imports all imports except for imports of capital goods and industrial supplies and materials. The theory behind this choice was that the best definition of "consumer" imports was the one whose variation was best explained (highest R^2) by the variables theoretically thought to drive demand for consumer imports. Other definitions of consumer imports, did not explain consumer behavior as well and were rejected.
Hence, for consumer imports, the definition used is

$(M_{m\text{-}ksm})$ = Total Imports (M) – (Capital Goods Imports + Imported Industrial Supplies and Materials(M_{ksm}))

These definitions appear to be reasonable, if not exact, given the data available. Separate regressions were then run on total consumer demand, and separately for imported consumer goods alone. Results for the imports equation were subtracted from the results for the total consumption (C) equation, to estimate demand for domestically produced consumer goods. As noted earlier when discussing autocorrelation, the coefficients obtained in this manner (arithmetically) for each variable are exactly the same as those obtained statistically by regressing these same determinants on domestically produced consumer goods ($C\text{-}M_{m\text{-}ksm}$).

Investment imports were defined using the same process as imports of capital goods plus imports of industrial supplies and materials (M_{ksm}), i.e., total imports minus consumer imports.

Preliminary testing suggested that exchange rates have some lagged effects that go back as far as three years ago, so the average exchange rate for those years (XR_{Av0123}) was used. Individual variables for each year's exchange rate were not used. High levels of multicollinearity between the individual years' exchange rates made coefficient values for any one year change dramatically when another year's exchange rate variable was added or deleted. However, the coefficients on the average exchange rate variables tended to precisely or approximately add up to the sum of the coefficients when separate exchange rate variables were used for each year. In addition, adding an additional year's lag to the average increased explained variance, up through the three year lag. This suggests that the full effects of exchange rate changes take that long to achieve. For example, peoples' demand may be conditioned on what they recall price has been in the recent past as well as what it is today. It may also be that there are long lead times required for delivery of some items, e.g., machinery. If so, this year's actual purchases may have been the result of a prior year's decision to purchase, based on a prior year's price determined in part by that year's exchange rate.

In sections 9 below the results to the economic system attributable to a shock to exchange rates are used to estimate the resulting effects on the GDP, consumption and investment demand (both domestic and imports). Three separate methods for calculating these results are used. They yielded identical results:

1. The first of the three methods simply sums the three regression coefficient estimates of the effect of an exchange rate change on (1) domestically produced consumer goods and (2) investment goods, and (3) exports and uses the estimated multiplier/accelerator effect developed in Section 8 from the same econometric model to calculate the total effect on income and consumption.

2. A second method, commonly used in large scale econometric models such as Fair's to calculate the effects of a shock was also used as a check on the first. This method involves estimating the consumption, investment and import equations from their determinants and combining them with exogenous information on export demand and government demand to (additively) calculate the GDP.

3. A Keynesian "IS" curve model calculated directly from our econometric results. This IS model is used to predict changes, modified by the model's estimated multiplier effect, in the GDP likely to occur when the exchange rate shock occurs.

Finally we note that Heim (2008c) uses these same econometric equations for investment and consumption demand as used in this study. However, its results vary substantially from those reached here. This is because It utilizes a less theoretically sound, more ambiguous method for separating the income effects from substitution effects, and overstates both as a result. Since then, a more rigorous method for isolating the separate income and substitution effects has been developed (see sections 8 and 9 below), which markedly changes the estimates of the GDP, trade deficit, etc. obtained in Heim 2008c). There are other differences as well: this study uses a different, more reliable data in the export model, significantly changing the estimates expands of exchange rate changes on exports. This paper also extends the estimates of effects to cover to cover the 2008 period.

3. THE CONSUMER DEMAND MODEL:

We need a comprehensive theory of consumer demand so that in testing for exchange rate effects, we can control for changes caused by other things than the exchange rate itself. This paper uses a modified Keynesian theory of demand for consumer goods. It assumes that in general, the determinants of the demand for both domestic and imported consumer goods are the same as those mentioned in Keynes (1936), with the addition of two other variables. First, a "crowd out" variable is added, similar to the one used in investment studies to control for periods of limited credit availability which may occur in response to government deficits. Second, we also add an exchange rate variable.

Keynes argues in chapter 8 of the General Theory of Employment, Interest and Money (1936, pp.95-96) that income, wealth, fiscal policy (taxes) and possibly the rate of interest might influence consumption. However, he felt

> … income…is, as a rule, the principal variable upon which the consumption-constituent of the aggregate demand function will depend…windfall changes in capital-values will be capable of changing the propensity to consume, and substantial changes in the rate of interest and in fiscal policy may make some difference …

where "fiscal policy" is a reference to tax levels. In chapter 9 he also notes other factors that might affect the level of consumption spending: precautionary saving (for unknown, but potential, future needs), saving for known future needs (like retirement), and saving to finance improvements in future standards of living.

Heim (2008b) found that regression results on a modified Keynesian function of the following type explained about 90% of the variance in consumer spending in the 1960 - 2000 period:

$$C = \beta_1 + \beta_2\,(Y-T_{\mathbf{G}}) + \beta_3(T_G - G) - \beta_4\,(PR). + \beta_5\,(DJ)_{-2} + \beta_6\,(XR)_{AV0123} \qquad (1)$$

where

$(Y-T_{\mathbf{G}})$ = Total income minus taxes, defined as the GDP minus the portion of total government receipts used to finance government purchases of goods and services, i.e., total government receipts minus the portion used to finance government spending on transfer payments not included in the GDP definition of government spending.

$(T_G - G)$ = The government deficit, interpreted as a restrictor of consumer as well as investment credit. Usually we will disaggregate this into two separate variables in regressions: $\beta_{3A}\, T_{G(0)}$ and β_{3B} G. because it has been found the effects of each on consumer spending differs, with the tax variable the more important. (Heim 2008a)

PR = An interest rate measure, the Prime rate, for the current period. This rate is a base rate for much consumer credit. It is deflated to get the "real" rate using the average of the past two year's CPI inflation rate.

DJ_{-2} = A stock market wealth measure, the Dow Jones Composite Average, lagged two years

XR_{AV0123} = The trade - weighted exchange rate (XR), averaged over four years. In our regressions, an average of the XR value for the current and past three years is used, denoted XR_{AV0123}. This is done to capture what preliminary studies showed was slow, multiyear process of adjustment to exchange rate changes

First difference versions, shown below, of this consumption function (1) were used to reduce the distorting effects of multicollinearity and non-stationarity inherent in most time series econometric models:

$$\Delta C_0 = \beta_2\,\Delta(Y\text{-}T_{\mathbf{G}})_0 + \beta_3\,\Delta(T_G - G)_0 - \beta_4\,\Delta(PR)_0. + \beta_5\,\Delta(DJ)_{-2} + \beta_6\,\Delta(XR)_{AV0123} \qquad (2)$$

or

$$\Delta C_0 = \beta_2\,\Delta(Y\text{-}T_{\mathbf{G}})_0 + \beta_{3A}\,\Delta(T)_{G(0)} - \beta_{3B}\,\Delta(G)_0 - \beta_4\,\Delta(PR)_0. + \beta_5\,\Delta(DJ)_{-2} + \beta_6\,\Delta(XR)_{AV0123} \qquad (3)$$

These last two equations are the same except that in (3) we have divided the crowd out variable into two variables. We will test these hypotheses, particularly (3), further below, and use the results to calculate the effects of exchange rate change on consumer demand.

Using the Federal Reserve's real "Broad" exchange rate, , the government deficit variables, and the Keynesian variables, our regression findings for consumer demand model are as follows:

Total Consumer Demand

$$\Delta C_0 = .66\Delta(Y\text{-}T_G)_0 + .49\Delta T_{G(0)} + .04\Delta G_0 - 6.92\,\Delta PR_0. + .62\,\Delta DJ_{-2} + 2.83\,\Delta XR_{AV0123} \qquad R^2{=}92\%$$

(t) (29.2) (5.7) (0.3) (-3.2) (4.9) (3.2) D.W.= 2.0

Demand for Imported Consumer Goods

$$\Delta(M_{m\text{-}ksm})_0 = .11\Delta(Y\text{-}T_G)_0 + .30\Delta T_{G(0)} - .20\,\Delta G_0 - 5.00\,\Delta PR_0. + .34\,\Delta DJ_{-2} + 3.03\,\Delta XR_{AV0123} \qquad R^2{=}85\%$$

(t) (6.3) (5.0) (-2.0) (-3.5) (4.5) (5.6) D.W.= 1.8

Demand for Domestically Produced Consumer Goods

$$\Delta(C\text{-} M_{m\text{-}ksm})_0 = .55\Delta(Y\text{-}T_G)_0 + .19\Delta T_{G(0)} + .24\,\Delta G_0 - 1.92\,\Delta PR_0. + .28\Delta DJ_{-2} - .20\,\Delta XR_{AV0123} \qquad R^2{=}74\%$$

(t) (16.2) (1.5) (1.3) (-0.6) (1.9) (-0.2) D.W.= 1.8

Though not presented here, the same models without the exchange rate variable had R^2 of 91, 77 and 74% respectively. The exchange rate appears to have a major influence on import demand, adding 8%-points to explanatory power, but seems to have a minimal effect on domestic demand for consumer goods, leaving the explanatory power of this domestic demand equation unchanged. As we will show in section 8 below this is because the substantial negative income effect of declining exchange rates more than offset by a positive substitution effect, leaving the net of the two effects, shown by the regression coefficient close to zero and insignificant. The regression coefficients on the exchange rate variable clearly suggest an immediate drop in demand for imports of $3.03 billion when the exchange rate drops one point, and an increase in domestic demand of $0.20 billion. However, our confidence in our estimate of the domestic marginal effect remains high, since it is the same as that obtained by subtracting the import regression coefficient from the total consumption coefficient, and both of these are highly significant. These coefficients will be used below in estimating the total impact on the economy of declines in the exchange rate, including subsequent multiplier effects.

4. THE INVESTMENT DEMAND MODEL

The demand for Investment goods may also decline when the exchange rate declines, lowering real business income and raising import prices. How much of the decreased will be for domestic goods compared to imports depends on the marginal propensities to invest (MPI_D or MPI_M) in those goods in response to a change in the economy's real growth rate (i.e., the "accelerator effect") caused by a declining exchange rate. A secondary decrease in Investment may occur due to multiplier effects of the original change, reducing savings, causing increased crowd out effects.

If investment goods are a "normal" good, the effect on U.S.-produced investment goods should include a positive substitution effect resulting from reduced import demand; if they are "inferior " goods in the microeconomic sense of that word, the substitution effect, like the income effect, should be negative. i.e., if we find that demand for domestic investment goods declines in favor of imports when real income falls due to a declining exchange rate, even though it means imports are becoming more expensive. Whether the substitution effect is positive or negative and whether the income effect or substitution effect dominate are empirical questions are empirical questions addressed with the test results below.

The investment model tested includes key variables traditionally thought to influence investment. See, for example, Jorgenson (1971). Imported investment goods are defined as imported capital goods plus imported industrial supplies and materials. The current period is denoted without a subscript; prior years are subscripted with a -1 or -2. Since the variables in each are the same, the tested equations for domestic (I_D) and imported investment (I_M) goods all take the general form

$$\Delta I_D = (\Delta I - \Delta M_{ksm}) = \beta_{D1}\,\Delta ACC + \beta_{D2}\,\Delta DEP + \beta_{D3}\,\Delta CAP_{-1} + \beta_{D4}\,\Delta T_G - \beta_{D5}\,\Delta G - \beta_{D6}\,\Delta r_{-2} + \beta_{D7}\,\Delta DJ_{-2} + \beta D_{I8}\,\Delta PROF_{-2} + \beta_{D9}\,\Delta XR_{AV0123} \quad (7)$$

$$\Delta I_M = (\Delta M_{ksm}) = \beta_{M1}\,\Delta ACC + \beta_{M2}\,\Delta DEP + \beta_{M3}\,\Delta CAP_{-1} + \beta_{M4}\,\Delta T_G - \beta_{M5}\,\Delta G - \beta_{M6}\,\Delta r_{-2} + \beta M_{I7}\,\Delta DJ_{-2} + \beta_{M8}\,\Delta PROF_{-2} + \beta_{M9}\,\Delta XR_{AV0123} \quad (8)$$

The variables included in these equations are

ΔACC = An accelerator variable $\Delta(Y_t - Y_{t-1}) = \Delta\ GDP_t$

ΔDEP = Depreciation, a measure of investment needed this year just to replace worn out plant and equipment

ΔCAP_{-1} = A measure of last year's capacity utilization level

$\Delta PROF_{-2}$ = A measure of business profitability two years ago

The other variables have the same meanings they had in the consumption equations, with lags as noted.

Our purpose here is not to analyze definitively the components of the investment function, but just to provide estimates of the effect of the exchange rate on investment that have been obtained while controlling for at least some of the other variables commonly thought to affect investment, and whose influences might otherwise be picked up by the exchange rate variable due to intercorrelation.

The parameters in this investment demand model were estimated to be:

Total Investment Demand

$$\Delta I = .28\Delta ACC + 1.37\Delta DEP + .69\Delta CAP_{-1} + .52\,\Delta T_G - .61\Delta G - 8.46\Delta r_{-2} - .10\,\Delta DJ_{-2} + .35\,\Delta PROF_{-2} + 4.97\,\Delta XR_{AV0123} \quad R^2 = .89$$
$$t = (6.9)\quad (4.7)\quad (0.4)\quad (5.3)\quad (-3.4)\quad (-3.5)\quad (-0.4)\quad (2.0)\quad (4.2) \quad DW = 2.3$$

Demand For Imported Investment Goods

$$\Delta(M_{ksm}) = .05\Delta ACC + .46\Delta DEP + 1.25\Delta CAP_{-1} + .07\,\Delta T_G - .14\Delta G + 1.12\Delta r_{-2} + .30\,\Delta DJ_{-2} - .11\,\Delta PROF_{-2} - .40\,\Delta XR_{AV0123} \quad R^2 = .64$$
$$t = (1.9)\quad (4.5)\quad (1.4)\quad (2.0)\quad (-1.7)\quad (0.7)\quad (3.4)\quad (-1.09)\quad (-0.7) \quad DW = 2.1$$

Demand For Domestically Produced Investment Goods

$$\Delta(I - M_{ksm}) = .24\Delta ACC + .91\Delta DEP - .15\Delta CAP_{-1} + .45\,\Delta T_G - .47\Delta G - 9.59\Delta r_{-2} - .40\,\Delta DJ_{-2} + .47\,\Delta PROF_{-2} + 5.37\,\Delta XR_{AV0123} \quad R^2 = .88$$
$$t = (7.8)\quad (3.0)\quad (-0.4)\quad (6.0)\quad (-2.9)\quad (-7.3)\quad (-1.9)\quad (4.1)\quad (4.1) \quad DW = 2.1$$

Though not shown here, explained variance for the same three models without the exchange rate included were .85, .64 and .83.

The results for the MPI_D and MPI_M indicate that the accelerator effect of a decline in current year real income on investment is principally on domestically produced investment goods, with demand decreasing $ 0.24 billion for every billion decrease in the size of the change in current year GDP. Demand for imported goods on the other hand only decreases .05 billion. There appears to be an initial $5.37 billion decrease in demand for domestically produced investment goods for every single - point (~ 1.0%) decline in the trade weighted nominal Broad exchange rate from 2000 levels, as well as a $0.40 billion increase in demand for imported investment goods. Analysis below in Section 8 shows that this results from the sizable dominance of substitution over income effects, causing a decline in demand for both domestic and imported investment goods.

5. THE EXPORTS DEMAND MODEL (USING THE REAL BROAD EXCHANGE RATE INDEX)

There is also an increase in income that occurs because of the increase in exports associated with the decline of the exchange rate. A rough estimate of this effect can be obtained by regressing exports on the 4-year average exchange rate above and the growth in the American GDP over the 1960-2000 period. The income variable serves as a proxy for the growth in our major trading partners' incomes over this period. Our trading partners' incomes should have a major effect on the demand for our exports. The results of this regression, using first differences in the data to reduce multicollinearity and stationarity problems, as well as autocorrelation and heteroskedasticity controls are as follows:

$$\Delta X_0 = .12\ \Delta(Y_{AV12}) - 2.86\ \Delta XR_{AV0123} + .68\ AR(3) \qquad R^2 = 53\% \qquad (12)$$
$$(t) \quad (5.3) \quad (-2.6) \quad (5.4) \qquad D.W. = 2.1$$

6. THE TAX GROWTH MODEL

Part of tax growth is exogenous, i.e., varies with legislative changes in tax rates. However, part is endogenous, i.e., dependent on income growth from year to year. Below we estimate the effect of a change in total income (GDP) on part of tax revenues - the part raised to finance purchases of goods and services. The results of this regression, using first differences in the data to reduce multicollinearity and stationarity problems, as well as 2SLS and heteroskedasticity controls are as follows:

$$\Delta T_G = .26\ \Delta(Y) \qquad R^2 = 47\% \qquad (13)$$
$$(t) \quad (7.7) \qquad D.W. = 1.4$$

Both the consumption and investment equations above show a positive effect on demand of an increase in tax revenues, presumably by reducing crowd out caused by government deficits. Therefore, in calculating the full effects of a rise in real income due to exchange rate changes, it is important to also measure the secondary boost to income resulting from additional taxes collected as income grows. We might also define tax changes that are government - enacted, i.e., exogenous, as approximately ΔT_{EX} , where

$$\Delta T_{EX} = \Delta T_G - .26\ \Delta Y \quad \text{(or)} \quad \Delta T_G = .26\ \Delta(Y) + \Delta T_{EX} \qquad (14)$$

We say "approximately, because T_{EX} also contains the regression error term.

7. A MODEL FOR CALCULATING MULTIPLIER, ACCELERATOR AND CROWD OUT EFFECTS OF EXCHANGE RATE CHANGES

Some readers may be unfamiliar with notation commonly used by economists to denote different parts of the economy, or with commonly used economic terms like "multiplier" or "accelerator". To illustrate how these terms are used, the following definitions and derivations of the multiplier and accelerator are presented, using simplified versions of our above consumption and investment equations for ease of exposition:

The GDP (Y) is comprised of consumer goods (C), investment goods (I), goods and services produced for the government (G) and net exports (X-M):

$$Y = C + I + G + (X-M) \qquad (15)$$

In a simple model of the economy, demand for consumer goods might be defined as follows

$$C = (c_0 + m_0) + (c_1 + m_{c1})(Y-T_G) + (c_2 + m_{c2})\ T_G + (c_3 + m_{c3})\ G \qquad (16)$$

where (Y- T_G) is total income generated producing the GDP minus total taxes; $c_1 + m_{c1}$ are the marginal propensities to consume domestic and imported goods, T_G and G represent the variables measuring the extent to which consumer credit is crowded out by the government deficit. The disaggregated form of the deficit is used (T_G ,G separately) instead of just (T_G - G) because testing above indicates that the effects of the two variables on crowd out are different.

Demand for investment goods in a simple model of the economy might be described as

$$I = I_0 + (I_1 + m_{I1})\,\Delta Y - (I_2 + m_{I2})\, r + (I_3 + m_{I3})\, T_G + (I_4 + m_{I4})\, G \qquad (17)$$

where ΔY is an “accelerator” variable, indicating I grows (accelerates) in response to the general growth in the economy, r is the real interest rate, (I_1 + m_{I1}) are the marginal propensities to purchase domestically produced or imported investment goods in response to a change in the GDP,. (I_2 + m_{I2}) are the marginal propensities to invest in these goods when interest rates change. T_G + G represent the investment credit crowd out variables, again disaggregated.

Import demand might be expressed as

$$M = M_C + M_I = m_0 + m_{c1}\,(Y-T) + m_{I1}\,\Delta Y - m_{I2}\, r + (m_{c2} + m_{I3})\, T_G + (m_{c3} + m_{I4})\, G \qquad (18)$$

i.e., the demand for imported consumer or investment goods is driven by the same variables as is domestic demand.

Substituting (2), (3) and (4) into equation (1) gives

$$Y = (c_0 + I_0 - m_0) + c_1\,(Y - T_G) + I_1\,\Delta Y - I_2\, r + G + X + (c_2+I_3)\, T_G + (c_3+I_4)\, G \qquad (19)$$

i.e., the domestic GDP is a function of the demand for domestic C,I,G and X goods, as modified by crowd out problems

Collecting only the Y terms, we get

$$Y = \left[\frac{1}{(1-c_1)}\right] * \left[(c_0 + I_0 - m_0) - c_1\, T_G + I_1\,\Delta Y - I_2\, r + G + X + (c_2+I_3)\, T_G + (c_3+I_4)\, G \right] \qquad (20)$$

where $\frac{1}{(1-c_1)}$ is the standard consumption multiplier cited in textbooks and would equal $\frac{1}{(1-.55)}$ = 2.22

using the marginal propensity to consume domestically produced goods from the regressions above.

However, if we separate I_1 ΔY into its separate components, I_1 Y and - I_1 Y_{-1} , and recollect our current year Y terms, we get a modified multiplier (or multiplier/accelerator) coefficient that combines traditional multiplier and accelerator effects:

$$Y = \left[\frac{1}{(1-c_1 - I_1)}\right] \left[(c_0 + I_0 - m_0) - c_1\, T_G - I_1\, Y_{-1} - I_2\, r + G + X + (c_2+I_3)\, T_G + (c_3+I_4)\, G \right] \qquad (21)$$

where the numerical value the accelerator/multiplier coefficient is $\frac{1}{(1-.55-.24)} = 4.76$

again using our regression results above. We can further augment this function by noting that the tax component (T_G) of the “crowd out” variables in both the consumption and investment equation grows as income grows, as shown in our tax growth model above. Also, our consumption and investment regressions above suggest that a rise in taxes depresses consumption spending by decreasing disposable income -$.57B for each billion increase in T_G, but that the same rise in taxes stimulates consumer spending by +$.20B and investment spending by +$.44B, more than offsetting the negative impact of taxes on disposable income, for a net effect of +$.09B. Hence,

$(-c_1 + c_2 + I_3)\, T_G = (-.55 + .19 + .45)\, T_G = (.09)\, T_G = (.09)(.26\, Y + T_{EX}) = .02\, Y + .09\, T_{EX}$

Using this formulation and recombining the Y terms gives a further modified multiplier we will call the "Multiplier/Accelerator/Crowd Out" (M/A/C) multiplier:

$$Y = \left[\frac{1}{(1-c_1-I_1-[-c_1+c_2+I_3][.26])} \right] [\,(c_0 + I_0 - m_0) - c_1 T_{EX} - I_1 Y_{-1} - I_2 r + G + X + (c_2+I_3)\, T_{EX} + (c_3+I_4)\, G\,] \quad (22)$$

Expressed in first differences, which we used for econometric testing above, this becomes

$$\Delta Y = \left[\frac{1}{(1-c_1-I_1-[-c_1+c_2+I_3][.26])} \right] [\, - c_1 \Delta T_{EX} - I_1 \Delta Y_{-1} - I_2 \Delta r + \Delta G + \Delta X + (c_2+I_3)\, \Delta T_{EX} + (c_3+I_4)\, \Delta G\,] \quad (23)$$

where the numerical value of M/A/C multiplier becomes $\frac{1}{(1-.55-.24-.02)} = 5.26$

This is the multiplier we will use below to calculate the total effect of a change in the exchange rate on U.S. real income.

8. INCOME AND SUBSTITUTION EFFECTS OF A DECLINING EXCHANGE RATE ON DEMAND

Does the demand for imports decline when the real exchange rate drops? For 'normal" goods, economic theory suggests both the income and the substitution effects should be negative for imports, since real income drops as import prices rise, and because of a substitution away from (now) higher price imports, each causing a decrease in demand. For normal domestically produced goods, theory suggests the income and substitution effects should work in opposite directions: substitution effects increasing domestic demand, as higher import prices cause people to shift from imports to domestic goods, income effects decreasing demand. (e.g., Wold & Jureen, 1953, Prager, 1993, etc.)

Our statistical results for consumption demand are consistent with this theory. Heim (2009) suggests a method for separating the income and substitution effects of changes in real exchange rates on consumption. The method involved shows that the "pure" income effect must be the same for both domestically produced and imported consumer goods. It also shows the same is true for substitution effects, except for sign. Once this is done, it is relatively simple, using regression coefficients as estimates of the total effect of exchange rate changes, to calculate the separate income and substitution effects. Application of this method to consumption yields the results given in Table 1 below, where regression coefficients on the exchange rate variable equal total effects, and clearly indicating consumer imports are normal goods, and where substitution effects clearly dominate.

Table 1
Consumer Goods: Income and Substitution Effects

	Domestic Goods	Imports .
Income Effect	- $ 1.415 Billion	- $ 1.415 Billion
Substitution Effect	+ $ 1.615 Billion	- $ 1.615 Billion
Total Effect (=Reg.Coef.)	+ $ 0.200 Billion	- $ 3.030 Billion.

However, application of this method to investment suggests investment imports may be "inferior "goods, i.e., goods the U. S. substitutes into as real income decreases, and out of as real income increases. Applying the same method yields the results indicated in Table 2 below, where regression coefficients on the exchange rate variable equal total effects, the signs on the substitution effects clearly suggests investment imports are inferior goods, and where income effects clearly dominate.

Table 2
Investment Goods: Income and Substitution Effects

	Domestic Goods	Imports .
Income Effect	- $ 2.485 Billion	- $ 2.485 Billion
Substitution Effect	- $ 2.885 Billion	+ $ 2.885 Billion
Total Effect(=Reg.Coef)	- $ 5.370 Billion	+ $ 0.400 Billion.

These results show the initial effects on demand for consumer and investment goods of a decline in the exchange rate, *ceteris paribus.* However, since every change in consumption or investment demand changes the GDP, which through multiplier effects further changes consumption and investment, etc., the result will be some multiple of the initial effects. The initial effect on domestically produced consumer goods (+0.20B), plus the initial effect on domestically produced investment goods (-$5.37B), plus the initial effect on U.S. exports (+2.86B) will be subject to multiplier effects. This multiplier used (5.26) will be the M/A/C multiplier developed in Section 7 above.

The results above depend on the accuracy of our regression coefficient estimates of the effects on consumption and investment of a change in the exchange rate. In the consumption model, both the regression coefficients on the exchange rate variable in the consumer imports and total consumer demand equations are statistically significant. The coefficient on the exchange rate variable in the domestic consumption equation is not statistically significant. However, it is the same as that obtained by subtraction of the statistically significant estimate for imports from either the statistically significant estimate for total consumption demand. Hence it may be reasonable for use in estimating how exchange rate changes affect the demand for consumer goods. For the three investment equations, two of the three exchange rate coefficients are significant at the 1% level or better: total investment and domestic investment. The exchange rate coefficient for imported investment goods is not statistically significant, but its value is exactly the same as is obtained by subtraction of the two significant coefficient estimates. Hence, we feel reasonably confident in the internal consistency of all three of our point estimates.

We do not know with any certainty how much prices change when the exchange rate changes. A one point decrease the exchange rate (which would represent approximately a one percent decrease from the rate's 104.70 level in the year 2000) could increase import prices by about 1% percent, if the exchange rate change was passed entirely through to the consumer. However, recent evaluation by Federal Reserve staff of the "pass through" of exchange rate changes to import prices 1985 -2005 suggests that import prices only change about half as much as the exchange rate changes, and not even less than that, as others have claimed (Hellerstein, Daly & Marsh, 2006). This study finds the initial decline in combined domestic consumer and investment demand to be $-5.17 billion (= +0.20B-5.37B), equal to about only 32% of the dollar value of full 100% pass through ($15.32B). However, this is offset in part by a $2.86B increase in export demand, so that the net effect of the "pass through" is about 15% of a 100% pass through. Our reasoning is as follows:

In the year 2000, U.S. total imports (1996 dollars) were $1,532 billion. A 1.0% decrease in the exchange rate, if fully passed through, would be expected to increase import costs by 1%, or have an initial effect of decreasing real income of $15.32 billion. The initial drop in domestic demand would be based on the marginal propensities to consume and invest domestic goods, offset to some extent by increased US. Exports. Real disposable income also decreases the same amount, since there is no tax effect: nominal income (on which taxes are based) remains the same. The initial net decrease in demand, via multiplier effects, would lead to a total decline in demand 5.26 times as large. But again, these conclusions would be based on a full pass through assumption. Our approach is different. We make no explicit attempt to calculate the exact change in import prices resulting from changes in the exchange rate. Instead, we use our estimates of how consumption and investment vary when the exchange rate changes, controlling for other factors likely to cause changes in these two variables. We say, in essence, however much a one point decline in exchange rates changes import prices, the change causes an initial $ 0.20 billion increase in demand for domestic consumer goods, an initial $2.86 billion increase in demand for exports, and an initial $5.37 billion decline in demand domestic investment goods. These effects total an initial net decline in demand for American goods of $2.31 billion. This decline, multiplied by 5.26, gives us our total estimated decline in U.S. income of $12.15 billion.

9. THREE METHODS FOR CALCULATING THE IMPACT ON THE GDP OF A CHANGE IN THE EXCHANGE RATE

Three separate methods, all yielding the same results, are used to compute the effect of a change in the exchange rate on the GDP (Y):

Method 1: Use marginal effects estimates from the above domestic investment, consumption and export regressions to estimate the initial change in domestic consumption, investment and the GDP resulting from a one index point drop in the trade weighted exchange rate. Apply the M/A/C multiplier (5.88) to the result

Method 2: Use the method favored in many large scale econometric models of the economy (Fair 2003, Pindyck & Rubinfeld 1991). This involves separately estimating ΔC_D, ΔI_D, ΔG and ΔX (using the equations above), and simply summing the results to get ΔY

Method 3: Formally Construct a Keynesian IS curve, and predict ΔY from its determinants and the multiplier implied by the function. It is a slightly more formal presentation of Method 1.

Each of the methods can serve as a check on the estimates obtained from the others.

9.1 METHOD 1

$ + 0.20B (Billion)	- Total Estimated Effect (Positive Substitution Minus Negative Income Effect) Of A One Point Exchange Rate Decline On Demand For Domestically Produced Consumer Goods (C_D)
$ - 5.37B	- Total Effect (Negative Substitution plus Negative Income Effect) Of Decline In Demand For Domestically Produced Investment Goods (I_D)
$ + 2.86B	- Increase In Exports (X)
$ - 2.31B	- Initial Net Decline in Real U.S. Income from Impact of Declining Exchange Rate:
x 5.26	- Multiplier/Accel/Crowd Out (M/A/C)Effect
$ -12.15B	- Decline in Real Income (Y) after Multiplier/Accel/Crowd Out (MAC)Effects
- 3.16B	- Δ Taxes Due To M/A/C Effect @ Historic .26 Rate (.26*12.15 = 3.16B)
$ - 8.99B	- $\Delta(Y-T_G)$ = Decline In Disposable Income Associated With A One Point Decline In The Exchange Rate

To see the impact of decreased credit availability (crowd out) due to decreased tax collections:

- $0.60B = ΔC_D Due to Crowd Out Effect, Caused By Decreased Taxes = (.19)($ -3.16B)
- $0.95B = ΔC_M Due to Crowd Out Effect, Caused By Decreased Taxes = (.30)($ -3.16B)

With this information we can summarize the changes in consumption and saving resulting from the decrease in disposable income of $ 8.99B as follows:

$ - 8.99B $\Delta(Y-T_G)$	$ - 8.99B $\Delta(Y-T_G)$	$ - 8.99B $\Delta(Y-T_G)$
x .55 MPC_D	x .11 MPC_M	x .34 MPS (1 -.55 -.11)
$ - 4.94B ΔC_D (Multip. Effect)	$ - 0.99B ΔC_M (Multip. Effect)	$ - 3.06B Δ Savings (Reduction in Domestic Funds Available)
$ +0.20B Initial ΔXR_{0123} Effect	$ - 3.03B Initial ΔXR_{0123} Effect	
$ -0.60B Crowd Out Effect	$ - 0.95B Crowd Out Effect	
$ -5.34B Total ΔC_D	$ - 4.97B Total ΔC_M	

9.2 METHOD 2:

We repeat the investment and consumption regression equations from sections 3 and 4 for easy reference as we calculate Method 2:

$$\Delta C_D = \Delta(C- M_{m\text{-}ksm})_0 = .55\Delta(Y\text{-}T_G)_0 + .19\Delta T_{G(0)} + .24\ \Delta G_0 - 1.92\ \Delta PR_0. + .28\Delta DJ_{-2} - 0.20\ \Delta XR_{AV0123}$$
$$\Delta C_M = \Delta(M_{m\text{-}ksm})_0 = .11\Delta(Y\text{-}T_G)_0 + .30\Delta T_{G(0)} - .20\ \Delta G_0 - 5.00\ \Delta PR_0. + .34\ \Delta DJ_{-2} + 3.03\ \Delta XR_{AV0123}$$

$$\Delta I_D = \Delta(I\text{-}M_{ksm}) = .24\Delta ACC + .91\Delta DEP - .56\Delta CAP_{-1} + .45\ \Delta T_G - .47\Delta G - 9.59\Delta r_{-2} - .40\ \Delta DJ_{-2} + .47\ \Delta PROF_{-2} + 5.37\ \Delta XR_{AV0123}$$
$$\Delta I_M = \Delta(M_{ksm}) = .05\Delta ACC + .46\Delta DEP + 1.25\Delta CAP_{-1} + .07\ \Delta T_G - .14\Delta G + 1.12\Delta r_{-2} + .31\Delta DJ_{-2} - .11\ \Delta PROF_{-2} - 0.40\ \Delta XR_{AV0123}$$

From these equations, we see three variables through which investment is affected by changes in the exchange rate:

1. the decrease in the <u>accelerator</u> income variable in the investment equation, or the disposable income variable in the consumption equation, due to the decrease in gross real income (including multiplier effects) caused by the one point decline in XR_{AV0123}
2. the decline in <u>tax collections</u> because of the decline in real income caused by the increase in import prices, and
3. through the one point decline in the <u>exchange rate</u> variable

In this case then, the estimated decline in domestic investment will be

$$\begin{aligned}\Delta I_D = \Delta(I\text{-}M_{ksm}) &= .24\ \Delta ACC \quad + .45\ \Delta T_G \quad + 5.37\ \Delta XR_{AV0123} \\ &= (.24)(\$ -12.15B) \quad + (.45)(\$ -3.16) \quad + (5.37B)(-1) \\ &= -2.92 \quad -1.42 \quad -5.37 \\ &= \$ -9.71B\end{aligned}$$

where the change in taxes ΔT_G is the difference between the change in gross income (ΔY)and the change in disposable income $\Delta(Y\text{-}\Delta T_G)$ given above.

We can also estimate the decrease in demand for imported investment goods as

$$\begin{aligned}\Delta I_M = \Delta(M_{ksm}) &= .05\ \Delta ACC \quad + .07\ \Delta T_G \quad - 0.40\ \Delta XR_{AV0123} \\ &= (.05)\ )(\$ -12.15B) \quad + (.07)(\$ -3.16B) \quad - (0.40)(-1) \\ &= \$ -0.61B \quad - \$ 0.22B \quad + 0.40 \\ &= \$ -0.43B\end{aligned}$$

By similar reasoning, we see that the changes in the demand for domestic and imported consumer goods are as follows

$$\begin{aligned}\Delta C_D = \Delta(C\text{-}M_{m\text{-}ksm}) &= .55\ \Delta(Y\text{-}T_G) \quad + .19\ \Delta T_G \quad - (0.20)\ \Delta XR_{AV0123} \\ &= (.55)(\$ -8.99) \quad + (.19)(\$ -3.16\ ) \quad - (0.20)\ (-1) \\ &= -4.94B \quad - 0.60B \quad + 0.20 \\ &= \$ -5.34B \text{ (same result as method 1)}\end{aligned}$$

and

$$\begin{aligned}\Delta C_M = \Delta(M_{m\text{-}ksm}) &= .11\ \Delta(Y\text{-}T_G) \quad + .30\ \Delta T_G \quad + 3.03\ \Delta XR_{AV0123} \\ &= (.11)(\$ -8.99) \quad + (.30)(\$ -3.16B) \quad + 3.03\ (-1) \\ &= -0.99B \quad -0.95B \quad - 3.03 \\ &= \$ -4.97B \text{ (same result as method 1)}\end{aligned}$$

So, by Method 2 we have

$$\begin{aligned}\Delta Y = \quad & \Delta C_D + \Delta I_D + \Delta G + \Delta X \text{ (+ Exogenous } \Delta XR \text{ rate effects on real income due to price decreases} \\ &= \$ -5.34 - 9.71 + 0 + 2.86 \\ &= \$ -12.19B \text{ (Same result as Method 1 = \$ - 12.15B, except for rounding)}\end{aligned}$$

9.3 METHOD 3:

Using the formal Keynesian "IS" curve method for calculating the GDP shown in Section 9, Eq. 23 above, holding all the other variables in that equation that could affect (ΔY) constant, except those shown below (since our hypothesis does not make them a function of exchange rate changes), we get the following "IS" curve:

$$
\begin{aligned}
\Delta Y &= \Delta C_D + \Delta I_D + \Delta G + \Delta X \\
&= (.55\Delta(Y-T_G) + .19\Delta T_G - 0.20\Delta XR_{AV0123}) + (.24\,\Delta ACC + .45\,\Delta T_G + 5.37\Delta XR_{AV0123}) + 0 - 2.86\,\Delta XR_{AV0123} \\
&= (5.26)(-0.20 + 5.37 - 2.86)(\Delta XR_{Av0123}) + (5.26)(.09)(\Delta T_{EX}) \\
&= (5.26)(-2.31B) + 0 \\
&= \$ - 12.15\text{ B (Same result as by Methods 1 and 2)}
\end{aligned}
$$

10. EXCHANGE RATE EFFECTS ON THE TRADE DEFICIT AND U.S. ASSETS

The estimated decline in the U.S. trade deficit resulting from a one point decline in the exchange rate is the sum of the resulting decrease in imports and the increase in exports

\$ 4.97B - Decline in C_M
0.43B - Decline in I_M
. <u>2.86B</u> - Increase in X
\$ 8.26B - <u>Decrease in Trade Deficit Associated with a 1 Point Drop in the Exchange Rate</u> (= Decreased Need To Transfer Ownership of U.S. Owned Assets To Foreigners Or Borrow From Them To Finance Trade Deficit)

<u>\$ - 3.06B</u> - Δ Savings = (.34 MPS)(- 8.99 $\Delta Y-T_G$)
\$ - 3.06B - <u>Decrease In Domestically Owned Wealth (Savings) Resulting From Exchange Rate - Induced Decline in Real Income</u>

The annual decrease in savings of \$3.06B is the estimate of <u>the decline</u> in normally expected domestic asset growth due to the exchange rate decline, which causes an decrease in real income and saving (asset accumulation). This decline in savings asset growth can be deducted from the annual decrease in U.S. assets required to fund the trade deficit (\$8.26B). The two together mean U.S ownership of (U.S.) assets will grow annually at an estimated \$5.20 billion compared to the period before the decline of one point I n the exchange rate, *ceteris paribus.*

Our reasoning is as follows: every trade deficit is financed by a transfer of ownership of domestically owned assets (including money), or claims to such assets, to other countries or their citizens. This is how the money is raised that allows one country to buy more goods from another than the other wants to buy from the first. A decline in the trade deficit reduces the need to sell off (or borrow against) domestic assets to finance the deficit. This decline in need to sell off domestic assets is partially offset by the decline in domestic savings (decline in annual growth in U.S. – owned assets) that occurs because the exchange rate drops. This decrease in savings results from the income decrease caused by simultaneous rise in consumer demand and export demand more than offset by the decline in investment demand resulting from the exchange rate decline. Putting this together with the decline in the trade deficit, it is estimated that a one point reduction in the exchange rate would result in a (\$8.26B deficit decline – 3.06B savings decline = \$5.20B) net increase in U.S. ownership of capital assets each year compared to what would have occurred if the exchange rate had not changed.

Conversely, a <u>rise</u> in the U.S. exchange rate of one point would give the same results as above, but with the opposite sign. Income would increase \$12.15B, disposable income by \$8.99B, the trade deficit s would rise by \$8.26B and savings would rise \$3.06B, etc. This would reduce the annual net growth of U.S. assets by \$5.20 billion annually.

11. CONCLUSIONS

The analysis above indicates that when the Federal Reserve's real broad trade - weighted exchange rate index falls by one point, the results are as follows:

1. From Method #2 above we have

a. a decrease in demand for imported consumer and investment goods and services estimated at $5.40B (= 4.97B C_M, + 0.43B I_M).

b. a decrease in demand for domestically produced consumer and investment goods and services of $12.19B = (- 5.34B C_D, - 9.71 I_D + $2.86B X). Our study is too macroeconomic in nature to be able to say which specific industries are affected

The trade deficit would likely decrease an estimated $8.26 billion, due to the $5.40B reduction in imported consumer and investment goods, and $2.86B increase in exports.

Because a one point (~1%) drop in the exchange rate is small, so is the decline of the trade deficit. In dollars, the decline is only $8.3 billion. As a percent of GDP the trade deficit would only decline about one tenth of a percent from 4.34% to 4.25%, using 2000 values as the base year against which the decline is measured, as shown in Table 3 below

Table 3
Exchange Rate Impact on GDP and Trade Balance
(Billions of 1996 Dollars)

	Real GDP	Imports	Exports	Trade Deficit Dollars (% of GDP)
Actual 2000 Data	$9224.00	$1532.00	$1132.00	$400.00 (4.34%)
Effect of 1Pt. Drop In XR	9211.85	1526.60	1134.86	$391.74 (4.25%)
Effect of 10Pt Drop In XR	9102.50	1478.00	1160.60	$317.40 (3.49%)
Effect of 14.4Pt (13.8%)Drop In XR	9049.04	1454.24	1173.18	$281.06 (3.11%)

2. This suggests that even a fairly large, say 10%, drop in the exchange rate would only decrease the trade deficit as a percent of GDP moderately, by 0.85 percent, from 4.34 to 3.49%, or $82.6B, using the year 2000 GDP and trade deficit as the base year against which to measure the change.. This decrease in the trade deficit would be accompanied by a small 1.3% decrease in the GDP ($121.5B) in year 2000 dollars. Using the numbers from Method 2, and multiplying them by 10, we find that, the total of these changes divides as follows:

$$\Delta Y = \Delta_{CD} + \Delta_{ID} + \Delta G + \Delta X$$
$$\$-121.90B = -\$53.40B - \$97.10B + 0 + \$28.60B$$

However, in the period 2000 – 2008, The U.S. exchange rate dropped even more significantly. The Real Broad Index dropped 14.4 points (13.8%), from 104.7 to 90.3.

Using the 14.4 point drop in the Real Broad Index during the 2000-08 period, suggests that this would have been associated with a decrease in the GDP over the 8 year period of $175.0B, or 1.9% of the GDP. This drop would also have been associated with a drop in the trade deficit of about $119B. As a percent of the GDP, the trade deficit would drop 1.23 percentage points, from 4.34% to 3.11% of GDP other things equal.

Using the numbers from Method 2, and multiplying them by 14.4, we can disaggregate the total GDP change into its component parts t:

$$\Delta Y = \Delta C_D + \Delta I_D + \Delta G + \Delta X$$
$$-\$174.96 \sim= -\$76.90 - \$139.82B + 0 + \$41.18B$$

The $174.96B decrease in GDP associated with the estimated 14.4 point (or 13.8%) 2000-08 decline in exchange rates, would have resulted in a 1.9% decrease in 2000 - level real GDP, *ceteris paribus*. However, Bureau of Economic Analysis data indicated the real GDP grew 18.7% during the 2000-2008 period. Presumably, had the exchange rate decline not occurred, it would have grown 1.9% more, increasing the average annual growth rate slightly - less than one quarter percent per year from 2.33% to 2.58%.. The actual annual growth rate appears to have been lower than it might have been had the exchange rate not declined, but not much. Thus, the evidence indicates that the cheaper dollar of the 2000-2008 period did have a small negative effect on the U.S. GDP, consumption and investment overall, but these effects were swamped by larger scale macroeconomic events going on at the same time (e.g., post 9/11/01 military build up, increased investment spending) which provided far greater positive stimulus to the economy.

3. The $8.26 decline in the U.S. Trade deficit associated with a one point drop in the real Broad exchange rate index reduces the need for annual transfers of U.S. assets (including dollars) to foreign ownership. Other transfers are still needed to pay for the remaining trade deficit. Hence, there is a decline in the amount of U.S. owned assets that have to be transferred to the rest of the world to pay for the U.S's excess of imports over exports. Subtracting the decrease in U.S. assets (new savings) associated with the decline of the exchange rate, we estimate each point decline in the exchange rate increases U.S. ownership of assets $5.2 billion, or about $75 billion for the eight year period.

12. REFERENCES

__________. *Economic Report of the President*. Washington. U.S. Government Printing Office. 2002 (also 2009, 2001 and 1997 reports)

Fair, R. (2004) *Estimating How the Macroeconomy Works*, Appendix A: U.S. Model. 2004 Available at http://fairmodel.econ.yale.edu/rayfair/pdf/2003A.PDF

Heim, J. J. (2007) Does A Strong Dollar Increase Demand for Both Domestic and Imported Goods? *Journal of International Business and Economics.* Gale Group/Thomson Publishing 7(3), 12-22.

Heim, J.J. (2008a). The Consumption Function. *Review of Business Research* 8(2), 18-36.

Heim, J.J. (2008b). What Determines Market Demand for Investment Goods? *International Journal of Business Strategy* 6(1), 67-80.

Heim, J. J. (2008c) How Falling Exchange Rates 2000 - 2007 Have Affected the U.S. Economy And Trade Deficit. *RPI Working Papers in Economics, No. 803, Department of Economics, Rensselaer Polytechnic Institute*, January 2008.

Heim, J. J. (2009). A Method For Separating Income And Substitution Effects Of Exchange Rate Changes On Aggregate Demand. *RPI Working Papers in Economics, No. 901, Department of Economics, Rensselaer Polytechnic Institute*, February 2009.

Hellerstein, R., Daly, D. and Marsh, C. (2006) "Have U.S. Import Prices Become Less Responsive to Changes in the Dollar?" *Current Issues in Economics and Finance*, Federal Reserve Bank of New York, Vol.12, No. 6, 1-6

Jorgenson, D. Econometric Studies of Investment Behavior: A Survey, *Journal of Economic Literature*, 9(4), Dec. 1971, pp. 1111-47.

Keynes, J.M. *The General Theory of Employment, Interest and Money*. New York: Harcourt, Brace and World, Inc. 1964

Prager, J. 1993. *Applied Microeconomics*. Boston: R. J. Irwin, Inc.

Pyndick, R. & Rubinfeld, D. (1991) *Econometric Models & Economic Forecasts*. New York: McGraw - Hill.

Samuelson, P. (1939) Interactions Between the Multiplier Analysis and the Principle of Acceleration. *Review of Economics and Statistics* 21(2) No. 2, 75-78.

Wold, H., and L. Jureen. 1953. *Demand Analysis.* Wiley Publications in Statistics. New York: John Wiley & Sons.