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ABSTRACT

This paper compares the demand for the three individual components of aggregate investment demand: (1) demand by businesses for plant and equipment, (2) business inventory investment and (3) residential housing construction. The models tested are largely based on Keynesian theories of business investment demand, with some allowance for residential housing demand being more driven by Keynes' consumer demand variables. Other possible determinants of investment are also tested, including "crowd out" effects of government deficits on business investment and demographic effects on the residential construction market. Annual data for the U.S., 1960 – 2000, are tested using two stage least squares regression techniques modified to eliminate heteroskedasticity in the data. The models are estimated in "first differences", rather than levels of the data to reduce the effects of multicollinearity, non stationarity and autocorrelation. The models explain about 90% of the variance in plant and equipment demand, 85% of the variance in residential housing demand for and 67% of inventory demand. The results indicate that demand for each of these three types of investment goods is driven by different combinations of variables Business investment in plant and equipment appears determined by how much the overall economy is growing (the accelerator effect), the availability of credit (crowd out), the availability of depreciation reserves, the prime interest rate lagged three years, business profits and stock values lagged one year, and the effects of an exchange rate change over the four year period following the change. Inventory investment seems mainly determined by availability of depreciation reserves, crowd out, interest rates, unexpected changes in consumer demand and the accelerator. Residential construction demand seems mainly driven by disposable income, the effect of general growth in the economy on consumer spending (the accelerator), credit availability (crowd out), current year mortgage rates, and prior year consumer wealth levels.

1. INTRODUCTION

A recent study (Heim, 2008) indicated that the overall demand for investment goods in the U.S. economy, is driven, in order of importance, by

- the current growth rate of the economy (an "accelerator" effect),
- the size of available depreciation allowances,
- limitations on ability of businesses to borrow to finance investment due to the "crowd out" effects of government deficits,
- the prime interest rate, which is policy - controllable by the Federal Reserve because of its rigid relationship to the federal funds rate.
- Corporate profits, and
- the exchange rate.

However, that study did not develop separate demand functions for each of the three parts of total investment:

- business demand for plant and equipment,
- business demand for inventory, and
- residential housing demand.

Do these findings for demand overall hold equally for each type of investment, particularly the two smaller components of investment, residential construction and inventory investment? Or are the findings for

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overall investment demand merely reflecting the largest component: demand for business plant and equipment, which represents over 2/3 of all investment? Different factors may drive the demand for housing and inventory investment. This paper attempts to determine econometrically the demand functions for each of these three types of investment, using data for the period 1960 - 2000.

Table 1 below shows trends in total U.S. investment and its component parts, for selected years since 1960.

TABLE 1
COMPONENTS OF REAL U.S. INVESTMENT 1960 – 2000
(Billions of Chained 2000 Dollars)

Year	Total Investment	Business plant & equipment	Residential Investment (Housing)	Inventory Investment
1960	$ 266.4	$ 140.0	$ 157.2	$ 9.0
1970	426.8	260.1	192.3	4.8
1980	644.0	435.6	239.7	- 7.6
1990	893.3	594.5	298.4	13.8
2000	1,735.5	1,232.1	446.9	56.5
% of Total	100%	64.3%	35.7%	2.8%

Source: Economic Report of the President 2005, Appendix Tables B1, B7
*Due to chain indexing, totals do not add to 100%

Overall, from 1960 - 2000, total investment in real 2000 chained dollars averaged 14% of GDP, a significantly smaller percentage than consumption (67%) and government purchases of goods and services (21%). Net exports accounted for the remainder, averaging (-2%) for the period.

  Investment nonetheless remains a significant portion of the GDP, and the second largest part determined largely internally (after consumption) by other variables in the economic system. Hence, to know why the GDP is what it is, in part we must understand what drives the demand for investment goods, a significant portion of the GDP.

2. THEORIES OF DEMAND FOR INVESTMENT GOODS

Our theory of demand for business plant and equipment component of investment is taken from John Maynard Keynes' theory of investment demand (Keynes, 1936, pp. 135-151). Keynes noted that expectations, interest rates, profitability, stock value, and capacity utilization affected the demand for investment goods. Since Keynes, other factors have been added to the list of possible investment determinants.   Terragossa (1997) noted depreciation allowances could also make a difference, Spencer & Yohe (1970) and Heim (2008) noted "Crowd Out" could be an important factor. Heim (2008) also noted a relationship of exchange rates to investment demand for both foreign and domestic goods.

The demand for residential housing is principally a demand by consumers, rather than business. Keynes, found that income was most important, but that taxes, wealth and interest rates might also affect general levels of spending by consumers. In addition, Du Reitz (1977) found average age of the population related to fluctuations in housing demand. Rosser (1999), in a somewhat more microeconomic study found that significant explanatory variables also included how long you had been in the work force, and whether you were living with a partner and had children. He did not find that (given your number of years

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in the work force) that student loan obligations, age, gender, housing prices or relative prices of owning versus renting significantly affected the probability you would own a home.

As relates to inventory investment, Temin (1977) reports little relationship between credit conditions and inventory investment. However, Carpenter, Fazzari and Peterson (1998) provides "new evidence of the importance of financing constraints". Lovell (1964) reports on the importance of the accelerator in determining the level of inventories. (King 2003) notes Kalecki and Keynes wrote inventory investment should be affected by the same things that affect fixed investment, but also the availability of finance and expectations of sales. Choi and Kim (2001) also note that "inventory fluctuations are largely attributable to unexpected sales shocks". If correct, we should find our capacity to thoroughly explain variation in inventory demand over the 1960 – 2000 period more limited than our ability to explain plant and equipment (P&E) and housing demand during the same period.

3. METHODOLOGY

Together, the following eight variables constitute, for testing purposes, this study's hypothesis of the determinants of demand for plant and equipment and inventories. :

(1) $I_{P\&E,INV} = f(\text{ACC, DEP, } r_{PR}*Y_{-2}, (T_G\text{-}G), \text{DJ, CAP, PROF, XR})$,   which, in linear form is:

(2) $I_{P\&E,INV} = \alpha + \beta_1 (\text{ACC}) + \beta_2 (\text{DEP}) + \beta_3 (r_{PR}*Y_{-2}) + \beta_4 (T_G\text{-}G) + \beta_5 (\text{DJ}) + \beta_6 (\text{CAP}) + \beta_7 (\text{PROF}) + \beta_8 (\text{XR})$

Where

- $I_{P\&E,INV}$ = Business investment in plant, equipment and inventories
- ACC = The Accelerator (ΔY). It is a measure of the rate of growth of the economy, therefore a measure of business climate: i.e., the overall current boom/bust condition of the economy
- . DEP = Depreciation
- $r*Y_{-2}$ = The Prime Interest Rate(r), multiplied by the size of the GDP (Y) two years earlier
- $(T_G\text{-}G)$ = The government budget deficit/surplus or (T_G and G may be modeled separately)
- DJ = =The Dow Jones Composite Stock Index
- CAP = Capacity Utilization
- PROF = Business Profits
- XR = The Exchange Rate

The hypothesized determinants of housing demand (residential fixed investment) were different on theoretical grounds. Several of the variables above were not tested (capacity utilization, profits, the depreciation) for lack of mention in the theoretical literature, and some were tested in a form different from that used above (mortgage interest rate vs. prime interest rate as the interest rate variable). Other variables, not hypothesized above as determinants of P&E or inventory investment, were included among the hypothesized determinants of residential housing demand. These included disposable income ($Y\text{-}T_G$), cost of housing relative to income (H_{PRICE}) and the percentage of population in prime house-buying age groups in the population (POP). Though not commonly postulated as a determinant of housing demand, the accelerator variable is included in our tests as a possible determinant of housing demand. It is viewed as a measure of consumer confidence in current economic conditions, since it measures the current rate of growth of the economy.

Hence, our model of residential construction (housing) demand, in linear form, becomes:

(3) $I_{RES} = \alpha + \beta_2 (Y\text{-}T_G) + \beta_1 (\text{ACC}) + \beta_3 (r_{MORT}*Y_{-2}) + \beta_4 (T_G\text{-}G) + \beta_5 (\text{DJ}) + \beta_6 (H_{PRICE}) + \beta_7 (\text{POP}) + \beta_8 (\text{XR})$

Where ($Y\text{-}T_G$) represents disposable income and the rest of the variable names have the same definitions as before.

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Through econometric testing of the three different types of investment we can determine which of these hypothesized determinates really do move in ways consistent with the hypothesis they are determinants of investment. Testing will also suggest something about the possible marginal effects on investment that may result from changes in these determinants, and how reliable our estimates of these marginal effects are likely to be.

3.1 DATA USED

The various investment models are tested on annual 1960 – 2000 data taken from the *Economic Report of the President, 2002,* appendix tables B2, B7, B26, B28, B54, B73, B82, B95. All the data are in real, rather than nominal values, deflated where necessary using the most appropriate chained price index (base year =1996) from Table B7. An exception to this is the real prime interest rate. The nominal rate is deflated using the average of the past two years consumer price index from Table B60.

Variable (Abbrev. Used)	Table	Definition
Total Investment Goods (I)	B2	Yearly production of equipment and structures for residential or business use , and changes in the level of inventories
Business Fixed Investment (BUSI)	B18, B7	Nominal values of business plant and equipment investment, deflated using table B7 business plant and equipment costs deflator
Residential Fixed Investment (RESI)	B18, B7	Nominal values of residential fixed investment, deflated using table B7 residential housing costs deflator
Inventory Investment (INV)	B18, B7	Nominal values of yearly inventory change (inventory investment), deflated using table B7 business plant and equipment costs deflator
Accelerator (ACC)	B2	Yearly change in the level of the GDP ($\Delta Y =$ ACC)
Depreciation (DEP)	B26	Yearly business depreciation of fixed plant and equipment (capital consumption allowances)
Government Purchases (G)	B2	Consolidated Federal State and Local Government Goods And Services (G) spending (on goods & services, but excluding spending on Transfer Payments) Deflated using chained 1996 dollars from Table B7.
Taxes (T_G)	B82	Consolidated Federal, State and Local Government Receipts, exclusive of Transfer payments, deflated using chained 1996 dollars. (Table B7),
Crowd Out (T_G-G)		Taxes (T_G) minus G (as T_G,G were defined above).
Taxes (T_{EX})	B82	T_G - (.26*real GDP), where (.26*real GDP) is the rate at which taxes automatically grow as a result of their being income – based (see main text). This variable attempts to define tax changes that are strictly exogenous, i.e., due strictly to changes in tax statutes.
Dow Jones Composite	B95	A measure of how cheaply (i.e., how much) investment can

Average (DJ)		be financed by a given amount of new stock issuance. (A Proxy for Tobin's "q", a measure of the incentive to invest).
Interest rate ($r*Y_{-2}$)	B73	The "real" prime interest rate, i.e., the prime interest rate minus the average of the past two years CPI inflation, taken from Table B60, This is modified by Y to reflect the fact that a given change in interest rates should have a greater effect on large economies than on small ones. Modification is achieved by use of the interactive variable $r*Y_{-2}$ where the level of the GDP two years before the interest rate year is used to scale the impact of a change in r to a rough indicator of economy size. r is multiplied by Y_{-2} to get each data value used.
Capacity Utilization (CAP)	B54	Manufacturing output as a % of capacity
Corporate Profitability (PROF)	B28	A measure of business profitability (data from the *2003 Economic Report of the President* used for 1999 and 2000)
Exchange Rate (XR)	B110	The Federal Reserve's Real Broad Exchange Rate, averaged over the current and past three years
Business and Personal Income, After Taxes ($Y-T_G$)	B2, B82	Real GDP minus the portion of taxes used by government to purchase goods and services
Housing Prices, Relative to Income (H_{PRICE})	B2, B3 B34	Census data on nominal house prices deflated using GDP deflator, then divided by real per capita disposable Income
House Buying Cohort Size (POP)	B34	Age 16-24 cohort as % of 65 and over cohort. Used To obtain estimate of the net effect on housing demand of changes in the ratio of a major demographic: cohorts who are net house buyers versus those which is a net sellers of houses. Ideally, the cohort used would have been a little older, say 20 - 30, but the table used did not provide the ideal breakdown. Other cohort sizes available in this table (20-24), 25-45) were not found to be as systematically related to housing demand as the (16-24) cohort.

3.2 THE ECONOMETRIC TESTING PROCEDURE

Econometric methods were used to determine which of the variables in the hypothesized investment equations actually were related to investment over the 40 year period 1960-2000, and what their relative importance had been.

To obtain our estimates, the generalized least squares linear regression method was used, calculated using E-Views© software. Fully specified model regression coefficients were used to estimate marginal effects on investment of a given-sized change in one of its determinants. However, A "stepwise" regression procedure was employed to determine which of the variables explained the most variance in investment during the 40 year period studied. In the stepwise procedure, variables not already in the regression are added to the regression "step by step" based on which one of them will increase explained variance the most, if added to the regression.

For example, the first step in this study's stepwise procedure involved regressing each of the hypothesized determinants of investment (noted above) separately on investment, and noting the amounts of variance each explained. The one that explained the most (i.e., had the highest R^2) became

the first variable in the regression. Next, this variable and one of the remaining possible determinants were run in a second round of regressions. This was the second "step" of the procedure. The variable that added the most to the variance explained by the first variable alone was then selected to become the second variable added to the regression. In like manner, a third, fourth, etc. variables were added to the regression until all variables were added. The difference between the old and new R^2 was taken to define the new variable's relative importance in explaining variance in investment during the 40 year test period. Variables which added nothing to explained variance when entered in the regression or add so little their t-statistics are insignificant at the 5% level were rejected as determinants of investment.

Though helpful, one must also be aware of the pitfalls of stepwise results. In the presence of multicollinearity, some of the variance in a variable not in the regression may be "picked up" by a variable with which it is correlated which is in the regression. This will result in an overstatement of the included variable's contribution to explaining variance and bias its regression coefficient (Goldberger 1961; Pindynk and Rubinfeld 1991). In this sense, our method estimates the maximum amount of variance each variable might add. To get a minimum amount of variance a variable may be adding, we repeat the stepwise procedure, this time starting with all variables in the regression and subtracting the one that reduces variance the most. In the presence of multicollinearity, there is no absolute answer to the question how to unambiguously assign explained variance between each of two intercorrelated i.e., multicollinear, explanatory variables. Hence, we can use the stepwise addition and stepwise subtraction procedures together to estimate the range of the possible contributions to variation in the dependent variable a specific explanatory variable may have had during the period studied.

Instructive as this is in explaining why in the past investment changed as it did, it does not allow us to simulate how much investment is likely to vary in the future if one or more of its determinants is changed by specific amounts. For this, we will use regression coefficient estimates of the marginal change in the dependent variable related to a 10% change in an explanatory variable's value in the year 2000.

The study also tests the stability ("robustness") of the estimated marginal effects of these variables by adding or subtracting variables from the regression to see how much the estimated marginal effects (regression coefficients) of the remaining variables change. Needless to say, the more they change with slight changes to the model, the less reliable they become. Consistent with the implications of Goldberger (1961) and Pindyck and Rubinfeld (1991) the more completely specified the model is, i.e., the more variance it explains for non spurious reasons, the more stable the marginal effect estimates remain when variables are added or subtracted from the model.

3.3. MEASURING A VARIABLE'S LAGGED EFFECTS ON INVESTMENT

Investment theory provides an idea of what variables to test when searching for determinants of investment demand. However, it rarely tells us how long it takes for a change in one of investment's determinants to bring about a change in investment. Is it immediate? After a one year lag? Longer. Evidence suggests selecting the right lag is critically important in the testing process. In one study (Heim, 2007A), only the two year - lagged version of the prime interest rate showed any affect at all on GDP, but the effect it showed was substantial! Had the test been run using different length lags, researchers would have erroneously concluded that interest rates had no effect on the GDP, when in fact they do.

To determine the appropriate lags to use with a variable, we tested individual variables by adding them to a preliminary model containing two explanatory variables that investment theory suggested were important: the accelerator and crowd out. Preliminary testing suggested that current period values for both these variables were the lags most systematically related to investment. One of the remaining six hypothesized determinants of investment was then added to this two – explanatory variable model. and tested for seven different lags: +3 in the future to -3 in the past. The lag for a variable selected as most appropriate for inclusion in the larger investment model was the one which added the most to explained variance, unless the sign on the variable was theoretically wrong, or if the result suggested the direction of causation was backward. If so, the result was rejected. For example, current year interest rates were found positively correlated with changes in the GDP. But theory tells us investment demand should be negatively related to interest rates. Hence, a finding of positive current year interest relationships would

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be rejected if favor of a different lagged relationship with a negative sign. (Mishkin 2006 explains how movement in the same direction of both supply and demand curves, as occurs during boom periods, can cause interest rates to increase, even though the demand for bonds is negatively related to interest rates. Similarly, if future years depreciation reserves were more significantly related to current investment than current or prior year accumulated we would assume the regression has the direction of causation backwards: (current investment, by increasing a company's capital stock, increases the amount the company can depreciate in future years, but not vice-versa.)

3.4. STABILITY OF REGRESSION COEFFICIENTS

An additional use, then, of the stepwise procedure results is to provide a way of assessing the stability (robustness) of the marginal effects (regression coefficient) of any one variable, as we add or subtract other variables from the model being tested. Stepwise addition/subtraction of variables to the model, and retesting, provides direct evidence of how much regression coefficients vary as new variables are added/subtracted from the model. Tables showing how particular estimates vary with addition/subtraction of other variables from the model are presented.

Regression coefficients provide point estimates of how much investment may vary when one of its determinants varies. However, these estimates often significantly, (or even wildly!) differ from regression to regression as variables are added or subtracted from the regression. This occurs when explanatory variables already in the regression are significantly correlated with the variable being added or subtracted. Results shown later in this study the more variance a regression already explains, the less likely adding a variable will substantially change other coefficients. Hence, in incompletely specified regressions, in which important explanatory variables are left out, the possibility of overstating the marginal effects of a variable, or its statistical significance, are substantial, and results are subject to major change when the omitted variable is added. (Goldberger, 1961)

Since the base problem affecting the stability (or robustness) of our estimates is intercorrelation among the explanatory variable set, we can enhance the likelihood of stable point estimates by reducing the intercorrelation before running the regressions. One way of doing this that is often successful is to use "first difference" rather than "levels" of the data when estimating regression coefficients, i.e., use

$$\Delta Y_t = (Y_t - Y_{t-1})$$

instead of Y_t as the unit of measurement. This technique has the added advantage in time series data sets, such as the one used here, of reducing potential autocorrelation problems (Griffiths, Hill, Judge, 1993), and can reduce nonstationarity.

In first differencing the data, in linear models the constant term is eliminated. The models to be estimated become:

Business Fixed Investment Demand:

(4) $\Delta I_{PE} = \beta_1 \Delta(ACC) + \beta_2 \Delta(DEP) + \beta_3 \Delta(r_{PR}*Y_{-2}) + \beta_4 \Delta(T_G-G) + \beta_5 \Delta(DJ) + \beta_6 \Delta(CAP) + \beta_7 \Delta(PROF) + \beta_8 \Delta(XR)$

Inventory Investment Demand

(5) $\Delta I_{INVEN} = \beta_1 \Delta(ACC) + \beta_2 \Delta(DEP) + \beta_3 \Delta(r_{PR}*Y_{-2}) + \beta_4 \Delta(T_G-G) + \beta_5 \Delta(DJ) + \beta_6 \Delta(CAP) + \beta_7 \Delta(PROF) + \beta_8 \Delta(XR)$

Residential Investment Demand:

(6) $\Delta I_{RES} = \beta_1 \Delta(ACC) + \beta_2 \Delta(Y-T_G) + \beta_3 \Delta(r_{MORT}) + \beta_4 \Delta(T_G-G) + \beta_5 \Delta(DJ) + \beta_6 \Delta(H_{Price}) + \beta_7 \Delta(POP) + \beta_8 \Delta(XR)$

3.5. SIMULTANEITY BETWEEN THE DEPENDENT AND EXPLANATORY VARIABLES

Total Investment, the dependent variable in our model, and the growth of the economy variable (ACC = Y_t - Y_{t-1}), one of the explanatory variables, are simultaneously determined, since I_t is part of Y_t. Changes in I cause change in Y, which causes further changes in I, etc. This simultaneity can bias regression estimates (Griffiths, Hill, Judge, 1993). This is also true of the disposable income variable in the residential investment equation. Two Stage Least Squares regression technique is the appropriate form of regression to use under such circumstances to avoid the bias (Griffiths, Hill, Judge, 1993)). In an equation with the accelerator or disposable income as a determinant of investment, the remaining explanatory variables were used as first stage regressors.

3.6 HETEROSKEDASTICITY

Evidence of heteroskedasticity was found in preliminary testing, and Newey West heteroskedasticity corrections were made in all tests. (Newey West, 1987)

4. FINDINGS: THE DEMAND FOR INVESTMENT GOODS IN TOTAL

Heim (2008) reported the following marginal impacts for variables determining total investment demand (plant and equipment, residential and inventory)) in the U.S. 1960-2000:

The relative importance of each of these variables in explaining the demand for investment goods was found to be as follows:

TABLE 2
STEPWISE ADDITION TO THE REGRESSION OF HYPOTHESIZED DETERMINANTS OF TOTAL INVESTMENT (USING SEPARATE T_G, G VARIABLES TO REPRESENT CROWD OUT)

$$\Delta I_t = f\,[\,\beta_{1T,1G}\,\Delta(\text{Crowd Out})_t,\ \beta_2\,\Delta Dep_t,\ \beta_3\,\Delta Acc_t,\ \beta_4\,\Delta r_{t-2}{*}Y_{t-4},\ \beta_5\,\Delta DJ_{t-1},\ \beta_6\,\Delta Prof_{t-1},$$
$$\beta_7\Delta XR_{AV(t-t-3)},\ \beta_8\Delta Cap_{t-1}\,]$$

R^2/Adj.R^2 (DW) β (t-stat.*)	$\Delta T_{G(t)}$ $\beta_{1t}(t)$	ΔG_t $\beta_{1G}(t)$	ΔACC_t $\beta_3(t)$	ΔDEP_t $\beta_2(t)$	$\Delta r_{t-2}{*}Y_{t-4}$ $\beta_4(t)$	ΔDJ_{t-1} $\beta_5(t)$	$\Delta PROF_{t-1}$ $\beta_6(t)$	$\Delta_{XRAV(t-t-3)}$ $\beta_7(t)$	ΔCAP_{t-1} $\beta_8(t)$
50/49% (1.4)	.89 (6.9)	-.23 (-1.2)							
70/68% (1.4)	.74 (5.4)	-.01 (-0.1)	.27 (5.4)						
80/79% (1.8)	.64 (6.5)	-.56 (-3.4)	.27 (6.6)	1.21 (5.0)					
84/83% (1.7)	.56 (5.4)	-.41 (-2.2)	.27 (8.9)	1.29 (5.6)	-1.55 (-2.3)				
86/84% (1.7)	.48 (5.5)	-.35 (-1.8)	.27 (9.1)	.94 (4.5)	-1.56 (-2.5)	.50 (3.6)			
88/85% (1.8)	.42 (4.5)	-.29 (-1.3)	29 (8.2)	.77 (2.7)	-1.39 (-2.5)	.62 (4.8)	.26 (1.8)		
90/87% (2.2)	.43 (4.6)	-.39 (-2.2)	.29 (10.1)	.85 (3.1)	-1.20 (-2.8)	.50 (3.2)	.39 (3.1)	3.78 (2.3)	
90/87% (2.2)	.43 (4.4)	-.39 (-2.2)	.29 (8.5)	.86 (3.0)	-1.17 (-2.5)	.50 (3.2)	.38 (2.6)	3.77 (2.2)	.17 (0.2)
90/87% (2.2)	.42(4.7)**	(**)	.29 (8.4)	.88 (5.5)	-1.14 (-2.4)	.51 (3.2)	.37(2.6)	3.80(2.3)	.36 (0.2)

Source: Heim (2008), p.10)
(*) t- statistics of 2.0 = 5% significance; t - statistics of 2.7 = 1% level of significance.
(**) Full Model, But With The Crowd Out Variable (T_G- G) Reported As one Deficit Variable). Shows Choice Of Crowd Out Variable Formulation Does Not Significantly Affect Regression Coefficient Estimates.

The results in Table 2 are presented for each step in the stepwise regression procedure. Showing each stepwise equation's results individually provides information about regression coefficient stability. It shows that the stability of regression coefficients increases significantly as the total variance (R^2) explained by the model increases. Put another way, the stability of estimates of the effects of individual variable increases dramatically the more completely the model specifies all the determinants of investment, i.e., the larger the amount of total variance explained. It is no exaggeration to say that until the model explains about 85% of all the movement in investment, regression coefficients jump around so much when variables are added or subtracted from the model as to be simply unreliable.

Experimentation with income modifiers lagged from 1-4 periods on the variables left regression coefficients virtually unchanged and did not increase explained variance by more than one tenth of a percent. As noted, the results reported above use 4 year lag on income when using it as an economy size measure.

Table 3 shows the result of stepwise addition and subtraction of variables from the model. The results in Table 3 clearly indicate that

- the crowd out problem,
- the availability of depreciation reserves to finance investment, and
- the inclination to increase/decrease investment in sync with the changes in the economy's growth rate, i.e., the point we are at in the business cycle

were the factors whose variation is most associated with change in investment levels during the 1960 – 2000 period. The results also suggest that interest rates and the value of company stock may also have had a major influence, though the stepwise results are somewhat ambiguous on this point: stepwise subtraction results suggest a small role; stepwise addition a large role. Finally, the stepwise analysis suggests year - to - year changes in company profits, the exchange rate, or capacity utilization had little systematic effect on investment.

TABLE 3
CONTRIBUTIONS TO EXPLAINED VARIANCE IN INVESTMENT

Variable	Stepwise Addition Adds To R^2	Stepwise Subtraction Subtracts from R^2
Crowd Out	50 %	22 %
Acceleration	20	11
Depreciation	10	20
Interest Rate	4	16
Stock Market	2	18
Profits	2	NA*
Exchange Rate	2	NA*
Capacity Utilization	0	NA*
Explained Variance:	90%	87%

* Lack of constant term results in negative R^2 with further subtractions

The Heim (2008) study also reports the estimated effect on investment of a 10% change in the year 2000 value of these variables. The results were as follows:

Table 4
MARGINAL IMPACT ON INVESTMENT OF A 10% CHANGE* IN ITS DETERMINANTS

Change In Investment	Marginal Effect (Regression Coefficient)	Change in Determinant	Name of Determinant
$ 10 Billion	.42	$ 22.7 Billion	Government Deficit Reduction
$ 11 Billion	.29	$ 36.7 Billion	Accelerator (Change in GDP)
$101 Billion	.88	$115 Billion	Depreciation Allowances
$ 7 Billion	(1.17)(.73)($8.5 Tr.)	0.73% Δ Rate	Prime Interest Rate (x real GDP_{1998})
$ 33 Billion	.51	64 Points	Dow Jones Composite Index
$ 18 Billion	.37	$ 49 billion	Corporate Real After Tax Profits
$ 40 Billion	3.80	10.5 Points	Real Broad Exchange Rate

(*) 10% change in year 2000 real value (1996 = 100).

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Clearly a 10% increase in depreciation reserves is associated with the largest increase in investment. Next in importance, though only a third as strong, was a 10% increase in stock values, presumably due to a "Tobin's q" type of stimulus to investment. Third in importance would be a 10% increase in corporate profits. A 10% change in the government deficit, the growth rate of the economy or interest rates would, by comparison, result in a relatively small change in investment.

4.1 DETERMINANTS OF BUSINESS DEMAND FOR PLANT AND EQUIPMENT

Business demand for fixed investment is the demand for commercial or factory buildings and the business equipment to be housed in them.. Table 5 below presents the results of regressing business plant and equipment investment on the determinants of this kind of investment hypothesized earlier in this paper

TABLE 5
PLANT AND EQUIPMENT INVESTMENT: REGRESSIONS OF HYPOTHESIZED DETERMINANTS
(1 AND 2-VARIABLE FORMULATIONS OF CROWD OUT VARIABLE USED)

$$\Delta I_{P\&E(t)} = f\,[\,\beta_{1T\text{-}2G}\,\Delta \text{Crowd Out}_t,\quad \beta_2\,\Delta Dep_{t-1},\quad \beta_3\,\Delta Acc_t,\quad \beta_4\,\Delta r_{t\text{-}2or3}*Y_{t\text{-}4or5},\quad \beta_5\,\Delta DJ_{-1},\quad \beta_6\,\Delta Prof_{t-1},$$
$$\beta_7 \Delta XR_{AVt\,to\,(t-3)},\quad \beta_8 \Delta Cap_{t-1}\,]$$

R^2/Adj.R^2 (DW) B (t-stat.***)	$\Delta T_{G(t)}$ $\beta_{1T}(t)$	ΔG_t $\beta_{1G}(t)$	$\|\Delta ACC_t=\Delta Y_t\|$ $\beta_3(t)$	ΔDEP_t $\beta_2(t)$	$\|\Delta r_{t\text{-}2or3}*Y_{t\text{-}4or5}\|$ $\beta_4(t)$	ΔDJ_{t-1} $\beta_5(t)$	$\Delta PROF_{t-1}$ $\beta_6(t)$	$\Delta_{XRavt\text{-}(t-3)}$ $\beta_7(t)$	ΔCAP_{t-1} $\beta_8(t)$
2 variable crowd out; (r income modified)									
91/88% (1.9)	**.22 (5.0)	**-.33 (-3.8)	.04 (3.1)	.87 (6.5)	¹ -0.19 (-1.1)	.54 (6.1)	.53 (5.2)	4.10 (4.0)	
92/89% (1.8)	**.20 (5.1)	**-.40 (-4.5)	.08 (3.6)	.95 (7.0)	¹ +0.14 (0.6)	.56 (7.4)	.43 (3.5)	3.96 (3.5)	2.46 (2.3)
93/91% (2.0)	**.21 (5.7)	**-.35 (-3.5)	.05 (3.8)	.83 (7.2)	² - .64 (-3.7)	.66 (8.6)	.48 (5.5)	3.87 (4.4)	
93/90% (1.8)	**.19 (5.3)	**-.37 (-3.8)	.06 (3.8)	.89 (7.6)	² - .53 (-2.7)	.65 (8.7)	.43 (4.6)	3.79 (4.0)	1.19 (1.5)
2 variable crowd out; (r not income modified)									
91/88% (1.9)	**.22 (4.9)	**-.33 (-3.7)	.04 (3.2)	.86 (6.4)	¹ -0 .76 (-1.1)	.54 (6.1)	.53 (5.1)	4.11 (4.1)	
92/90% (1.8)	**.20 (5.0)	**-.41 (-4.5)	.08 (3.8)	.96 (7.1)	¹ +0.82 (0.9)	.56 (7.5)	.43 (3.5)	3.96 (3.5)	2.57 (2.5)
92/90% (2.0)	**.22 (6.2)	**-.36 (-3.6)	.04 (3.5)	.85 (7.0)	² -2.71 (-3.1)	.62 (8.4)	.48 (5.2)	3.92 (4.3)	
93/90% (1.8)	**.20 (5.8)	**-.38(-3.9)	.06 (3.5)	.91 (7.4)	² -2.18 (-2.2)	.61 (8.6)	.43 (4.4)	3.83 (4.0)	1.22 (1.4)
1 variable crowd out; (r income modified)									
90/88% (1.8)	* .23 (5.0)		.04 (3.2)	.79 (6.2)	¹ -0.23 (-1.2)	.53 (5.9)	.51 (5.7)	3.86 (4.8)	
91/89% (1.8)	* .21 (5.2)		.06 (2.5)	.80 (5.9)	¹ -0.07 (-0.3)	.54 (6.3)	.45 (3.3)	3.67 (3.8)	1.30 (1.0)
92/90% (1.9)	* .22 (5.6)		.05 (3.5)	.73 (6.0)	² -0.60 (-3.0)	.64 (8.5)	.47 (6.0)	3.60 (5.7)	
92/90% (1.8)	* .21 (5.5)		.05 (2.9)	.74 (5.7)	² -0.56 (-2.5)	.63 (8.7)	..45 (4.3)	3.53 (4.9)	.49 (0.5)
1 variable crowd out, (r not income modified)									
90/88% (1.8)	* .23 (4.9)		.04 (3.2)	.78 (6.0)	¹ -0.90 (-1.2)	.53 (5.8)	.51 (5.7)	3.88 (4.8)	
91/88% (1.6)	* .21 (5.1)		.06 (2.5)	.79 (5.7)	¹ -0.13 (-0.1)	.54 (6.4)	.45 (3.3)	3.67 (3.8)	1.38 (1.0)
92/90% (1.8)	* .22 (6.0)		.05 (3.2)	.74 (5.8)	² -2.51(-2.6)	.60 (8.0)	.46 (5.5)	3.64 (5.6)	
92/90% (1.7)	* .22 (5.9)		.05 (2.6)	.75 (5.5)	² -2.26 (-2.0)	.60 (8.2)	.44 (4.1)	3.57 (4.7)	.52 (0.5)

Δ Acc=d(d(Y))
(*) Government Deficit Reported As One Variable (T_G-G) : (¹) Uses 2 period interest rate lag: Δr_t-2*Y_t-4
(**) Government Deficit Reported As Two Separate Variables (T_G, G) : (²) Uses 3 period interest rate lag: Δr_t-3*Y_t-5
(***) t- statistics of 2.0 = 5% significance; t - statistics of 2.7 = 1% level of significance.

When using a lagged value of the GDP to adjust the interest rate variable to economy size, tests were undertaken using from one to 5 period lagged values of (Y). Regression coefficients on other variables remained stable whichever lag was chosen. Therefore, somewhat arbitrarily, GDP (Y) values lagged two periods more than the interest rate lag used (r_-2 or -3) were chosen (r_-2or-3*Y_-4or-5).

Table 5 indicates that using the income modified version of the interest rate variable (Δr_t-2or3*Y_t-4or5) compared to just (Δr_t-2or3) results in variation in interest rate effect when the overall economy size

changes, as expected. Here again, though, the form chosen causes virtually no change in the marginal estimates (regression coefficients) of any of the other variables.

Table 5 also indicates that using the two variable formulation of the crowd out (government deficit) variable may be the most appropriate, since the effects on P&E investment demand seem to differ for the two variables. The results seem to indicate that raising the deficit by increases in government spending has a 1.5 to 2 times the negative effect on P&E investment that raising the deficit by cutting taxes has. However, the values of other regression coefficients seem essentially unaffected by the choice of the one or two variable form of "crowd out" used..

The most unexpected finding in table 5, given the findings reported earlier in this paper on a prior study of the determinants of total investment, was that the two period lagged interest rate variable, was not found even mildly statistically significant. However, the three period lagged version was found uniformly significant (t =2.4 – 3.8). This is directly contradictory to the result obtained for the total investment results discussed earlier, and is surprising because P&E investment tended to be about 2/3 of total investment during the period tested.

Table 6 below uses the stepwise regression procedure to calculate both the maximum and the minimum amount of variance in P&E investment 1960-2000 that can be attributed to any one explanatory variable. We do this by calculating results for both the stepwise addition variant of this process and the stepwise subtraction variant. In stepwise addition, we add the remaining variable to the regression that adds the most to explained variance). Using stepwise subtraction, we reduce the regression's variables by the variable whose elimination reduces explained variance the most)

TABLE 6
RANGE OF POSSIBLE CONTRIBUTIONS TO EXPLAINED VARIANCE IN P&E INVESTMENT
(STEPWISE ADDITION VS. SUBTRACTION)

	Method	
Variable	Stepwise Addition	Stepwise Subtraction
DJ_{-1}	47.7%	25.8%
$PROF_{-1}$	19.2 -	7.3
$(T, G)_{(2\ VAR.)}$	8.3 -	17.8
DEP_{-1}	7.0 -	9.6
XR_{AV}	7.1 -	17.2
$ACC_{(Y)}$	1.7 -	N.A.*
r_3y_5	1.4 -	N.A.*
$CAP_{-1\ OR\ -2}$	0.1% -	16.8%

* Negative R^2 due to lack of constant term

Other ranges of results can be obtained with different orders of entry. It reminds us that as long as any part of investment's variance can be explained by either of two (or more) explanatory variables, we cannot know with certainty which of the explanatory variables is truly "explaining" this variance in the dependent variable, rather than just coincidentally correlated with the explanatory variable that is related to investment.

Using the stepwise addition and subtraction methods noted above, Table 6 indicates the four most variables whose movement was most related to change to the changes in P&E investment that occurred during this period were:

- A company's stock value, a Tobin's q proxy, (DJ_{-1})
- company profits ($PROF_{-1}$)
- availability of credit (the crowd out variables T and G) and
- the exchange rate. XR_{AV}

These are important findings since at least two of these variables (profits, credit availability) are policy – controllable, and therefore imply P&E investment can be stimulated by appropriate public policy. Table 5 results also suggest that the depreciation variable explained a moderate amount amount of variance, and of course, is also policy controllable.

The results also indicate that the

- Accelerator and ,
- interest rates

explain virtually none of the variance in P&E investment, though statistically significant determinants of P&E investment. This result can occur when a variable, though systematically related to another, does not vary much over the period studied, or has a rather small marginal effect.

Finally, the Table 6 results suggest that capacity utilization is so intercorrelated with other variables, it shows no contribution to explained variance if entered last in a regression, or a significant amount if entered early. Hence, it is difficult to make any judgments as to its actual impact in the period studied.

Table 7 allows further examination of the stability of regression coefficients in the face of changes to the model tested. Here again, estimates become more stable as additional variables are added to the model, increasing explained variance. Again we notice that the most stable results seem to occur when adding (or subtracting) variables to models that already explain about 90% of the variance. In addition, we find that using a disposable income definition of the accelerator instead of a gross income definition had no effect on the marginal effect estimates of the other variables, except for a small increase in the estimated impact of a change in the deficit due to a change in the level of savings (an average of .19 versus .26 billion per billion change in the rate of saving).

TABLE 7
VARIATION IN ESTIMATES OF MARGINAL EFFECTS OF P&E DETERMINANTS
AS VARIABLES ARE ADDED TO THE P&E MODEL

R^2/Adj.R^2 (DW) B (t-stat.***)	ΔDJ_{t-1} $\beta_{1T}(t)$	$\Delta PROF_{t-1}$ $\beta_{1G}(t)$	$\Delta T_{G(t)}$ $\beta_3(t)$	ΔG_t $\beta_2(t)$	ΔDEP_{t-1} $\beta_4(t)$	$\Delta XR_{avt-(t-3)}$ $\beta_5(t)$	$\Delta ACC=\Delta Y_t$ $\beta_6(t)$	$\Delta r_{t-3}*Y_{t-5}$ $\beta_7(t)$	ΔCAP_{t-1} $\beta_8(t)$
2 variable crowd out; (r income modified);									
48/48% (1.3)	1.37(11.3)								
67/66% (1.5)	1.30(14.5)	.50 (5.1)							
75/73% (1.2)	.98 (9.3)	.40 (3.9)	.22 (4.0)	- .01 (-0.1)					
82/80% (1.2)	.69 (8.9)	.36 (4.1)	.26 (5.5)	- .26 (-2.2)	. 67 (3.6)				
89/88% (2.1)	.54 (6.3)	.50 (4.9)	.26 (5.4)	- .39 (-4.3)	.86 (8.4)	4.22 (4.1)			
91/89% (2.0)	.55 (6.2)	.54 (5.2)	.23 (5.2)	- .35 (-3.9)	.85 (6.3)	4.18 (4.1)	.04 (3.1)		
93/91% (2.0)	.66(8.6)	.48 (5.5)	.21 (5.7)	- .35 (-3.5)	.83 (7.2)	3.87 (4.4)	.05 (3.8)	-.64 (-3.7)	
93/91% (1.8)	.65 (8.6)	.43 (4.6)	.19 (5.3)	- .37 (-3.8)	.89 (7.6)	3.79 (4.0)	.06 (3.8)	-.53 (-2.7)	1.19 (1.5)
(The regression below modified to use (Y-T) Defn. of ACC variable instead of $\Delta ACC_t=\Delta Y_t$ used immediately above)									
92/90% (1.8)	.57 (7.6)	.45 (4.8)	.26 (7.5)	- .39 (-3.9)	.87 (8.1)	3.97 (3.9)	.06 (3.5)	-.51 (-2.4)	.33 (0.5)

A problem that arises in estimating the demand for P&E investment is that Income (Y), and change in income (ΔY) = ACC, are both statistically significant variables in our tests. One can read Keynes and find him citing "income" as a determinant of investment, but it seems that he had company profits more in mind than (Y), our gross income and real GDP variable. In addition, including it in the regression markedly changes other regression coefficients. The same is the case when we substitute it for the accelerator variable in the regression, as noted in Table 8 below. From this we conclude it is most likely

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the relatively high intercorrelation between Y and ΔY (.6) that is causing the other variables regression coefficients to be unstable, a common side effect of multicollinearity. The acceleration variable declines to statistical insignificance when the income variable is added to the equation. Normally, we might take this as a sign income is the variable truly related to investment, but many investment studies have found the accelerator significant; often the most important, variable in an investment regression. Hence, in this case, we are reluctant to drop it in favor of the income variable.

We hypothesized that the income variable might be picking up growth in investment demand over time due simply to the growing size of the economy, e.g., a given growth in the Dow Jones average should generate more investment in a large economy than in a small one. However, adding an economy size modifier (Y_{-2}) so that the variable tested became $DJ_{-1}* Y_{-2}$ modestly decreased, not increased, the variable's statistical significance, suggesting (Y) was not obtaining its statistical significance from its ability to proxy for economy size. The same was true when a size modifier was added to the exchange rate, capacity utilization, and depreciation variables. Finally, when entered as a separate variable, the (Y_{-2}) variable was insignificant (Unlike Y_0). If (Y_0) was just a proxy for size adjustment over the 40 year span of the data, (Y_{-2}) should have worked nearly as well.

Only when (Y_0) was applied to the Accelerator variable as an economy - size modifier was there a slight improvement in statistical significance. However, the variable used as the income variable is the GDP itself (Y_0). P&E investment is part of (Y_0). If we regress (Y_0) with $I_{P\&E}$ subtracted out, the income variable $(Y- I_{P\&E})$ becomes statistically insignificant (and the statistical significance of the accelerator climbs from t= 0.5 to t= 1.6). It appears that the only reason (Y_0) is statistically significant as a determinant of P&E investment demand is that it contains P&E investment as one of its subcomponents.

TABLE 8
FLUCTUATION IN REGRESSION COEFFICIENTS WHEN (Y) AND (ΔY) ARE BOTH USED AS EXPLANATORY VARIABLES IN THE P&E MODEL

Variable	Combination Of (Y), (ΔY) Used	β (t)	Variable	Combination Of (Y), (ΔY) Used	β(t.)
T_G	Only ΔY=ACC	.20 (5.6)	$PROF_{-1}$	Only ΔY=ACC	.42 (4.4)
	Only Y	.16 (5.6)		Only Y	.36 (3.8)
	Both (ΔY), (Y)	.16(5.3)		Both (ΔY), (Y)	.36 (3.9)
G	Only ΔY=ACC	- .38 (-3.9)	XR_{AV}	Only ΔY=ACC	3.83 (4.0)
	Only Y	- .46 (-4.2)		Only Y	3.64 (4.6)
	Both (ΔY), (Y)	- .45 (-3.9)		Both (ΔY), (Y)	3.65 (4.4)
DEP_{-1}	Only ΔY=ACC	.91 (7.4)	CAP_{-1}	Only ΔY=ACC	1.22 (1.4)
	Only Y	.52 (3.4)		Only Y	.50 (0.8)
	Both (ΔY), (Y)	.58 (2.9)		Both (ΔY), (Y)	.71 (0.8)
$R_{-3}*Y_{-5}$	Only ΔY=ACC	-2.18 (-2.2)	ΔY	Only ΔY=ACC	.06 (3.5)
	Only Y	-1.75 (-1.9)		Only Y	N.A.
	Both (ΔY), (Y)	-1.78 (-1.9)		Both (ΔY), (Y)	.01 (0.5)
DJ_{-1}	Only ΔY=ACC	.61 (8.6)	Y	Only ΔY=ACC	N.A.
	Only Y	.54 (6.8)		Only Y	.08 (5.2)
	Both (ΔY), (Y)	.55 (7.4)		Both (ΔY), (Y)	.07 (3.0)

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The regression with only the accelerator (ΔY) had an R^2 of .92.7 and a Durban Watson statistic D. W. = 1.8. The regressions with either Y alone, or both Y and ΔY as variables had an R^2 6/10 of a percent higher (93.3%) and a D. W. two tenths of a point lower (1.6).

4.2 DETERMINANTS OF DEMAND FOR RESIDENTIAL HOUSING

Residential fixed investment is new residential housing built to be owner occupied or built for rental as residential property. Table 9 below presents the results of regressing residential investment on the determinants of residential investment described in Section 2 of this paper.

TABLE 9

HYPOTHESIZED DETERMINANTS OF RESIDENTIAL HOUSING INVESTMENT
(USING BOTH 1 AND 2-VARIABLE FORMULATIONS OF THE CROWD OUT VARIABLE)

$\Delta I_{RES(t)} = f$ [$\beta_1 \Delta Y\text{-}T_{G(t)}$, $\beta_{2T\text{-}2G} \Delta$Crowd Out Variable(s)$_t$, $\beta_3 \Delta Acc_t$, $\beta_4 \Delta r_{t\text{-}2or3}{}^*Y_{t\text{-}4or5}$, $\beta_5 \Delta DJ_{\text{-}2}$, $\beta_6 \Delta P_{HOUSE(t)}$, $\beta_7 \Delta POP_{16\text{-}24(t)}$, $B_8 \Delta XR_{AVt\ to\ (t\text{-}3)}$]

R^2/Adj.R^2 (DW) B (t-stat.**)	$\Delta(Y\text{-}T_{G(t)})$ $\beta_{1T}(t)$	$\Delta T_{G(t)}$ $\beta_{2T}(t)$	ΔG_{tt} $\beta_{2G}(t)$	$\Delta r_{MORT}Y_{\text{-}4}$ $\beta_3(t)$	ΔACC_t $\beta_4(t)$	$\Delta DJ_{t\text{-}2}$ $\beta_5(t)$	$\Delta P_{HOUSE(t)}$ $\beta_6(t)$	$\Delta POP_{16\text{-}24}$ $\beta_7(t)$	$\Delta XR_{AVt\text{-}(t\text{-}3)}$ $\beta_8(t)$
2 variable crowd out; (r income modified) 83/78% (1.5)	.07 (2.4)	.22 (5.3)	-.24(-2.4)	- 2.13 (4.6)	.05 (2.0)	-.22 (-2.0)	-.02 (-2.4)	122.2(1.1)	.70 (1.2)
1 variable crowd out*; (r income modified) 83/79% (1.5)	.06 (2.8)	* .23 (5.6)	(N.A.)	- 2.10 (5.3)	.06 (2.1)	-.22 (-2.1)	-.02 (-3.1)	121.3(1.2)	.67 (1.3)
2 variable crowd out; (r not income modified) 85/81% (1.6)	.06 (2.4)	.24 (7.3)	-.27(-2.9)	-13.05 (6.9)	.05 (2.0)	-.27 (-2.7)	-.02 (-2.3)	201.5(2.2)	.80 (1.7)
1 variable crowd out* (r not income modified) 85/82% (1.5)	.06 (2.6)	* .24 (7.5)	(N.A.)	-12.73(7.8)	.05 (2.2)	-.27 (-2.7)	-.02 (-3.2)	197.1(2.2)	.73 (1.8)

Δ Acc=d(d(Y-T$_G$))
(*) Government Deficit Reported As One Variable (T$_G$-G)
 (**) t- statistics of 2.0 = 5% significance; t - statistics of 2.7 = 1% level of significance.

When the mortgage interest rate variable was income adjusted so the effects of an interest rate change would be measured accounting for differences in the overall economy's size, one, two, three, four and five year lags were tried with the income variable. Regardless of the lag used, regression coefficients on other variables remained the same or changed only slightly. The three year lag added about 1.3% explained variance, mostly by raising the t-statistic on the interest rate variable from approximately (3.5 - 4.5) with the other lags to (6.7). The regression coefficient was unchanged using the three year lag. Since regression coefficients (Marginal effects) are a key interest in this paper, and are essentially unchanged by the economy-size lag used, for consistency we stayed with the four year lag.

Table 9 results also indicate that using the income modified version of the interest rate variable ($\Delta r_{MORT(t)}{}^*Y_{t\text{-}4}$) instead of the non income modified variable ($\Delta r_{MORT(T)}$) actually explains 2% less variance, even though it allows for variation in marginal effect of an interest rate change as the overall economy changes in size.   However, choice of one or the other of these variables does not seem to change the regression coefficients on any of the others. This indicates the decision as to which form of the interest rate variable to use will not disturb the stability of the marginal effect estimates for the other variables.

Preliminary tests suggested that there is an accelerator affect on housing demand as well as business investment demand. Including the accelerator variable added 2% to explained variance. These tests with the accelerator indicated that the disposable income version of the income variable worked best as the

accelerator: $\Delta(Y-T_G)$. Use of this form increased the t statistic on the accelerator variable from 1.5 to 2, compared to the more common form of the accelerator $\Delta(Y)$, and raised most other t statistics as well (similar tests with P&E or total investment indicated the (ΔY) form was the more statistically significant). Hence, Table 9 above uses the $\Delta(Y-T_G)$ form of the accelerator.

The results for the two variable formulation of the government deficit / crowd out problem shown in Table 9 suggest that raising the government deficit by raising government spending or cutting taxes has about the same effect on demand for residential investment. Recall that our results on plant and equipment investment indicated spending increases had a significantly larger effect. Table 9 also indicates that regardless of whether the one or two variable form of the crowd out variable was used, the values of other regression coefficients were essentially unaffected, providing some additional evidence of their robustness.

Using stepwise regression, Table 10 below provides estimates of how much the total variation in residential investment during the 1960-2000 period can be attributed to any one variable. Estimates of both the maximum and the minimum amount of variance that may be attributable to a particular variable are calculated, using both the stepwise addition and subtraction variants of this method. calculating results for both the stepwise addition variant of this process and the stepwise subtraction variant. These results should be viewed as informative, but not conclusive, since other methods for determining order of entry will yield different results.

TABLE 10
RANGE OF VARIATION IN RESIDENTIAL HOUSING DEMAND
EXPLAINED BY SPECIFIC VARIABLES RELATED TO DEMAND
(STEPWISE ADDITION VS. STEPWISE SUBTRACTION METHOD)

Variable	Range of Variation	
P_{HOUSE}	37.1%	11.9
$(T, G)_{(2\ VAR.)}$	31.4 -	25.2
MORT	7.2 -	10.8
$ACC_{(Y-TG)}$	4.4 -	9.7
DJ_{-2}	1.4 -	0.3
$(Y-T_G)$	1.9 -	24.6
POP	1.6 -	0.9
XR_{AV}	0.8% -	2.0.

Using this method, the three variables that seemed to explain the most variance in residential housing demand were

- the Price of Housing relative to per capita income (P_{HOUSE}),
- the credit 'crowd out" variables (T, G), and
- mortgage interest rates

The results also suggest that, three other variables had an effect, but only a minor one, on the level of residential investment during this period:

- The Dow Jones Composite Index, a measure of consumer wealth, (DJ_{-2})
- Demographic changes in the mix of younger and older people in the population (POP)
- The exchange Rate (XR_{AV})

For one variable, disposable income ($Y-T_G$), the estimated range of effect on investment varied so much with order of entry that little can be said with confidence about its individual contribution.

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Table 11 allows further examination of the stability of regression coefficients in the face of changes to the model tested. Here again, we see the tendency of regression coefficient stability to increase as additional variables are added to the model, increasing explained variance. Again we notice that the most stable results seem to occur when adding (or subtracting) variables to models that already explain about 80% of the variance. In addition, we find that using a disposable income definition of the accelerator instead of a gross income definition had no effect on the marginal effect estimates of the other variables, except for a small increase in the estimated impact of a change in the deficit due to a change in the level of savings (an average of .21 versus .27 billion per billion change in the rate of saving).

TABLE 11

VARIATION IN ESTIMATES OF MARGINAL EFFECTS OF RESIDENTIAL HOUSING DETERMINANTS AS VARIABLES ARE ADDED TO THE MODEL

R^2/Adj.R^2 (DW) B (t-stat.**)	$\Delta P_{HOUSE(t)}$ $\beta_{1T}(t)$	$\Delta T_{G(t)}$ $\beta_{2T}(t)$	ΔG_{tt} $\beta_{2G}(t)$	$\Delta r_{MORT}Y_{-4}$ $\beta_3(t)$	ΔACC_t $\beta_4(t)$	$\Delta(Y-T_{G(t)})$ $\beta_5(t)$	ΔDJ_{t-2} $\beta_6(t)$	ΔPOP_{16-24} $\beta_7(t)$	$\Delta XR_{AVt-(t-3)}$ $\beta_8(t)$
(r income modified); 2 separate (T_G, G) crowd out variables used;									
37/37% (1.3)	-.042(-6.0)								
68/66% (1.7)	-.047(-7.8)	.24 (8.7)	-.14 (-1.6)						
74/72% (1.7)	-.042(-6.1)	.23 (8.5)	-.12 (-1.8)	-1.54 (-2.4)					
79/76% (1.4)	-.031(-3.4)	.23 (6.7)	-.11 (-1.7)	-1.60 (-2.8)	.08 (3.0)				
80/77% (1.4)	-.027(-3.4)	.21(5.6)	-.21 (-2.3)	-1.98 (-3.7)	.06 (1.8)	.04 (1.4)			
82/79% (1.5)	-.026(-3.4)	.23 (5.3)	-.21 (-2.3)	-1.96 (-3.7)	.06 (1.8)	.05 (1.9)	-.17 (-1.6)		
83/79% (1.5)	-.023(-3.1)	.23 (5.0)	-.22 (-2.1)	-2.15 (-5.0)	.06 (2.2)	.06 (2.2)	-.19 (-1.7)	136.5(1.3)	
83/78% (1.5)	-.021(-2.4)	.22 (5.3)	-.24 (-2.4)	-2.13 (-4.6)	.05 (2.0)	.07 (2.4)	-.22 (-2.0)	122.2(1.1)	.70 (1.2)
83/78% (1.6) ***	-.017(-1.7)	.17 (3.6)	-.23 (-2.2)	-2.19 (-4.5)	.05 (1.7)	.07 (2.5)	-.17 (-1.5)	147.5(1.4)	.70 (1.2)
(Same as above except for consistency with P&E, INV models, Acc=ΔY, DJ_-1 is used, and the lag on mort*Y is -2. Using this formulation reduces biasing effects of multicollinearity when adding component parts of investment together, by reducing the number of explanatory variables by two. Virtually the same results are obtained for each variable in the residential demand model.)									
83/79% (1.8)	-.015(-1.5)	.19 (5.4)	-.20 (-1.5)	-2.22(-5.4)	.05 (1.7)	.07 (2.2)	-.19 (-2.0)	158.5(1.6)	.62 (1.1)
83/79% (1.5)	-.022(-3.1)	.23* (5.7)	(N.A.)*	-2.10 (-5.3)	.06 (2.1)	.06 (2.8)	-.22 (-2.1)	121.3(1.1)	.67 (1.3)
(r not income modified)									
85/81% (1.6)	-.017(-2.3)	.24 (7.3)	-.27 (-2.9)	-13.06(-6.9)	.05 (2.0)	.06 (2.4)	-.27 (-2.7)	201.5(2.2)	.80 (1.7)
85/82% (1.5)	-.018(-3.2)	.24* (7.5)	(N.A.)*	-12.73(-7.8)	.05 (2.2)	.06 (2.6)	-.27 (-2.7)	197.1(2.2)	.73 (1.8)

Δ Acc=d(d(Y-T_G))

(*) Government Deficit Reported As One Variable (T_G-G)

(**) t- statistics of 2.0 = 5% significance; t - statistics of 2.7 = 1% level of significance.

(***) Same as immediately preceding equation, except accelerator = $\Delta(\Delta Y)$, not $\Delta\Delta(Y-T_G)$ used in all other equations in this Table.

Overall, coefficients tend to remain relatively stable when (theoretically justifiable) variables are added or subtracted from the model, enhancing the confidence we can have in the regression coefficients as point estimates of marginal effects. This is especially true in models that explain 80% or more of the variance.

Neither the one or two variable form of the crowd out variable, or the use (or not) of an economy size modifier seem to affect the marginal effect estimates for the other variables in the model.

In the previous section (4.1) we noted that both total income of all the factors of production (Y) and the change in income (ΔY), the accelerator, when separately entered in the P&E demand function, were found statistically significant. We concluded that because only one becomes insignificant when both are included in the regression, and for theoretical reasons, that income was fundamentally proxying for the accelerator. We concluded that only the accelerator variable belonged in the demand function, since business income was already represented (profits) and because the accelerator was key to investment theory. In table 11, both remain statistical significance in the fully developed models of residential housing demand, and both warrant inclusion on theoretical grounds as well. So they are included.

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4.3 DEMAND FOR INVENTORY INVESTMENT

A firm invests in inventories whenever, intentionally or unintentionally, it produces goods which are stored until a later time. As we noted in the earlier theory section, Kaleki and Keynes both argued that since businesses invest in inventory as well as P&E, we might expect many of the same factors that affect P&E demand to affect inventory demand, However, in addition to seeing accelerator effects, credit constraints, interest rates and depreciation reserves affect inventory investment, Choi and Kim (2001) remind us that much inventory investment results from "unexpected sales shocks". Therefore, a sizable amount of unexplained variance should be one of the "factors" influencing demand for inventories, i.e., we should not find inventory demand nearly as predictable as demand for other types of investment.

Table 12 below presents the results of regressing inventory investment, 1960 - 2000 on the determinants of this kind of investment hypothesized earlier in this paper. Preliminary testing of all the previously hypothesized determinants of business plant and equipment and residential investment was undertaken, both jointly and one at a time with the variables shown below. None were found to be statistically significant, except for those shown below (government spending is also shown since it is part of the crowd out variable when the two variables comprising crowd out are specified separately).

TABLE 12

REGRESSION OF HYPOTHESIZED DETERMINANTS OF RESIDENTIAL HOUSING INVESTMENT (USING BOTH 1 AND 2-VARIABLE FORMULATIONS OF THE CROWD OUT VARIABLE)

$\Delta I_{INV(t)} = f\ [\beta_1\ ACC_t,\ \ \beta_2\ \Delta DEP_t,\ \beta_{3T-3G}\ \Delta Crowd\ Out\ Variable(s)_t,\ \beta_4\ \Delta r_{t-2}*Y_{t-4},\ \beta_5\ \Delta C_t$

R^2/Adj.R^2 (DW) B (t-stat.**)	$\Delta(ACC_0)$ $\beta_{1T}(t)$	ΔDEP_0 $\beta_2\ (t)$	$\Delta\ T_{G(0)}$ $\beta_{3T}(t)$	ΔG_0 $\beta_{3G}(t)$	$\Delta r_{PR-2}\ Y_{-4}$ $\beta_4(t)$	ΔC_0 $\beta_5(t)$
(r income modified)						
67/62% (2.4)	.17 (5.3)	.54 (2.4)	.17(-3.5)	.02 (0.1)	-.70 (-1.9)	-.16 (-2.7)
65/61% (2.4)	.16 (5.4)	.51 (2.5)	*16 (4.0)	*(N.A.)	-.58 (-1.8)	-.12 (-2.7)
(r not income mod.						
67/62% (2.5)	.17 (5.3)	.55 (2.3)	.16 (3.5)	.01 (0.1)	- 3.25(1.9)	-.16 (-2.7)
65/61% (2.4)	.16 (5.6)	.52 (2.4)	*.15 (4.1)	*(N.A.)	-2.75(1.9)	-.12 (-2.7)

Real Inventory Investment (I_{INV}) = B18 NominalInvChangeB1/(FI_DefB7)
Δ Acc=d(d(Y-T$_G$))
(*) Government Deficit Reported As One Variable (T$_G$-G)
(**) t- statistics of 2.0 = 5% significance; t - statistics of 2.7 = 1% level of significance.

The variables found systematically related to current year changes in inventory levels are sensible:

Δ in the (current year) rate of growth of the economy - the accelerator: (ACC_0),
Δ in depreciation reserves to finance inventories (DEP_0),
Δ in access to credit to finance inventories, measured by deficit/crowd out variables ($T_{G(0)}$, G_0)
Δ in interest rates ($r_{PR-2}Y_{-4}$), modified to reflect the size of the economy
Δ in consumer demand (C_0)

. The first four seem sensibly related without much thought at all. A little more puzzling is the 5th variable found statistically significant, the consumption variable. Changes in the level of consumer demand seemed to be negatively related to changes in inventories. Our hypothesis as to why this occurs is fundamentally Keynesian: demand drives production, and that short run production increases in response to demand increases, tend, by accident or intent, to be less than demand increases, resulting in inventory drawdown (and inventory build up if demand decreases, if short run production cuts tend to be less than

the demand drop.. If this explanation is plausible for explaining the systematic way inventories vary with changes in production of consumer goods, one might expect similar negative relationships between inventory change and change in the other components of the GDP:

exports,
investment and
government goods and services .

However, when entered in the above regressions, these additional variables were not statistically significant. This may be because the changes in inventories due to these variables is relatively small compared to changes due to the effects of changes in consumption, because consumption is 2/3rds of the GDP. Also, since roughly 1/3 of the annual fluctuation in inventory investment seems to be random, the smaller movements in inventory due to explanatory variables like non-inventory investment, government purchases, or exports may get swamped by the random changes in inventory levels, and hard to discern statistically. (This happens with even some of the 5 stronger variables above if they are entered in the regression early, before the variance attributable to the other significant variables is separated out of inventory fluctuations.) And as we know from previous discussions, regression coefficients themselves tend to fluctuate substantially when less that 80% of variance is explained by a model, bringing home with a vengeance Goldberger's axiom that coefficients tend to be biased (inaccurate) in the presence of less than fully specified models.

These five variables were added to the regression one-by-one on the basis of how much they added to explained variance. The 5th variable added, depreciation, raised explained variance from 63.1 to 67%. A wide range of other variables were tested as potential "5th" variables for the regression, but these only raised explained variance from 63.1 – 63.7%, far less than the increase obtained by adding depreciation as the fifth variable. Needless to say, all were statistically insignificant; some had wrong signs. These variables included

DJ_{-1}, DJ_{-2}, $PROF_{-1}$, $PROF_{-2}$, CAP_{-1}, CAP_{-2}, H_{P-1}, $POP_{16-24(0)}$, DEP_{-1}, $(Y-T_G)-I_{INV}$, $MORT_0$

The exception to this was the mortgage interest rate variable (MORT) which raised explained variance above to 66.7%, but this was still less than the 67.2% that obtained with depreciation as the 5th variable. The mortgage variable had a positive sign (Our earlier section on factors affecting demand for residential housing indicated housing demand (and therefore housing production) go up when current mortgage rates go down. Increases in demand should reduce inventories (as the variable expressing the relationship between growth in consumer demand and inventories indicates), even in the face of additional production. By comparison, the sign on our earlier-entered prime interest rate variable (r_{-2} or $r_{-2}Y_{-4}$) is negative. It is also inversely related to investment goods purchased with it, but this is a relatively small portion of investment goods, and it is the interest rate at which inventories are financed; the higher this rate, the more expensive inventory purchases become, hence it should be negative.

These variables were again tested as potential "6th" variables. With one exception, none added more than a fraction of a point to explained variance, and were again not statistically significant. The one exception was housing prices (H_{P-1}). As housing prices increased, This variable showed a decline in inventories associated with a rise in housing prices. According to our theory above, inventory growth should be contracyclical to product demand. Our earlier findings on residential investment showed housing demand negatively associated to housing price, and we would expect falling housing demand to result in growing housing inventories. But this result shows declining inventory demand under this scenario. We suspect that we are seeing procyclical effects associated with boom periods: both prices and demand rise rise in good times, with rising demand causing a drawdown of inventories. Hence, changing housing prices upward is not likely cause a decline in inventories (or at least housing inventories), and since our inventory model is supposed to describe what causes inventories to rise and fall, we do not find this relationship one that indicates this, and do not include it in describing the determinants of inventory demand.

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TABLE 13
RANGE OF POSSIBLE CONTRIBUTIONS TO EXPLAINED VARIANCE
(STEPWISE ADDITION VS. STEPWISE SUBTRACTION METHOD)

Variable	Range	
$+ACC_{(Y-T)}$	47.0%	35%
$+(T, G)_{(2 VAR.)}$	11.0 -	17
$+C$	2.0 -	5.8
$+r_2Y_4$	3.0	NA*
$+DEP_0$	` 4.0	9.O .
Total Expl. Variance:	67.0%	67.8% .

* Negative R^2 due to lack of constant term

Other results are possible with other more random selection of order of entry. It is the regression's way of reminding us that as long as any piece of investment's variance is also carried in two or more individual explanatory variables, we cannot know with certainty which of the explanatory variables is truly "explaining" this variance in the dependent variable.

However, using method selected, the two most important variables related to inventory investment were

- change in the accelerator (ACC_0)
- the credit 'crowd out" variables (T, G) representing the size of the government deficit, and

The results also suggest that, though they effect residential investment, the following variables were less influential during the 1960 – 2000 period examined:

- increases in consumption spending which lowers available inventories
- a change in the PR interest rate two years earlier which affects production (and hence inventories) today.
- Availability of depreciation reserves for inventory purchases.

Table 14 provides an examination of regression coefficient stability when variables are added/subtracted from the model. With only five or six variables in the model, and only 2/3 of the variance explained, it is harder to see the pattern of increasing coefficient stability as the amount of variance the model explains increases. Nonetheless, overall, coefficients stay reasonably stable under most hypotheses about what's in the model and what's not, and in what form. The most significant exception to this is the government purchases variable, where estimates start out suggesting it has about as much impact on crowd out as tax changes, but move to a position of no impact when the consumption variable is added to the model.(This later result is more consistent with our findings for P&E and residential investment, namely, that increases in the government deficit due to increased spending have less effect on crowd out than deficit increases due to tax changes.

TABLE 14

VARIATION IN ESTIMATES OF MARGINAL EFFECTS OF INVENTORY INVESTMENT DETERMINANTS AS VARIABLES ARE ADDED TO THE MODEL

R^2/Adj.R^2 (DW) B (t-stat.**)	ΔACC_0 $\beta_{1T}(t)$	$\Delta T_{G(0)}$ $\beta_{2T}(t)$	ΔG_0 $\beta_{2G}(t)$	$\Delta r_{PR-2}Y_{-4}$ $\beta_3(t)$	ΔC_0 $\beta_4(t)$	ΔDEP_0 $\beta_5(t)$
(r income modified); 2 separate (T_G, G) crowd out variables used, except as asterisked)						
47/47% (2.9)	.14 (6.0)					
58/56% (2.6)	.12 (5.0)	.15 (3.4)	-.19 (-3.4)			
60/56% (2.5)	.12 (5.2)	.13 (3.5)	-.14 (-1.7)	- .41 (-1.3)		
63/58% (2.6)	.14 (5.7)	.16 (3.7)	.00 (0.1)	- .48 (-1.5)	-.05 (-2.0)	
67/62% (2.4)	.17 (5.3)	.17 (3.5)	.02 (0.1)	- .70 (-1.9)	-.16 (-2.7)	.54 (2.4)
*65/61% (2.4)	.16 (5.4)	.17* (4.0)*	(N.A.)*-	- .58 (-1.8)	-.12 (-2.7)	.51 (2.5)
(r not income modified; 2 separate (T_G, G) crowd out variables used, except as asterisked)						
67/62% (2.5)	.17 (5.3)	.16 (3.5)	.01 (0.1)	-3.24 (-1.9)	-.16 (-2.7)	.55 (2.3)
*65/61% (2.4)	.16 (5.6)	.15* (4.1)*	(N.A.)*	-2.75 (-1.9)	-.12 (-2.7)	.52 (2.4)

Δ Acc = Δ (Δ (Y))
(*) Government Deficit Reported As One Variable (T_G-G)
(**) t- statistics of 1.8 = 8% significance; 2.0 = 5% significance; 2.7 = 1% level of significance.

Neither the one or two variable form of the crowd out variable, or the use (or not) of an economy size modifier seem to affect the marginal effect estimates for the other in the model.

4.4. SUMMARY AND CONCLUSIONS

We summarize our findings on the determinants of P&E, residential and inventory investment demand as follows

TABLE 15

SUMMARY OF REGRESSION RESULTS FOR THE THREE COMPONENT PARTS OF INVESTMENT

R^2/Adj.R^2 (DW)	ΔT_G $\beta_{1t}(t)$	ΔG $\beta_{1G}(t)$	ΔACC_t $\beta_3(t)$	ΔDEP_t $\beta_2(t)$	$\Delta r_{PR-2}Y_{-4}$ $\beta_4(t)$	ΔDJ_{t-1} $\beta_5(t)$	$\Delta PROF_{t-1}$ $\beta_6(t)$	$\Delta XR_{AV(t-t-3)}$ $\beta_7(t)$	ΔCAP_{t-1} $\beta_8(t)$
(P&E)[1] .93/91%(1.8)	.19 (5.3)	- .37 (-3.8)	.06 (3.8)	.89 (7.6)		.65 (8.7)	.43 (4.6)	3.79 (4.0)	1.19 (1.5)
(INV)[2] .67/62% (2.4)	.17 (3.5)	.02 (0.1)	.17 (5.3)	.54 (2.4)	- .70 (-1.9)				
(RES)[3] .83/78%(1.5)	.22 (5.3)	- .24 (-2.4)						.70 (1.2)	
Sum of 1,2,3 ($\Sigma\beta_i$)	.58	- .59	.23	1.43	- .70	.65	.43	4.49	1.19
90/87%(2.2) (TOT[4])	.43 (4.4)	- .39 (-2.2)	.29 (8.5)	.86 (3.0)	-1.17 (-2.5)	.50 (3.2)	.38 (2.6)	3.77 (2.2)	.17 (0.2)
98/96%(2.2) (TOT[5])	.87(6.9)	- .64 (-4.0)	.03 (0.3)	.12 (0.6)	- .88 (-1,7)	.63(2.9)	.15 (1.5)	4.16 (4.3)	- 2.32 (-0.7)

TABLE 15 (CON'D.)

(Tble.14 Continued)	$\Delta P_{HOUSE(-1)}$ $\beta_9(t)$	$\Delta(Y-T_{G(t)})$ $\beta_{10}(t)$	ΔPOP_{16-24} $\beta_{11}(t)$	ΔC_t $\beta_{12}(t)$	$\Delta r_{PR-3}Y_{-5}$ $\beta_{13}(t)$	$\Delta r_{Mor(0)}*Y_{-4}$ $\beta_{14}(t)$	ΔDJ_{t-2} $\beta_{15}(t)$	$\Delta ACC_{t(Y-TG)}$ $\beta_{16}(t*)$
(P&E)[1]					- .53 (-2.7)			
(INV)[2]				-.16 (-2.7)				
(RES)[3]	- 021(2.4)	.07 (2.4)	122.24 (1.1)			-2.13(-4.6)	-.22(-2.0)	.05 (2.0)
Sum of 1,2,3(($\Sigma\beta_i$))	-.021	.07	122.24	-.16	- .53	-2.13	-.22	.05
(TOT[4])								
(TOT[5])	-.035(-3.3)	.50 (4.3)	200.95(1.8)	-.44 (-2.4)	-.37(-1.0)	+.10 (0.1)	-.27 (-1.2)	.03 (0.3)

(**) t- statistics of 2.0 = 5% level of significance; 2.7 = 1% level of significance.
Sources:
[1.] Table 7
[2.] Table 13
[3.] Table 11
[4.] Total regression results (TOT[4]) taken from Heim, 2008, p.10.
[5.] Total regression results (TOT[5]) from regression of all variables in the 3 models on sum of (P&E, RES and INV).

In evaluating the Table 14 results, we notice that each of the three different component parts of investment (P&E, RES and INV) have several determinants in common: namely, the accelerator (ACC) variable and the two crowd out variables, (T_G, G). Each of these variables has an (estimated) non-zero marginal effect on P&E, RES and INV when changed. Should we expect the sum of these three estimated individual effects for, say, the accelerator, to equal the marginal effect estimated when calculating the effect of the accelerator on total investment demand? The answer is <u>yes</u> if the determinants of demand of total investment are exactly the same for all three of its components as well, as shown in table 15 below. The answer is <u>no</u> if they are not. Our work above strongly suggests they are not, that some of the determinants are the same, but many differ from component to component. Table 14 shows the sum of the coefficients from the P&E, RES and INV regressions containing only the <u>theoretically correct</u> determinants of the individual type of investment tested do not equal either the coefficients from the Heim 2008 study of total investment's determinants, or the coefficients obtained regressing the theoretically correct determinants of all three component parts on total investment.

Table 16 shows regressions for each of the P&E, RES and INV components of "total investment". All three use the same explanatory variables. They are then compared to regressions for the whole of investment. The first estimates ($\Sigma_\beta =$) just sum the regression coefficients from the individual regressions of the three parts of total investment. In addition, two regressions are also presented: The first represents the regression of total investment defined as the sum of the real values of investment's three component parts. The second set of values for total investment are taken from Table B2 of the *Economic Report of the President, 2002*. The sum of chain indexed deflated parts do not usually equal the total, accounting for the small differences in these two

TABLE 16

ARE REGRESSION ESTIMATES OF THE EFFECTS OF A VARIABLE ON <u>TOTAL</u> INVESTMENT MERELY THE SUM OF REGRESSION ESTIMATES FOR THE SAME VARIABLE OBTAINED BY SEPARATE REGRESSIONS OF INVESTMENT'S PARTS?
(USING DETERMINANTS OF ALL 3 TYPES INVESTMENT AS DETERMINANTS OF EACH)

R^2/Adj.R^2 (DW)(DEP VAR)	$\Delta T_{G(t)}$ $\beta_{1t}(t^*)$	ΔG_t $\beta_{1G}(t^*)$	ΔACC_t $\beta_3(t^*)$	ΔDEP_t $\beta_2(t^*)$	$\Delta r_{t-2}*Y_{t-4}$ $\beta_4(t^*)$	ΔDJ_{t-1} $\beta_5(^*t)$	$\Delta PROF_{t-1}$ $\beta_6(t^*)$	$\Delta_{XRAV(t-t-3)}$ $\beta_7(t^*)$	ΔCAP_{t-1} $\beta_8(t^*)$
Parts of Total Investment Regressions:									
97/95% (2.0) (P&E)[1]	.26(2.5)	- .33 (-3.0)	- .02 (-0.3)	- .55 (-2.2)	.43 (2.0)	.76(5.5)	.30 (4.1)	3.27 (7.8)	.40 (0.2)
91/84% (1.7) (RES)[2]	.29 (2.4)	-.19 (-1.5)	- .10 (1.1.)	.36 (1.9)	- .76 (-2.1)	-.20 (-1.4)	.01 (0.1)	.14 (0.2)	-2.63 (-1.4)
89/80% (2.1) (INV)[3]	.31 (3.0)	- .12 (-1.6)	+ .15 (1.9)	.31 (0.9)	- .55 (-1.4)	.07 (0.6)	-.16 (-3.0)	.75 (1.3)	- .09 (-0.1)
Sum of Parts ($\Sigma\beta_i$)	.86	-.64	.03	.12	- .88	.63	.15	4.16	- 2.32
98/96% (2.2) (TOT[4])	.87(6.9)	- .64 (-4.0)	.03 (0.3)	.12 (0.6)	- .88 (-1,7)	.63(2.9)	.15 (1.5)	4.16 (4.3)	- 2.32 (-0.7)
97/95% (2.1) (TOT[5])	.74(5.6)	- .62 (-4.1)	.11 (1.0)	.10 (0.5)	- .67 (-1.3)	.76 (3.6)	.16 (1.7)	4.17 (4.3)	- .39(-0.1)

TABLE 16 Con'd.)

(DEP.) (VAR.)	$\Delta P_{HOUS(-1)}$ $\beta_9(t^*)$	$\Delta(Y-T_G)_{(t)}$ $\beta_{10}(t^*)$	$\Delta POP_{16-24(t)}$ $\beta_{11}(t^*)$	ΔC_0 $\beta_{12}(t^*)$	$\Delta r_{t-3}*Y_{t-5}$ $\beta_{13}(t^*)$	$\Delta r_{MORT}*Y_{-4}$ $\beta_{14}(t^*)$	ΔDJ_{t-2} $\beta_{15}(t^*)$	$\Delta ACC_{(Y-TG)t}$ $\beta_{16}(t^*)$
Parts of Total Investment Regressions:								
(P&E)[1]	-.01(-1.9)	.20 (3.2)	26.62(0.3)	- .02 (-0.3)	- .64 (- 2.4)	2.70 (7.2)	.07 (0.5)	- .01(-0.2)
(RES)[2]	-.03(-2.7)	- .10(-1.5)	88.03(0.9)	.17 (2.0)	- .14 (-0.4)	-2.08(-2.9)	-.39 (-3.8)	.16 (2.5)
(INV)[3]	.00(0.2)	.41(3.9)	86.30(0.9)	-.58 (-4.4)	.40 (1.8)	- .52(-1.0)	.05 (0.3)	- .13(-1.8)
Sum of Parts ($\Sigma\beta_i$)	- .04	.51	200.95	-.43	- .38		- .27	.02
(TOT[4])	-.03(3.3)	.50 (4.3)	200.95(1.8)	-.44 (-2.4)	- .37(-1.0)	.10 (0.1)	- .27(-1.2)	.03 (0.3)
(TOT[5])	- 03(2.5)	.50 (4.2)	230.37(1.8)	- .42 (-2.3)	- .28 (-0.8)	.56 (0.6)	-.29 (-1.2)	-.05 (-0.6)

(**) t- statistics of 2.0 = 5% level of significance; 2.7 = 1% level of significance.
Sources:
[1.] Table   7
[2.] Table 11
[3.] Table 13

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[4.] Total regression results (TOT[4]) taken from Heim, 2008, p.10.
[5.] Total regression results (TOT[5]) from regression. of all variables in the 3 models on sum of (P&E, RES and INV).
Notes:
(1A) Except for rounding, Sum of Parts ($\Sigma\beta_i$) and (TOT[4]) coefficient results will always be exactly the same, when exactly the same explanatory variables are used in each model, and the dependent variable is the sum of component model dependent variables.
(2A) Note the slight differences in obtained in (TOT[4]) and (TOT[5]) results because the sum of chain index parts do not usually equal the total. (Bernanke 2005, p.48)

As a second example, Table 17 shows the same result when just the determinants of P&E are tested as the determinants of the three component parts of total investment.

TABLE 17

A SECOND EXAMPLE OF THE ESTIMATED EFFECTS OF A VARIABLE ON TOTAL INVESTMENT CALCULATED AS THE SUM OF THE ESTIMATED EFFECTS OF THAT VARIABLE ON ALL THREE SUBCATEGORIES OF INVESTMENT
(USING SAME DETERMINANTS OF DEMAND FOR ALL THREE SUBCATEGORIES)

R^2/Adj.R^2 (DW) β (t-stat.*)	$\Delta T_{G(t)}$ $\beta_{1t}(t)$	ΔG_t $\beta_{1G}(t)$	ΔACC_t $\beta_3(t)$	ΔDEP_t $\beta_2(t)$	$\Delta r_{t-2}*Y_{t-4}$ $\beta_4(t)$	ΔDJ_{t-1} $\beta_5(t)$	$\Delta PROF_{t-1}$ $\beta_6(t)$	$\Delta_{XRAV(t-t-3)}$ $\beta_7(t)$	ΔCAP_{t-1} $\beta_8(t)$
87/84% (2.2) (P&E)	.19(4.2)	- .34 (-3.2)	.07 (3.5)	.80 (4.6)	.22 (0.7)	.59(5.2)	.35 (2.8)	3.28 (2.8)	2.12 (2.3)
70/61% (1.7) (RES)	.10 (4.0)	.04 (0.4)	.12 (6.6)	.10 (0.4)	- .95 (-1.6)	- .07 (-0.6)	-.01(-0.1)	1.20 (2.1)	-1.79 (-1.3)
61/50% (2.6) (INV)	.15 (3.3)	- .08 (-0.8)	.11 (3.9)	-.05 (-0.3)	- .56 (-1.6)	- .04 (-0.3)	-.01 (-0.1)	-.66 (-0.9)	- .81 (-0.8)
Sum of Parts(TOT[1])	.44	- .38	.30	.85	- 1.29	.48	.33	3.82	- .48
90/87% (2.1)(TOT[2])	.44 (4.7)	- .39 (-2.4)	.30 (9.1)	.85 (3.0)	-1.29 (-2.5)	.48 (3.1)	.34 (2.5)	3.83 (2.2)	- .48 (-0.5)
90/87%(2.2)(TOT[3])	.43 (4.4)	-.39 (-2.2)	.29 (8.5)	.86 (3.0)	-1.17 (-2.5)	.50 (3.2)	.38 (2.6)	3.77 (2.2)	.17 (0.2)

Sources, Notes: Same as Table 15.
Determinants of demand in Table 16 are from P&E investment demand function.

Notice that in both Table 16 and 17, the regression coefficients showing any specific variables' effect on a subcomponent of total can be added up to give the same estimated effect on total investment, as the estimated effect from the total investment regression itself. . The parts add up precisely to the total However, as we saw earlier in Table 15, this relationship breaks down when the determinants of demand are different for the different parts of investment. Then, the sum of the regression coefficients does not equal the regression coefficient for the whole.

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