

The Economic Consequences of Dollar Appreciation for US Manufacturing Investment: A Time-Series Analysis

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**Descriptive Statistics, Correlations, Granger-Causality, and Unit Roots
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Descriptive Statistics, Correlation Matrix, and Granger-Causality Tests

Table A.1 gives the descriptive statistics for the variables in the data set, along with definitions and sources.¹ Simple correlation coefficients for this data set are shown in Table A.2. The investment rate is negatively correlated with the user cost of capital,² but otherwise does not have strong contemporaneous correlations (there is only a weak negative correlation with the real dollar index). The net profit rate is positively correlated with the cash flow ratio and the GDP growth rate, and negatively correlated with the real dollar index and real Aaa interest rate. The cash flow ratio is positively correlated with the user cost of capital as well as the net profit rate. The real dollar index and real Aaa interest rate are positively correlated with each other.

Table A.3 shows ‘Granger-causality’ tests for statistical relationships between each variable and the lags of the other variables, after controlling for its own lags. These tests were conducted using only two annual lags due to the short sample period. The investment rate is

¹ See the appendix included at the end of the text for more details on variable definitions and sources. The statistics given in Table A.1 are for the whole sample period, 1973-2004, but means for the sample period used in the regressions (1974-2004) were used in calculating the exchange rate elasticities in section 5 of the paper.

² The user cost of capital is measured in levels in all tables in this unpublished appendix. However, this variable was always expressed as a percentage rate of change in the regressions reported in the text.

Granger-caused (at least at the 10% significance level) by the net profit rate, GDP growth rate, and user cost of capital, but not by the cash flow ratio, real dollar index, or real Aaa interest rate.³ The net profit rate is Granger-caused (at the 10% level) only by the real dollar index, while the cash flow ratio is Granger-caused by the net profit rate and GDP growth rate. Also, the real Aaa interest rate is Granger-caused (at least at the 5% level) by the cash flow ratio and GDP growth rate.⁴ The user cost of capital is Granger-caused by the net profit rate at the 10% level and by the real Aaa interest rate at the 1% level (although it should be recalled from equation (4) in the text that the contemporaneous real Aaa interest rate is part of the user cost by definition). Importantly, the null hypothesis of no Granger causality is always accepted for two key variables that we wish to treat as exogenous: the GDP growth rate and real dollar index are not significantly Granger-caused by any variables in the data set.

Unit Root Tests

Results of conventional augmented Dickey-Fuller (ADF) tests are shown in Table A.4. Lag length was selected by the Akaike and Schwartz Information Criteria (AIC and SIC, respectively). Each variable was tested first using only an intercept, and was retested with a trend and intercept only if it was found to have a unit root without a trend. Variables which had a unit root with a trend and intercept were also tested in first differences (except for user cost of capital, which was tested in percentage changes for consistency with how it is expressed in the

³ Note that the real interest rate is measured here in levels, while in the regressions reported in the text it is measured in first differences.

⁴ This could be caused by upward pressure of greater corporate borrowing on long-term corporate bond rates during boom periods, or by endogenous policy responses of the Fed (raising interest rates during a cyclical upswing), or possibly by inflationary consequences of higher growth and investment (which could reduce the real interest rate if the nominal interest rate does not adjust).

investment function). The null hypothesis in the ADF test is a unit root, i.e. integrated of order one or $I(1)$.

The ADF test is known to have low power to reject the null hypothesis of a unit root in relatively short time series, such as those used here (32 years of annual data). Therefore, we also used the alternative test due to Kwiatkowski *et al.* (1992), in which the null hypothesis is that the variable is stationary or $I(0)$. The results of these tests (shown in Table A.5) show that the null hypothesis of stationarity is accepted at the 1% and 5% significance levels for all variables used in the regressions (including the percentage change in user cost, although not user cost in levels), although results at the 10% significance level vary for some series depending on whether a trend is included and whether the variables are expressed in levels or differences.

Table A.1. Detailed variable definitions and descriptive statistics

<u>Variable</u>	<u>Definition</u>	<u>Units</u>	<u>Source(s)</u>
Investment rate	Gross investment as a percentage of the net capital stock at end of previous year ^a	Percent	BEA
Net profit rate	Net corporate profits as a percentage of net capital stock at end of previous year ^b	Percent	BEA
Cash flow ratio	Corporate cash flow as a percentage of net capital stock at end of previous year ^{b,c}	Percent	BEA
GDP growth rate	Growth rate of real gross domestic product in chained 2000 dollars	Percent	BEA
Real dollar index	Broad, trade weighted index of the real value of the dollar ^d	March 1973 = 100	FRB
Real Aaa interest rate	Real Moody's Aaa corporate bond interest rate ^e	Percent	FRB and BEA
User cost of capital	See equation (4) in text for definition.	Percent	BEA, FRB, ERP, and author's calculations

<u>Descriptive Statistics (sample period 1973-2004, 32 observations)</u>							
	<u>Investment rate</u>	<u>Net profit rate</u>	<u>Cash flow ratio</u>	<u>GDP growth rate</u>	<u>Real dollar index</u>	<u>Real Aaa interest rate</u>	<u>User cost of capital</u>
Mean	9.133623	10.89318	16.46032	3.08125	97.82802	4.707187	16.68114
Median	8.842798	10.51915	16.33729	3.5	94.89875	5.42	16.35256
Maximum	12.13372	18.08795	22.17846	7.2	122.0475	8.91	22.51633
Minimum	6.588945	3.084476	11.20308	-1.9	86.565	-0.67	12.478
Std. Dev.	1.477959	3.942217	2.661196	2.050718	9.368224	2.381049	2.496182
Skewness	0.656756	0.098161	-0.050602	-0.598515	0.844619	-0.513238	0.288537
Kurtosis	2.579703	2.550951	2.483479	2.998881	2.881213	2.795043	2.421724
Jarque-Bera	2.535949	0.32025	0.369381	1.910507	3.823518	1.460879	0.88989
Probability	0.281401	0.852037	0.831361	0.384715	0.14782	0.481697	0.640859
Sum	292.2759	348.5816	526.7302	98.6	3130.497	150.63	533.7965
Sum Sq. Dev.	67.71527	481.7734	219.5409	130.3688	2720.672	175.7512	193.1587

Notes: BEA refers to U.S. Department of Commerce, Bureau of Economic Analysis, www.bea.gov; ERP is the *Economic Report of the President 2006*, statistical tables, www.gpoaccess.gov/eop/download.html; FRB stands for Federal Reserve Board, www.federalreserve.gov/releases/.

^aBoth investment and capital stock are measured in chained 2000 dollars, using chained real quantity indices linked to the current-dollar values for 2000; from historical data for 1947-2004 on a North American Industrial Classification (NAICS) basis (released 15 March 2006).

^bNet profits and cash flow are measured in current dollars; capital stock is measured at current (i.e. replacement) cost. Both the net profit rate and cash flow ratio were spliced at 1999 using Standard Industrial Classification (SIC)-based data for earlier years and NAICS-based data for 2000-2004 (data for years prior to 1998 were not available on a NAICS basis, and 1998-1999 changes were needed for splicing).

^cCash flow is defined as undistributed corporate profits plus corporate capital consumption allowances (depreciation of capital stock).

^dPrice-adjusted and trade weighted, including both 'major' currencies and 'other important trading partners' currencies.

^eReal interest rate calculated by subtracting the percentage change in the GDP chain-type price index from the nominal Aaa corporate bond rate.

Table A.2. Correlation matrix (sample period 1973-2004, 32 observations)

	Investment rate	Net profit rate	Cash flow ratio	GDP growth rate	Real dollar index	Real Aaa interest rate	User cost of capital
Investment rate	1.00						
Net profit rate	0.02	1.00					
Cash flow ratio	-0.09	0.84	1.00				
GDP growth rate	0.04	0.31	0.29	1.00			
Real dollar index	-0.14	-0.52	-0.22	0.11	1.00		
Real Aaa interest rate	-0.05	-0.55	-0.33	0.21	0.47	1.00	
User cost of capital	-0.60	0.28	0.44	-0.05	0.05	0.24	1.00

Note: See Table 1A for variable definitions and sources.

Table A.3. Granger-causality tests (sample period 1973-2004, 30 observations used after 2 lags)

<u>P-values for the null hypothesis that the row variable does not Granger-cause the column variable:</u>							
	Investment rate	Net profit rate	Cash flow ratio	GDP growth rate	Real dollar index	Real Aaa interest rate	User cost of capital
Investment rate		0.218	0.123	0.324	0.601	0.386	0.890
Net profit rate	0.004***		0.014**	0.785	0.916	0.384	0.073*
Cash flow ratio	0.126	0.396		0.583	0.969	0.008***	0.202
GDP growth rate	0.037**	0.101	0.033**		0.198	0.015**	0.501
Real dollar index	0.159	0.080*	0.399	0.572		0.266	0.124
Real Aaa interest rate	0.888	0.175	0.360	0.598	0.513		0.000***
User cost of capital	0.061*	0.979	0.645	0.747	0.767	0.186	

Note: See Table 1A for variable definitions and sources.

Significance levels: *10%, **5%, ***1%.

Table A.4. Augmented Dickey-Fuller (ADF) tests for unit roots
(sample period 1973-2004, 32 annual observations)

	Specification	Criterion	Lags	<u>Null hypothesis: unit root I (1)</u>	
				Significance Level (p value)	Accept/Reject (level)
Investment rate	Intercept	AIC, SIC	1	0.293	Accept
"	Intercept + trend	AIC, SIC	1	0.306	Accept
"	First differences, intercept	AIC, SIC	1	0.001	Reject 1%
Net profit rate	Intercept	AIC, SIC	0	0.371	Accept
"	Intercept + trend	AIC	1	0.221	Accept
"	Intercept + trend	SIC	0	0.443	Accept
"	First differences, intercept	AIC, SIC	0	0.000	Reject 0.1%
Cash flow ratio	Intercept	AIC, SIC	0	0.148	Accept
"	Intercept + trend	AIC, SIC	1	0.020	Reject 5%
GDP growth rate	Intercept	AIC	3	0.002	Reject 1%
"	Intercept	SIC	0	0.001	Reject 1%
Real dollar index	Intercept	AIC, SIC	1	0.055	Reject 10%
Real Aaa interest rate	Intercept	AIC, SIC	2	0.419	Accept
"	Intercept + trend	AIC	6	0.756	Accept
"	Intercept + trend	SIC	2	0.807	Accept
"	First differences, intercept	AIC	6	0.243	Accept
"	First differences, intercept	SIC	0	0.001	Reject 1%
User cost of capital	Intercept	AIC, SIC	0	0.944	Accept
"	Intercept + trend	AIC	8	0.047	Reject 5%
"	Intercept + trend	SIC	4	0.060	Reject 10%
"	Percentage change, intercept	AIC, SIC	0	0.001	Reject 0.1%

Notes: AIC is the Akaike Information Criterion; SIC is the Schwartz Information Criterion.

All variables are measured in levels except as noted.

Table A.5. Kwiatkowski-Phillips-Schmidt-Shin tests for stationarity
(sample period 1973-2004, 32 annual observations)

		<u>Null hypothesis: stationary I (0)</u>				
		<u>Critical values</u>				
		<u>10% level</u>	<u>5% level</u>	<u>1% level</u>		
		<u>Bandwidth</u>	<u>LM Statistic</u>	<u>0.347</u>	<u>0.463</u>	<u>0.739</u>
Investment rate	Intercept	4	0.388	Reject	Accept	Accept
Net profit rate	Intercept	4	0.451	Reject	Accept	Accept
"	First differences, intercept	4	0.074	Accept	Accept	Accept
Cash flow ratio	Intercept	14	0.248	Accept	Accept	Accept
GDP growth rate	Intercept	12	0.214	Accept	Accept	Accept
Real dollar index	Intercept	4	0.087	Accept	Accept	Accept
Real Aaa interest rate	Intercept	4	0.253	Accept	Accept	Accept
User cost of capital	Intercept	4	0.488	Reject	Reject	Accept
"	Percentage change, intercept	3	0.404	Reject	Accept	Accept
				<u>0.119</u>	<u>0.146</u>	<u>0.216</u>
Investment rate (real)	Intercept + Trend	4	0.100	Accept	Accept	Accept
Net profit rate	Intercept + Trend	3	0.100	Accept	Accept	Accept

Notes: All tests were run using the Newey-West bandwidth selection method* with Bartlett kernel spectral estimation in EView 4.1. All series are measured in levels except as indicated.

*Newey, W. & West, K. D. (1994) Automatic lag selection in covariance matrix estimation, *Review of Economic Studies*, 61, pp. 631-653.