



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: sternd@rpi.edu

Do Falling Import Prices Increase Market Demand for Domestically Produced Consumer Goods?

John J. Heim
Rensselaer Polytechnic Institute

Number 0707

July 2007

For more information and to browse and download further *Rensselaer Working Papers in Economics*, please visit: <http://www.rpi.edu/dept/economics/www/workingpapers/>

DO FALLING IMPORT PRICES INCREASE MARKET DEMAND FOR DOMESTICALLY PRODUCED CONSUMER GOODS?

John J. Heim¹
Department of Economics
Rensselaer Polytechnic Institute
110 8th Street
Troy, NY 12180
heimj@rpi.edu

Abstract: Rising exchange rates can lower prices on imported consumer goods. The lower prices have two effects. A substitution effect shifts in demand from domestically produced goods to imports. An income effect also allows more import purchases. It also allows some income previously spent on imports to be shifted to domestic spending. This shift may or may not increase total demand for U.S. consumer goods. This paper finds it does, and that increases in demand for domestically produced consumer goods and services are about five times as large as the increase in demand for imported consumer goods and services. The paper also finds that the increase in demand for domestic goods is about three times as large as the increase in the trade deficit resulting from the higher exchange rate. JEL E00, F40

For years now, the rhetorical battle in the United States has raged over whether the Chinese exchange rate is kept artificially high, thereby making it possible (and profitable!) for Americans to buy many Chinese Yuan for each dollar they are willing to spend. This makes foreign goods seem cheap compared to American counterparts and may cause a decline in purchases of American goods. Similarly, the more Yuan it takes to buy a dollar, the less American exports goods the Chinese are able to buy.

The argument is also made that if only the Chinese would lower their managed exchange rate to some “reasonable”, but usually undefined, level trade would again be fair, and a large portion of the trade imbalance between the two countries would disappear. Similar arguments are made regarding the exchange rates with some other American trading partners, such as Japan.

The question is, are American purchasing decisions to purchase domestic vs. foreign goods really that much affected by changes in the exchange rate between the United States and its major trading partners? Does a rising exchange rate (stronger dollar) not only mean rising imports but also declining purchases of domestically produced goods? If so, is it a one-for-one trade off, or are rising imports only partially financed by declining purchases of domestic goods? Also, rising exchange rates imply lower import prices which increase Americans’ real incomes and purchasing power through the “income

¹ John J. Heim is clinical associate professor of economics at Rensselaer Polytechnic Institute. He has benefited greatly from discussions of this and related topics with colleagues in the economics department at R.P.I. All responsibility for errors, of course, remains his own.

effect". Might it be that we purchase more domestic goods as well as more imported goods when a stronger dollar causes import prices to drop? These are empirical questions, which this paper seeks to answer. To do so we will examine the affect of exchange rate changes 1960-2000 on demand for both domestic and imported consumer goods and services. We will especially look to see if a rise in one is offset by a decline in the other, or accompanied by a rise in the other because the "income effect" swamps the "substitution effect" resulting from the change in relative prices.

METHODOLOGY

All data used in the study is 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.

To study the effect of exchange rate changes on consumption of domestically produced and imported consumer goods, we need a theory of consumer demand for consumer goods, so that in testing, we can control for changes in consumption causes by things other than the exchange rate. Essentially, this paper postulates a modified Keynesian theory of demand for consumer goods (described below). It assumes that in general, the determinants of the demand for 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.

The Basic Keynesian Function:

Keynes argues in chapter 8 of the General Theory of Employment, Interest and Money (1936) 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....(p.96)

though

...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 (pp.95-96)...

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.

Hence, we can sum up Keynes by saying his determinants of consumption spending included after tax income, wealth, and the interest rate, and a desire to save. To these, our consumption function below will add a crowd out factor as also being the result of fiscal policy (via government deficit effects on savings available to finance consumer credits) and a trade weighted exchange rate.

Keynes also argued (p. 97) that the proportion of total income saved would grow as income grew, resulting in falling average propensity to consume as income grew.

Typical tests in the late 30's and early 40's using cross-sectional data seem to verify this. For example, in Ruggles & Ruggles (1956, p.306) attempt to describe the Keynesian function in their classic text on national income accounting, using the income and consumption patterns of almost 40 million U.S. families in 1935-36 to illustrate a declining average propensity to consume/increasing average propensity to save as income increased. Their data are shown in Table C1. Note that about half of all personal saving was done by the top ½% of all income recipients – those families earning \$15,000 or more, and that the bottom two income groups had negative savings, i.e., average propensity's to consume greater than one. Data like this have provided our standard, though somewhat - even if only slightly – oversimplified (no provision for wealth or interest rate effects), interpretations of the Keynesian consumption function. Of course, a declining APC means the function has a positive intercept, as is commonly shown in textbook presentations of the Keynesian consumption function.

**Consumers' Income and Expenditure, by Income Group, 1935-36
(in millions, unless otherwise noted)**

Income Group (in dollars)	# of Families (000)	Personal Income	Personal Taxes	Dispos_ able. Income	Consumption Expenditures	Personal Saving
Under \$780	13,153	\$6,190	171	\$6,019	\$7,226	-\$1,207
780-1,450	13,153	14,154	616	13,638	13,890	-252
1,450-2,000	5,974	10,035	409	9,626	9,164	462
2,000-3,000	4,434	10,577	465	10,112	9,043	1,069
3,000-5000	1,818	6,644	343	6,301	5,125	1,176
5,000-15,000	749	5,839	413	5,426	3,529	1,897
\$15,000 & Over	<u>178</u>	<u>5,820</u>	<u>750</u>	<u>5,070</u>	<u>2,237</u>	<u>2,833</u>
Total.....	39,458	\$59,259	\$3,067	\$56,192	\$50,214	\$5,978

Source: Ruggles & Ruggles, (1956, p.306)

In another study (Heim, 2007), it was 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:

$$(1) \quad C_0 = \beta_1 + \beta_2 (Y-T_G)_0 + \beta_3 (T_G - G)_0 - \beta_4 (PR)_0 + \beta_5 (DJ)_{-2} + \beta_6 (XR)_{-2}$$

where

$(Y-T_G)_0$ = Total income minus taxes, defined as the GDP minus that portion of total government receipts used to finance government purchases of goods and services, i.e., total government receipts minus what's needed to finance transfer payments in the current period.

$(T_G - G)_0$ = 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 $\beta_{3B} G$. because we found the effects of each on consumer spending to differ, with the tax variable the more important. (Heim 2007a)

PR_0 = An interest rate measure, the Prime rate, for the current period. This rate is a base rate for much consumer credit.

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

XR_{-i} = The trade - weighted exchange rate, lagged "i" years. In some regressions, an average of the XR value for the past two or three years is used, denoted XR_{AV12} or XR_{AV123}

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

$$(1A) \quad \Delta C_0 = \beta_2 \Delta(Y-T_G)_0 + \beta_3 \Delta(T_G - G)_0 - \beta_4 \Delta(PR)_0 + \beta_5 \Delta(DJ)_{-2} + \beta_6 \Delta(XR)_{-2}$$

or

$$(1B) \quad \Delta C_0 = \beta_2 \Delta(Y-T_G)_0 + \beta_{3A} \Delta(T)_{G(0)} - \beta_{3B} \Delta(G)_0 - \beta_4 \Delta(PR)_0 + \beta_5 \Delta(DJ)_{-2} + \beta_6 \Delta(XR)_{-2}$$

We will test these hypotheses using regression analysis using different levels of lag in the exchange rate variable from 0 lag (current year value) to -3 lag (the exchange rate value 3 years ago. We will estimate the regression using multiple lags in the same equation, and using average exchange rate values for several periods to capture any incompleteness in the adjustment to a change in the exchange rate that takes place in the year the rate changes.

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 consumption variable (C) in the GDP accounts or its component part, consumer imports, and income (Y) inherent in these equations, two stage least squares estimates of disposable income $\Delta(Y-T_G)_0$ were used. The remaining right hand side variables were used as first stage regressors. Newey-West heteroskedasticity corrections were also made. Testing for autocorrelation was also done. Where the autocorrelation variable's coefficient was found significant at the 5% level, it was included; otherwise no correction was made.

Baseline findings for each model, absent only the exchange rate variable, are also presented. They are shown to give an idea of the amount of additional variance in consumer spending the exchange rate explains. Though useful, the extent to which entering the exchange rate variable changes the percent of variance explained needs to be interpreted with care, since order of entry in an equation can affect how much additional variance appears to be explained. This is a problem when there is significant multicollinearity between the last variable entered and the other explanatory variables. One important sign of success in avoiding this problem is finding little or no change in the estimated marginal effects of the variables already in the regression when adding the exchange rate. Therefore, we show results for how all consumption function coefficients change when entering an exchange rate variable, compared to their values in the baseline model.

Our initial set of findings establish a baseline model of consumption with all the variables discussed above except the exchange rate. In the model, equations for total consumption (C) are presented, i.e., consumption of both domestic and imported consumer goods as "C" is used in the GDP identity

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

There is some difficulty unambiguously separating consumer imports out of total imports in the CEA's data Appendix to the *Economic Report of the President, 2002*, Table B-104. It is not clear from that table, for example, how much of the value of motor vehicle imports or petroleum imports are for business inventory investment vs. consumer use. To address this, we examined four different possible estimates of consumer goods imports:

1. Total Imports (M)
2. Total Imports minus capital goods imports (M_{m-k})
3. Total Imports minus capital goods imports and industrial supplies and materials (M_{m-ksm})
4. Total Imports minus capital goods imports, industrial supplies and materials, and one half of petroleum imports (M_{m-kstp})

Data on imported services (Table B-106 in the CEA data appendix) does not distinguish between business and consumer services imports or extend back beyond 1974, so no deduction from total imports for business services imports could be made in calculating consumer imports.

We estimated a demand function for imported consumer goods using each of these definitions. We did this based on the theory that the demand for imported goods is a function of the same variables as the demand for domestic goods. We then define the variable best approximating imports of consumer goods and services imports as the one

whose variance is most systematically explained by the Keynesian demand function (augmented by inclusion of consumer credit crowd out variable(s)).

We then subtract our imports equation results from our total consumption (C) results to obtain our estimates of how those same consumption determinants affect demand for domestically produced consumer goods. We find that the coefficients obtained from the regression of the variable (C-M) on our standard consumption determinants are the same as we obtain from simply subtracting the M regression results from the C regression results, and this holds true for all variants of M used.

The results of preliminary testing indicated the 3rd definition above provided the definition of consumer imports most systematically explained (highest R²) by the determinates of consumer spending discussed above, so this is the definition of consumer demand used in the remainder of the study. Interestingly, there was relatively little change in the estimated effects (regression coefficient) of the exchange rate on consumption of domestic and imported consumer goods, regardless of which definition was used.

To illustrate a sample of the results of this preliminary testing, we show below the findings for total explained variance (R²) and the exchange rate regression coefficient for each definition of imports. Results are shown for the specific tests in which the exchange rate variable was defined as the average exchange rate for the current and past three years. The regression coefficient on that variable is also shown.

Equation	Consumer Imports Definition			
	(M)	(M _{m-k})	(M _{m-ksm})	(M _{m-ksmp})
Imported Consumer Goods	88%	92%	93%	88%
Domestic Consumer Goods	58%	68%	73%	73%
Exchange Rate Coefficient	2.01	2.00	1.96	2.23

After estimating the baseline model (no exchange rate variable included), we then estimate a model that includes the current year exchange rate (XR₀). We then estimate models that includes the current year rate and one or more past three years' exchange rates as separate variables. Finally, we then estimate some models in which the exchange rate variable is an average of the current year rate and one or more past year rates. For example, (XR_{AV01}) would be the average exchange rate for the current and past year.

We include multiple years' separate rates, or multiple year average rates, on the theory it may take more than one period for spending to fully adjust to a change in exchange rates. Therefore, not only this year's exchange rate change but prior years' changes may affect current period consumption. 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.

FINDINGS

As noted earlier, limitations in the data mean the findings below are for consumer demand models which assume all imported goods are consumer goods except those imports described in Table B-104 as “capital goods” and “industrial supplies and materials” (M_{m-ksm}), and all services imports are assumed to be consumer services imports. We believe this definition to be reasonable, if not exact, one.

The Baseline Model - No Exchange Rate:

This model is presented so that we can assess how much additional explanatory power the model has when we do later add an exchange rate variable. Though results are presented for all the other variables thought to influence consumer spending, these are not our focus in this study. They are presented simply to allow comparisons with results on the same variables in later models containing the exchange rate. To the extent these regression coefficients stay about the same when an exchange rate variable is added to the model, it reduces the chances that the exchange rate variable’s estimated effect is distorted by its ability to pick up variance attributable other variables in the equation, because it is correlated with them.

Note that here, and in subsequent models, we most often use the disaggregated version of the crowd out variable, because their seems to be different effects on consumer credit availability that result from changing the government deficit by changing taxes compared to changing government spending levels. This we hypothesize may be due to a tendency of the monetary authorities to accommodate increases in the deficit caused government spending by increasing the money supply, than to do so when the deficit increase is the result tax cuts.

Each model’s findings will be presented in the form of three equations. The first presents our findings on how well our hypothesized determinants of consumption actually explain total consumption demand (consumption of both domestic and imported goods, C). the second presents our findings on how well our hypothesis can explain demand for imported consumer goods and services (M_{m-ksm}), and the third equation presents our findings on how well our hypothesis explains demand for domestically produced consumer goods and services ($C - M_{m-ksm}$).

The “no exchange rate” baseline model results are as follows:

$$\begin{array}{l} \Delta C_0 = .66 \Delta(Y-T_G)_0 + .52 \Delta T_{G(0)} + .10 \Delta G_0 - 7.23 \Delta PR_0 + .42 \Delta DJ_{-2} \\ (t) \quad (26.6) \quad (5.2) \quad (0.5) \quad (-3.0) \quad (2.2) \end{array} \quad \begin{array}{l} R^2 = 88\% \\ D.W. = 1.8 \end{array}$$

Minus

$$\begin{array}{l} \Delta(M_{m-ksm})_0 = .08 \Delta(Y-T_G)_0 + .25 \Delta T_{G(0)} - .12 \Delta G_0 - 4.23 \Delta PR_0 + .57 \Delta DJ_{-2} \\ (t) \quad (4.5) \quad (4.5) \quad (-1.7) \quad (-3.3) \quad (9.6) \end{array} \quad \begin{array}{l} R^2 = 83\% \\ D.W. = 1.1 \end{array}$$

Equals:

$$\begin{array}{l} \Delta(C - M_{m-ksm})_0 = .58 \Delta(Y-T_G)_0 + .27 \Delta T_{G(0)} + .22 \Delta G_0 - 2.99 \Delta PR_0 - .15 \Delta DJ_{-2} \\ (t) \quad (20.5) \quad (2.7) \quad (1.4) \quad (-0.9) \quad (-0.8) \end{array} \quad \begin{array}{l} R^2 = 73\% \\ D.W. = 2.0 \end{array}$$

Notice that the regression coefficients in the last regression are precisely (except for rounding) those you would obtain subtracting the coefficients in the second equation from those in the first! Our confidence in each of the regression's findings is strengthened by being able to correctly predict the results of the third regression from those obtained in the first two.

In the first two equations we find all the Keynesian - postulated determinants of consumption significant at least the 3% (t=2.3) level. We also find the tax variable in the (disaggregated) government deficit expression highly significant, but not the government spending variable. Above, we noted that this difference in results might be anticipated.

Running our regressions in first differences of the variables instead of in levels provides somewhat smaller levels of explained variance. This is to be expected when using time series data, since levels tend to overstate explained variance. But it is generally considered a technique that strengthens the credibility of the rest of the parameter estimates. Even using first differences and without yet adding the exchange rate variable, the baseline model explains most of the variance in consumer spending, particularly for total consumption of domestic and imported goods (88%), and for imported consumer goods (83%). 73% of the variation in domestically produced goods and services is explained.

If we entered the government deficit variables as one variable $\Delta(T_G - G)_0$ we see in a way we are more used to visualizing, how systematically the government deficit seems to be related to consumer spending. In our studies, it is the second most powerful explainer of consumer demand, after income. Below, to illustrate, we have used one deficit variable in the total consumption equation. Because it masks the differential effects of its two components, hereafter we will only show results for the two variable version of the deficit.

$$\Delta C_0 = .73 \Delta(Y-T_G)_0 + .47 \Delta(T_G - G)_0 - 6.92 \Delta PR_0 + .56 \Delta DJ_{.2} \quad R^2 = 83\%$$

(t) (20.0) (4.2) (-2.4) (2.7) D.W. = 1.7

As we noted, the regression coefficients in the second last regression are precisely (except for rounding) those you would obtain subtracting the second equation from the first. This finding holds for both one stage least squares (1SLS or OLS) and two stage least squares (2SLS), as well as for either of these accompanied by heteroskedasticity adjustments.

It is only approximately true when different methods are used for different equations in the model or when autocorrelation corrections are made to equations. For example, in the model above we found 1st and 2nd order autocorrelation in the imports equation, but not in the C or (C- M_{m-ksm}) equations. Below we show how the autocorrelation controls change the import equation coefficients (and standard errors, R², and Durbin Watson statistics).

$$\Delta(M_{m-ksm})_0 = .08 \Delta(Y-T_G)_0 + .24 \Delta T_{G(0)} - .02 \Delta G_0 - 3.62 \Delta PR_0 + .46 \Delta DJ_{.2} + .51 AR(1) \quad R^2 = 86\%$$

(t) (5.2) (4.7) (-0.3) (-3.8) (5.5) (4.6) D.W. = 1.7

In our next model, we add the current year exchange rate to the baseline model. The effect on our three equations is as follows:

$$\Delta C_0 = .66 \Delta(Y-T_G)_0 + .52 \Delta T_{G(0)} + .09 \Delta G_0 - 7.25 \Delta PR_0 + .43 \Delta DJ_{-2} - .15 \Delta XR_0 \quad R^2 = 88\% \\ (t) \quad (26.8) \quad (5.0) \quad (0.5) \quad (-3.1) \quad (2.1) \quad (-0.3) \quad D.W. = 1.8$$

$$\Delta (M_{m-ksm})_0 = .09 \Delta(Y-T_G)_0 + .25 \Delta T_{G(0)} - .09 \Delta G_0 - 4.15 \Delta PR_0 + .54 \Delta DJ_{-2} + .71 \Delta XR_0 \quad R^2 = 87\% \\ (t) \quad (4.6) \quad (5.5) \quad (-1.3) \quad (-4.1) \quad (9.8) \quad (5.0) \quad D.W. = 1.4$$

$$\Delta(C - M_{m-ksm})_0 = .58 \Delta(Y-T_G)_0 + .27 \Delta T_{G(0)} + .18 \Delta G_0 - 3.10 \Delta PR_0 - .11 \Delta DJ_{-2} - .86 \Delta XR_0 \quad R^2 = 75\% \\ (t) \quad (24.1) \quad (2.5) \quad (1.1) \quad (-1.2) \quad (-0.6) \quad (2.1) \quad D.W. = 2.1$$

Notice that the exchange rate here is statistically significant in both the import and domestic consumption equations, and adds about 4% to the 83% explained variance levels in the imports baseline equation. It also adds about 2% to explained variance in the baseline domestic consumption equation. Since the effect of these two equations is to reduce domestic purchases about as much as imports are increased, it is not surprising that in the total consumption equation, where the exchange rate variable shows only a near-zero net effect, we do not find the exchange rate statistically significant. But this should not be misinterpreted as meaning the exchange rate does not matter.

The coefficients on our baseline model variables are virtually unchanged by adding the exchange rate variable. This is a good sign that neither they, nor the exchange rate variable's coefficient, are being distorted by an ability to explain part of each other's variance because their movements over time are correlated.

For our third model, we add both the current and immediate past year exchange rates to the baseline model as one way of hypothesizing that it may take more than one period for exchange rate changes to result in increased purchases, perhaps because of long production lead times required after orders are placed. Our results are

$$\Delta(C)_0 = .66 \Delta(Y-T_G)_0 + .54 \Delta T_{G(0)} + .04 \Delta G_0 - 6.72 \Delta PR_0 + .41 \Delta DJ_{-2} - .47 \Delta XR_{-0} + .88 \Delta XR_{-1} \quad R^2 = 89\% \\ (t) \quad (27.4) \quad (5.5) \quad (0.3) \quad (-2.9) \quad (2.3) \quad (-1.1) \quad (1.6) \quad D.W. = 2.0$$

$$\Delta(M_{m-ksm})_0 = .08 \Delta(Y-T_G)_0 + .26 \Delta T_{G(0)} - .14 \Delta G_0 - 3.58 \Delta PR_0 + .52 \Delta DJ_{-2} + .37 \Delta XR_{-0} + .93 \Delta XR_{-1} \quad R^2 = 92\% \\ (t) \quad (6.1) \quad (6.4) \quad (-2.9) \quad (-5.4) \quad (9.7) \quad (3.2) \quad (5.2) \quad D.W. = 2.0$$

$$\Delta(C - M_{m-ksm})_0 = .58 \Delta(Y-T_G)_0 + .27 \Delta T_{G(0)} + .19 \Delta G_0 - 3.13 \Delta PR_0 - .11 \Delta DJ_{-2} - .84 \Delta XR_{-0} - .05 \Delta XR_{-1} \quad R^2 = 75\% \\ (t) \quad (24.0) \quad (2.5) \quad (1.2) \quad (-1.2) \quad (-0.6) \quad (2.0) \quad (-0.1) \quad D.W. = 2.1$$

Adding the past year exchange rate adds substantially (5%) to explained variance in imports compared to using only the current year rate, and adds slightly to total consumption (1%). Both years exchange rates are highly significant in the import equation, and the current year rate is significant in the domestic consumption equation.

To test for the possibility of further lagged delays in the effects of an exchange rate change, we add the exchange rate for two years ago to the above average and get

$$\Delta(C)_0 = .67\Delta(Y-T_G)_0 + .50\Delta T_{G(0)} + .02 \Delta G_0 - 6.85 \Delta PR_0 + .44 \Delta DJ_{-2} - .28 \Delta XR_0 + .43 \Delta XR_{-1} + .96 \Delta XR_{-2}$$

(t) (27.9) (4.9) (0.2) (-2.7) (2.6) (-0.8) (1.0) (1.8)
R²=90% D.W.= 2.0

$$\Delta(M_{m-ksm})_0 = .09\Delta(Y-T_G)_0 + .24\Delta T_{G(0)} - .16 \Delta G_0 - 3.67 \Delta PR_0 + .54 \Delta DJ_{-2} + .50 \Delta XR_0 + .62 \Delta XR_{-1} + .66 \Delta XR_{-2}$$

(t) (10.1) (7.3) (-3.6) (-7.0) (9.0) (4.3) (4.2) (4.0)
R²=94% D.W.= 2.0

$$\Delta(C - M_{m-ksm})_0 = .58\Delta(Y-T_G)_0 + .26\Delta T_{G(0)} + .18 \Delta G_0 - 3.17 \Delta PR_0 - .10 \Delta DJ_{-2} - .78 \Delta XR_0 - .19 \Delta XR_{-1} + .30 \Delta XR_{-2}$$

(t) (24.7) (2.2) (1.2) (-1.2) (-0.6) (-2.0) (-0.5) (0.5)
R²=75% D.W.= 2.1

Adding the two year ago rate to the current and past year variables adds another 2% to explained variance in the import equation and another 1% to the total consumption variance. Notice the multicollinearity between the various years' exchange rate variables leads to noticeable changes in their coefficients as additional exchange rates are added to the equation. This suggests we should have more confidence in our finding that the exchange rate significantly affects domestic and imports purchase decisions, but less confidence in how much of the total effect takes place in the initial year of the change in rates, compared to subsequent years.

Adding the exchange rate from three years ago to the average, we get

$$\Delta(C)_0 = .67\Delta(Y-T_G)_0 + .51\Delta T_{G(0)} + .04 \Delta G_0 - 7.03 \Delta PR_0 + .42 \Delta DJ_{-2} - .25 \Delta XR_0 + .43 \Delta XR_{-1} + .91 \Delta XR_{-2}$$

(t) (26.6) (4.8) (0.3) (-2.5) (2.5) (-0.6) (1.0) (1.3)
+ .09 ΔXR_{-3} R²=90%
(0.1) D.W.= 2.0

$$\Delta(M_{m-ksm})_0 = .09\Delta(Y-T_G)_0 + .24\Delta T_{G(0)} - .15 \Delta G_0 - 3.70 \Delta PR_0 + .54 \Delta DJ_{-2} + .50 \Delta XR_0 + .62 \Delta XR_{-1} + .65 \Delta XR_{-2}$$

(t) (9.6) (6.7) (-3.3) (-5.8) (8.2) (4.2) (3.9) (2.7)
+ .00 ΔXR_{-3} R²=94%
(0.0) D.W.= 2.0

$$\Delta(C - M_{m-ksm})_0 = .58\Delta(Y-T_G)_0 + .27\Delta T_{G(0)} + .19 \Delta G_0 - 3.33 \Delta PR_0 - .12 \Delta DJ_{-2} - .75 \Delta XR_0 - .19 \Delta XR_{-1} + .25 \Delta XR_{-2}$$

(t) (23.5) (2.1) (1.2) (-1.1) (-0.6) (-1.6) (-0.5) (0.3)
+ .09 ΔXR_{-3} R²=75%
(0.1) D.W.= 2.1

Adding the three year ago rate adds nothing to explained variance in any of the equations, and the t statistics and coefficient (marginal effect) estimates for it are very low.

Variables from the baseline model are not much multicollinear with the exchange rate variables. In fact, we have now entered an additional four variables to the baseline model without significantly changing any of the baseline model coefficients. This provides good evidence that neither the real values of these coefficients nor the exchange rate coefficients are being distorted by any significant ability to account for part of the other group's variation.

Models Using Average Exchange Rates

In our next models, the average of current and various past year exchange rates are used to see if these might more efficiently describe the multiyear effects on consumption

of a change in current year exchange rates, compared to using number of exchange rate variables. For the first of these models we average the current year) and the immediate past year rates. Our results are as follows:

$$\begin{array}{l} \Delta(C)_0 = .66\Delta(Y-T_G)_0 + .53\Delta T_{G(0)} + .10\Delta G_0 - 7.08 \Delta PR_0 + .41 \Delta DJ_{-2} + .39 \Delta XR_{AV01} \quad R^2=88\% \\ (t) \quad \quad \quad (25.1) \quad \quad (5.4) \quad \quad (0.6) \quad \quad (-2.8) \quad \quad (2.2) \quad \quad (0.7) \quad \quad D.W.= 1.8 \end{array}$$

$$\begin{array}{l} \Delta(M_{m-ksm})_0 = .08\Delta(Y-T_G)_0 + .26\Delta T_{G(0)} - .12 \Delta G_0 - 3.74 \Delta PR_0 + .52 \Delta DJ_{-2} + 1.29 \Delta XR_{AV01} \quad R^2=91\% \\ (t) \quad \quad \quad (5.6) \quad \quad (6.4) \quad \quad (-2.3) \quad \quad (-5.4) \quad \quad (10.1) \quad \quad (8.6) \quad \quad D.W.= 1.7 \end{array}$$

$$\begin{array}{l} \Delta(C- M_{m-ksm})_0 = .58\Delta(Y-T_G)_0 + .27\Delta T_{G(0)} + .22 \Delta G_0 - 3.34 \Delta PR_0 - .11 \Delta DJ_{-2} - .90 \Delta XR_{AV01} \quad R^2=74\% \\ (t) \quad \quad \quad (23.8) \quad \quad (2.5) \quad \quad (1.3) \quad \quad (-1.2) \quad \quad (-0.6) \quad \quad (-1.8) \quad \quad D.W.= 2.0 \end{array}$$

Note that the coefficients on this average exchange rate variable are virtually identical to the sums of the coefficients on the separate current year and past year exchange rate variables used in the model further above containing those two rates as separate variables. This suggests we can use a multiyear average exchange rate to capture the effects of a current year rate change whose full impact takes place over several years. The only loss in using the average is that explained variance is 1% lower in two of three equations, than when the two exchange rates are both included separately.

Using the average of ΔXR_0 , ΔXR_{-1} and ΔXR_{-2} to test if the effects of an exchange rate change require three years to be fully realized, we get

$$\begin{array}{l} \Delta(C)_0 = .67\Delta(Y-T_G)_0 + .52\Delta T_{G(0)} + .08\Delta G_0 - 6.89 \Delta PR_0 + .40 \Delta DJ_{-2} + 1.10 \Delta XR_{AV012} \quad R^2=89\% \\ (t) \quad \quad \quad (24.9) \quad \quad (5.4) \quad \quad (0.5) \quad \quad (-2.4) \quad \quad (2.3) \quad \quad (1.6) \quad \quad D.W.= 1.9 \end{array}$$

$$\begin{array}{l} \Delta(M_{m-ksm})_0 = .09\Delta(Y-T_G)_0 + .24\Delta T_{G(0)} - .15 \Delta G_0 - 3.69\Delta PR_0 + .54 \Delta DJ_{-2} + 1.78 \Delta XR_{AV012} \quad R^2=94\% \\ (t) \quad \quad \quad (9.5) \quad \quad (8.0) \quad \quad (-3.7) \quad \quad (-7.1) \quad \quad (9.9) \quad \quad (13.5) \quad \quad D.W.= 1.9 \end{array}$$

$$\begin{array}{l} \Delta(C- M_{m-ksm})_0 = .58\Delta(Y-T_G)_0 + .28\Delta T_{G(0)} + .23 \Delta G_0 - 3.20 \Delta PR_0 - .13 \Delta DJ_{-2} - .69 \Delta XR_{AV012} \quad R^2=74\% \\ (t) \quad \quad \quad (22.7) \quad \quad (2.6) \quad \quad (1.3) \quad \quad (-1.1) \quad \quad (-0.7) \quad \quad (-1.0) \quad \quad D.W.= 2.0 \end{array}$$

Note again that the coefficients on this average exchange rate variable are virtually identical to the sums of the coefficients on the separate variables used in the model above containing only those three rates, again suggesting that we can use multiyear average exchange rates to capture effectively the effects of a current year exchange rate change whose full impact on consumption is manifested over several years. The only loss in using the average is that in all three equations, explained variance is 1% lower than when the three exchange rates are all included as separate variables.

Finally, using the average of ΔXR_0 , ΔXR_{-1} , ΔXR_{-2} and ΔXR_{-3} to test if the effects of an exchange rate change require three years to be fully realized, we get

$$\begin{array}{l} \Delta(C)_0 = .67\Delta(Y-T_G)_0 + .53\Delta T_{G(0)} + .09\Delta G_0 - 7.39 \Delta PR_0 + .37 \Delta DJ_{-2} + 1.47 \Delta XR_{AV0123} \quad R^2=89\% \\ (t) \quad \quad \quad (24.6) \quad \quad (5.5) \quad \quad (0.6) \quad \quad (-2.5) \quad \quad (2.2) \quad \quad (2.1) \quad \quad D.W.= 2.0 \end{array}$$

$$\begin{array}{l} \Delta(M_{m-ksm})_0 = .09\Delta(Y-T_G)_0 + .25\Delta T_{G(0)} - .16 \Delta G_0 - 4.35 \Delta PR_0 + .52 \Delta DJ_{-2} + 1.96 \Delta XR_{AV0123} \quad R^2=93\% \\ (t) \quad \quad \quad (11.4) \quad \quad (7.7) \quad \quad (-2.6) \quad \quad (-7.8) \quad \quad (8.7) \quad \quad (6.8) \quad \quad D.W.= 1.9 \end{array}$$

$$\begin{array}{l} \Delta(C- M_{m-ksm})_0 = .58\Delta(Y-T_G)_0 + .28\Delta T_{G(0)} + .25 \Delta G_0 - 3.04 \Delta PR_0 - .15\Delta DJ_{-2} - .49 \Delta XR_{AV0123} \quad R^2=73\% \\ (t) \quad \quad \quad (22.0) \quad \quad (2.7) \quad \quad (1.4) \quad \quad (-1.0) \quad \quad (-0.8) \quad \quad (-0.7) \quad \quad D.W.= 2.0 \end{array}$$

In our findings here, adding the 3rd past year reduces explained variance 1% in two out of the three equations, compared to the model using the current and past two years' exchange rates as the average. In addition, this average does not nearly as precisely represent the sums of the coefficients from the model where all four exchange rate variables were estimated separately (the sums are 1.18, 1.57 and -.60 respectively).

The Total Effect of an Exchange Rate Change on Demand for Domestically Produced and Imported Consumer Goods

Next, the findings above will be used to estimate how much the demand for imports will increase (due to both income and substitution effects) when the trade weighted exchange rate rises one index point, or about 1%, from year 2000 values. Economic theory suggests both the income and the substitution effects should be positive, each causing increased purchases of imported consumer goods.

The findings above will also be used to evaluate what is likely to happen to demand for domestically produced consumer goods with the same exchange rate change. A negative substitution effect would be expected, as Americans reduce purchases of domestic consumer goods to buy cheaper imports. But lower import prices also increase Americans' real incomes. This income effect should result in increased purchases of domestic as well as imported consumer goods. Will the income effect dominate the substitution effect, so that there is a net increase in demand for domestic goods associated with a drop in imports prices due to exchange rate changes? This is an empirical question, to be examined in the remainder of this paper.

We will use average exchange rate variable coefficients to calculate the impact of a one index point (~1%) change in the exchange rate on purchases of domestically produced and imported consumer goods. In the calculations below, we have used the last set of regression results, which use the current and past three years average exchange rate variable, to make some key projections. This set was chosen despite limitations of this average discussed above. However, in this model, the regression coefficients on the exchange rate variable in both the total consumption and consumer imports equations are statistically significant, and these coefficients are important in our analysis below. This is the only exchange rate average for which both are significant. The coefficient on the exchange rate variable in the domestic consumption equation is not statistically significant. However, it is exactly the same as that obtained from subtraction of the two statistically significant estimates for total consumption and imports. Hence, these coefficients seem more reliable for use in estimating how exchange rate changes effect the demand for imported and domestically produced consumer goods than any others.

A one point increase in the trade-weighted exchange rate index (roughly a 1% increase at 2000 index levels) could reduce import prices about one percent, if the change was passed entirely through to the consumer. In the year 2000, U.S. total real imports (1996 dollars) were \$1,532 billion. A one percent saving reduces their cost by \$15.32 billion. Essentially, this means that real incomes in the U.S. increase by \$15.32 billion.

Are the statistical results immediately above consistent with what we would expect to happen to demand for imported and domestic consumer goods as a result of the one point (~ 1%) change in the trade - weighted exchange rate? The answer is, they are.

Using the estimates from the consumption function above, the marginal propensity to import consumer goods will be taken to be .0924, suggesting that the initial \$15.32 billion income effect of the drop in import prices should increase import spending \$1.42 billion. The exchange rate coefficient results above indicate demand for domestically produced consumer goods drops \$.49 billion. This represents the estimated substitution effect, i.e., the extent to which lower import prices causes a shift in spending from domestic consumer goods to spending on imported consumer goods. This increase in import spending should be added to the income effect to get an estimate of the total impact on import spending of the initial \$15.32 billion change in real U.S. income due to the exchange rate change. Doing so gives an estimated total effect of \$1.91 billion, almost identical to the \$1.96 billion result obtained in the consumer imports regression above!

\$ 15.32 B Increase in Real Income Due to Drop in Import Prices
x .0924 Marginal Propensity to Consume Imported C Goods (C_M)
\$ 1.42 B Increase in Import Demand Due to Income Effect of Δ XRate
.49 B Increase in Import Demand Due to Substitution Effect of Δ XRate
\$ 1.91 B Increase in Import Demand Due to Both Inc & Sub. Effects of Δ XRate

Again we find that the statistical results of one equation in the system corroborate the findings of another, increasing our confidence in the findings of both.

This initial \$15.32 billion increase in real income should also be viewed in the same way that any other first-round increase in income generated by new spending (e.g., increased government spending). The initial increase in income then leads to further increases in income through the multiplier effect. Using the 2.38 spending multiplier implied by the .58 marginal propensity to consume domestic goods in the above equations, the total increase in income attributable to the initial \$15.32 billion increase will be 2.38 times that much, or \$36.46 billion. The total increase in domestic and imported consumer goods spending resulting from this income increase (i.e., the income effect) would be

\$36.46 B ΔY	\$36.46 B ΔY
x .58 MPC Domestically Produced Goods	x .0924 MPC Imports
\$21.15 B ΔC_D	\$ 3.37 B ΔC_M (of which, \$1.42 noted above)
	+ .49 B substitution effect
	\$ 3.86 B Total Increase in Imports Due to the Δ XRate's positive effect on U.S. income

From this increase we must net out the reduction in income that occurs because of the decline in exports associated with the change in 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, which also affects 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 2SLS, autocorrelation and heterogeneity controls are as follows:

$$\Delta X_0 = .09 \Delta(Y)_0 - 2.48 \Delta XR_{AV0123} + .68 \Delta AR(3) \quad R^2 = 49\%$$

(t) (3.6) (-7.6) (4.1) D.W.= 1.5

Using the 2.38 spending multiplier implied by the .58 marginal propensity to consume domestic goods in the above equations, the decline in income attributable to the initial \$2.48 billion drop in exports will be \$5.90 billion. The drop in domestic and imported consumer goods spending associated with this drop in income is

\$-5.90 Billion ΔY	\$-5.90 Billion ΔY
$\times .58$ MPC Domestically Produced Goods	$\times .0924$ MPC Imports
\$-3.42 Billion C_D	\$-0.545 Billion C_M

So, we conclude that over four year period, the total effect of a change in the exchange rate of one point (about 1%) on demand for domestic and imported consumer goods would be

<u>Effect on Consumption of</u>	<u>Imported</u>	<u>Due to</u>
<u>Domestically</u>	<u>Goods</u>	
<u>Produced Goods</u>	<u>Goods</u>	<u>Due to</u>
\$+21.15 B	\$+3.37 B	36.46B Income Increase Due to XRate Rise ($\times .58$ MPC _D or $.0924$ MPC _M)
- .49 B	+ .49 B	Substitution Effect from Lower Import Prices
- .68 B ($.49 \times 2.38 \times .58$)	- .11 B	1.17B Income Drop Due to .49 Subst. Effect
- 3.42 B	- .55 B	Decrease in Income Caused By Declining X($\times .58$ MPC _D or $.0924$ MPC _M)
\$+16.56 B Total Change in Demand for C_D	\$+3.20 B Total Change in Demand for C_M	

We conclude that a reduction in import prices due to a ~1% rise in the trade weighted exchange rate would increase demand for imported consumer goods and services by \$3.20 billion. Perhaps a more important finding is that the positive income effect for Americans of an upward exchange rate change (lower import prices) so exceeds the small substitution effect that there is a net gain in American demand for domestically produced consumer goods of \$16.44 billion, roughly five times as large as the increased demand for imports.

These differences are in part explained by the fact that Americans propensity to consume imports (.0924) is relatively small compared to their propensity to consume domestically produced goods (.58). Hence, any income effect is overwhelmingly channeled into increased demand for domestic goods and services.

Effect of Exchange Rate Changes in on U.S. Income

The total effect on U.S real incomes is the difference between the total gain due to the lower prices resulting from the exchange rate change minus the loss due decline in exports for the same reason and the decline due to substitution effects, i.e.,

\$36.46 B - Income Increase Due to Lower Import Prices
- 1.17 B - Income Decline Due to Substitution effect
- 5.90 B - Income Decline Due to Decline in Exports
\$29.39 B - Net Increase In U.S Income Due to Lower
Import Prices

Other effects on income would result from the impact of these changes on Investment through the accelerator effect, but evaluating them is beyond the scope of this paper.

Effect of Exchange Rate Changes on U. S. Trade Deficit in Consumer Goods

We can see from the calculations above that the increase in the trade deficit is

\$ 2.48 B - Decline in Exports of Consumer Goods
3.20 B - Increase in Imports of Consumer Goods
\$ 5.68 B - Increase in Consumer Goods Trade Deficit
Caused by ~1% Change in Trade Weighted
U.S. Exchange Rate

Additional increases in the trade deficit might result from the impact of the income changes described above on investment through the income accelerator effect, but evaluating these is beyond the scope of this paper.

Conclusions

There are two major conclusions that seem supported by the above study:

1. When a rising exchange rate strengthens the dollar, it increases demand for imported consumer goods and services. It also increases overall demand for domestically produced consumer goods and services by about five times as

much. Our study is to macroeconomic in nature to be able to say which specific industries will be helped.

2. A one percent change in the trade weighted exchange rate, through its effect on demand for consumer goods and services, would likely result in about a \$5.7 billion increase in the consumer goods portion of the trade deficit. Additional increases in the deficit might result from changes in demand for investment goods, but this paper does not address that issue.

Final Note:

One might ask the extent to which order of entry affects the coefficients of variables in the regression equations in this study. This is essentially a multicollinearity question and to address it we present below the simple correlation coefficients of the exchange rate variables, and the results of the baseline model above with only one of the various year's exchange rates added. This will give us an estimate of the maximum amount of variance in current consumption that any one year's exchange rate - past or present - can explain, due to its own effects and its ability to pick up part of the variance attributable to other years' exchange rates effects.

Baseline Model Plus One XR Variable

Dependent Variable	XR Coefficient* (t-Statistic)	R ² (D.W.)
ΔC	(No XRate Var.)	88% (1.8)
ΔC	- .15 (-0.3) ΔXR_0	88% (1.8)
ΔC	+ .70 (1.4) ΔXR_1	88% (1.9)
ΔC	+1.14 (2.1) ΔXR_2	89% (2.0)
ΔC	+ .45 (1.0) ΔXR_3	88% (1.9)
ΔM_{m-ksmp}	(No XRate Var.)	79% (1.0)
ΔM_{m-ksmp}	+ .67(2.7) ΔXR_0	82% (1.2)
ΔM_{m-ksmp}	+1.31(4.9) ΔXR_1	91%(2.0)
ΔM_{m-ksmp}	+1.07(4.4) ΔXR_2	87%(1.5)
ΔM_{m-ksmp}	+ .10(0.4) ΔXR_3	79%(1.0)

*No Autocorrelation Corrections
In these Equations

Baseline Model Plus One XR Variable

Dependent Variable	XR Coefficient* (t-Statistic)	R ² (D.W.)
$\Delta(C-M_{m-ksmp})$	(No XRate Var.)	72% (1.8)
$\Delta(C-M_{m-ksmp})$	-.82(-2.3) ΔXR_0	74% (2.0)
$\Delta(C-M_{m-ksmp})$	-.61(-1.8) ΔXR_1	73% (1.9)
$\Delta(C-M_{m-ksmp})$	+.06(0.1) ΔXR_2	72% (1.8)
$\Delta(C-M_{m-ksmp})$	+.35(0.7) ΔXR_3	73% (1.8)

Correlation Coefficients

	XR_0	XR_1	XR_2	XR_3
XR_0	1.00			
XR_1	.35	1.00		
XR_2	-.05	.35	1.00	
XR_3	-.22	-.06	.35	1.00

Bibliography

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

Heim, J.J. "The Consumption Function", Rensselaer Polytechnic Institute, Department of Economics Working Paper. 2007

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

Kuznets, S. "Proportion of Capital Formation to National Product". *American Economic Review, Papers and Proceedings*. May, 1952

Ruggles, R and Ruggles, N. *National Income Accounts and Income Analysis*, 2nd ed. New York. McGraw Hill. 1956