Investment in the USA

In standard macroeconomics models investment is chosen to maximize shareholder value – the expected value of an appropriately discounted stream of dividends. Before the rational expectations revolution, macroeconomists used a quite different model of investment – the flexible accelerator which basically just means high GDP growth and low real interest rates are correlated with a high ratio of investment to GDP. The accelerator survives as a stylized fact to be explained by micro founded models. The idea is that a good model will explain the correlations which are named the flexible accelerator and will also give better conditional predictions than those derived from simply assuming that correlation is causation.

This is roughly comparable to models of consumption in which the stylized facts that the growth of aggregate consumption is smoother than the growth of GDP was explained by the permanent income hypothesis. An important difference is that there isn't a contemporary micro founded model of investment with the same central role as the PIH. Various models are used, each starting with a model of optimal demand for capital in which the marginal product of capital is equal to the user cost of capital and then adding adjustment costs because the simplest possible model implies a huge variation of aggregate investment, including periods of negative aggregate investment.

The key difference between the accelerator and contemporary models of investment is that, in contemporary models managers are forward looking and consider the future marginal products of capital. Again the contrast is similar to the contrast between the PIH and Keynesian theories of consumption. A difference is that the standard textbook model of optimal forward looking investment (the Q model) is radically rejected by the data while rejection of the PIH is more subtle. In both cases the claim that the new approach is better than the old approach pretty much necessarily implies a prediction about the association between current behavior and future outcomes. Existing models of investment with adjustment costs all imply that, other things equal, investment should be high if the future rate of profit is high. Also, other things equal, investment should be high if the future growth of GDP is high.

The aim of this note is to treat the flexible accelerator as a benchmark and see if the accelerator model is rejected, because correlations which are set to zero in the accelerator model are rejected against the alternative in which they have the sign implied by existing models based on inter-temporal optimization. It is well known that, if one treats contemporary DSGE models as null hypotheses and test all implications, the data reject the model. It is correctly argued that models are not hypotheses and are false by definition. It is further argued that the correct question is whether the model provides useful insights – useful candidate explanations for otherwise mysterious patterns. I do not think that data have been examined with an open mind, in an effort to answer this correct question.

To see if the modern approach makes it possible to improve on the accelerator one must deal with data. Interestingly old approaches are preserved in the variables estimated by the Bureau of Economic Analysis. The (few) contemporary macro models with which I am familiar treat investment as if it were all non-residential fixed investment. The models often don't include inventories or inventory investment. This is an odd choice since it is known that while inventory investment is a very small fraction of GDP on average (roughly 1%) it is highly variable and often negative. It is very strange that many economists have left inventories out of models which attempt to explain the business cycle. Also it no longer needs saying that housing investment is important and that it does not track non residential investment.

So the questions are whether investment is high when future profits or future GDP is high for other things equal, the other things being those included in the flexible accelerator and/or a time trend. Total investment and non residential fixed investment can be considered. "High" may mean high compared to GDP or high compared to non financial assets of non financial corporations. Amazingly for a huge variety of calculations and estimates the pattern is the opposite of that implied by models of optimal investment with adjustment costs. Impressively high investment is correlated with poor subsequent economic performance.

The pattern fits Austro-Minskyan models with investment bubbles which cause recessions when they burst. I don't quite understand how models whose clearest implications so radically contrasts with the data could have become so popular.

The data for this note are all quarterly series downloaded from FRED

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"Federal Reserve Economic Data"
"Link: http://research.stlouisfed.org/fred2"


PNFI "Private Nonresidential Fixed Investment (PNFI), Billions of Dollars,
Quarterly, Seasonally Adjusted Annual Rate"
BAA "Moody's Seasoned Baa Corporate Bond Yield (BAA), Percent, Quarterly, Not
Seasonally Adjusted"
GDPC1 "Real Gross Domestic Product (GDPC1), Billions of Chained 2009 Dollars,
Quarterly, Seasonally Adjusted Annual Rate"
GDP "Gross Domestic Product (GDP), Billions of Dollars, Quarterly, Seasonally
Adjusted Annual Rate"
GDPDEF "Gross Domestic Product: Implicit Price Deflator (GDPDEF), Index 2009=100,
Quarterly, Seasonally Adjusted"
AAA "Moody's Seasoned Aaa Corporate Bond Yield (AAA), Percent, Quarterly, Not
Seasonally Adjusted"
PRFI "Private Residential Fixed Investment (PRFI), Billions of Dollars, Quarterly,
Seasonally Adjusted Annual Rate"
GPDI "Gross Private Domestic Investment (GPDI), Billions of Dollars, Quarterly,
Seasonally Adjusted Annual Rate"
A371RC1Q027SBEA "Private inventories (A371RC1Q027SBEA), Billions of Dollars,
Quarterly, Seasonally Adjusted"
A371RX1Q020SBEA "Real private inventories (A371RX1Q020SBEA), Billions of Chained
2009 Dollars, Quarterly, Seasonally Adjusted"
GPDIC96 "Real Gross Private Domestic Investment, 3 decimal (GPDIC96), Billions of
Chained 2009 Dollars, Quarterly, Seasonally Adjusted Annual Rate"
NCBNATQ027S "Nonfinancial corporate business; nonfinancial assets, Level, Millions
of Dollars, Quarterly, Seasonally Adjusted Annual Rate"
NFCPATAX "Nonfinancial Corporate Business: Profits After Tax (without IVA and
CCAdj), Billions of Dollars, Quarterly, Seasonally Adjusted Annual Rate"

From which I calculate
qtr = year of the observation plus (the quarter -1)/4
nrfinvgdp = PNFI/GDP
nrfinvassets = PNFI/NCBNATQ027S
invgdp = GPDI/GDP
rinvrgdp = GPDIC96/GDPC1
hinvgdp = PRFI/GDP
vtryinv = 4*(A371RX1Q020SBEA-A371RX1Q020SBEA lagged one quarter)
vtryinvgdp = vtryinv/rgdp
agrgdp = (GDPC1/(GDPC1 lagged four quarters))-1
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agrgdpminv = (GDPC1-GDPIC96)/((GDPC1-GDPIC96) lagged four quarters))-1
That is lagged annual growth of GDP minus investment
infl = (GDPDEF/GDPDEF lagged four quarters) -1
lrbaa = BAA/100 - infl
That is the nominal yield of BAA bonds minus gdp deflator inflation
lraaa = AAA/100 - infl
invpri = GDPDEF*(GDPIC96/GPDI)
that is invpri is the gdp deflator divided by the investment deflator)
agrgdpqtr = agrgdp*(qtr-1947)
agrgdpinvpri = agrgdp*(invpri- the sample mean of invpri)

return = NFCPATAX/NCBNATQ027S
That is after tax profits divided by the value of nonfinancial assets of nonfinancial corporations
ld3grgdp = (GDPC1 lead three years/GDPC1)-1

I also attempt to calculate correspond to the return on capital which is relevant to models with adjustment costs. The idea is to find a first order condition for optimal investment conditional on future investment being constant. That means building a bit more capital then allowing it to depreciate. The future returns depend on some rate of profit - most naturally "return" the ratio of after tax profits to nonfinancial assets of nonfinancial corporations. The effect of current investment on future capital is calculated assuming a rate of depreciation, so all variables of this type are a function of the assumed rate of depreciation. Future returns are also discounted using the nominal interest rate on BAA corporate bonds.

So the favored theoretically relevant right hand side variable is

$$prret_t(delta) = \sum_{s=0}^{23} \frac{return_{t+s}}{(1 + delta + BAA/400)^s}$$

I also consider discounted profits divided by GDP (because the series for the value of assets seems very strange).

$$prprfgdp_t(delta) = \sum_{s=0}^{23} \frac{NFCPATAX_{t+s}}{(GDP_t)(1 + delta + BAA/400)^s}$$

And simple discounted future GDP divided by GDP lagged one year

$$prmgdp_t(delta) = \sum_{s=0}^{23} \frac{GDP_{t+s}}{(GDP_{t-4})(1 + BAA/400)^s}$$

The independent variable is either the ratio of nominal investment to nominal GDP invgdp or the ratio non residential fixed capital investment to nominal GDP nrfinvgdp. Models of investment based on value maximization with adjustment costs imply positive coefficients in the simple regressions.

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First consider delta = 0.0125 corresponding to annual depreciation of roughly 5%

. reg nrfinvgdp prret

Number of obs =     223
R-squared     =   0.5663

         Coefficient  T-statistic
Prret |  -.0615065     -16.99
_cons |   .161562       65.08
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Delta = 0.0125
. reg nrfinvgdp prprfgdp

Number of obs = 242
R-squared = 0.51

	Coefficient	t-statistic
prprfgdp	-.0406196	-15.81
constant	.1553388	65.28

```
Delta = 0.0125

. reg nrfinvgdp prmgdp

Number of obs =     241
R-squared     =    0.48

Delta = 0.0125

prmgdp|   -.0041905 -14.93
_cons |    .2243981  31.84
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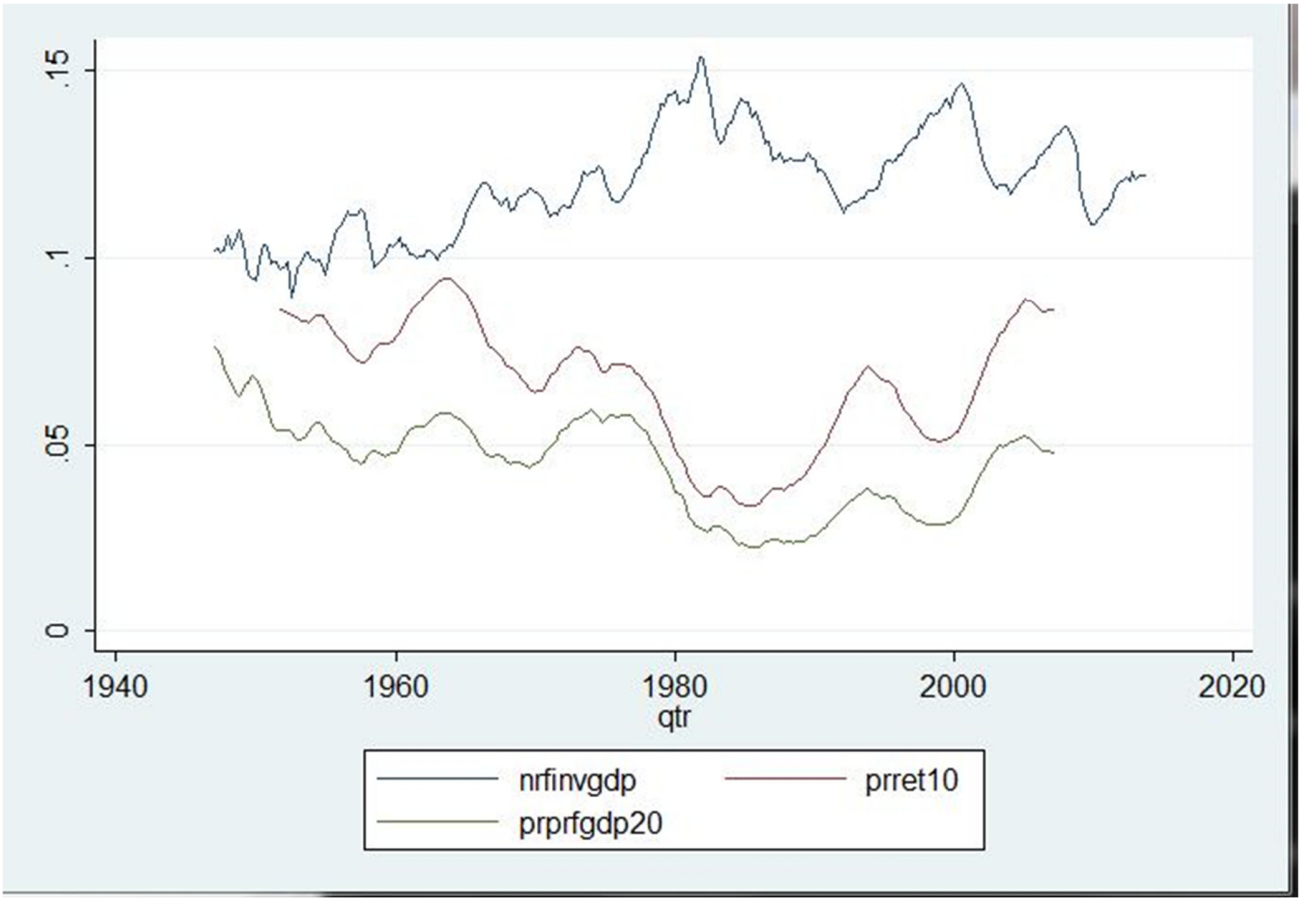
Consistently, the ratio of non residential fixed capital investment to GDP is lower when future prospects are better. This is the opposite of the implication of value maximization with adjustment costs. Instead it corresponds to informal models of over investment due to irrational exuberance followed by painful adjustment.

Figure 1 plots the time series of the ratio of nrfinvgdp = nonresidential fixed capital investment to GDP, Prret10 = prret divided by 10 to fit it on the same graph and prprfgdp20 = prprfgdp divided by 20.



To check robustness, now consider a very high rate of depreciation delta 5% per quarter.

. reg nrfinvgdp prret

Number of obs = 223
R-squared = 0.5256

	Coefficient	t-statistic
Prret	-.08431	-15.65
Constant	.1609397	60.72

Delta = 0.05

. reg nrfinvgdp prprfgdp

Number of obs = 242
R-squared = 0.4690

prprfgdp	-.0563876	-14.56
_cons	.1543423	61.50

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. reg nrfinvgdp prmgdp

  Number of obs =      241
   R-squared       =   0.4826

   nrfinvgdp |      Coef.           t
     Prmgdp |   -.0041905      14.93
       _cons |   .2243981      31.84
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Again all of the coefficients have a sign opposite that predicted by simple micro founded theory.

Finally, look at the ratio of total investment to GDP invgdp returning to the assumption of 1.25% depreciation per quarter.

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. reg invgdp prret

Number of obs =      223
 R-squared     =  0.1786

      invgdp |      Coef.         t
       prret |  -.0382015    -6.93
       _cons |   .1998795    52.89
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. reg invgdp prprfgdp

   Number of obs =      242
     R-squared     =  0.1236

      invgdp |      Coef.        t
    prprfgdp |  -.0224298 -5.82
       _cons |    .194053    54.37
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. reg invgdp prmgdp

  Number of obs =      241
  R-squared     =  0.0422

      invgdp |      Coef.   Std. Err.      t
      prmgdp |  -.0013636    -3.25
       _cons |   .2086368      19.78
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Results are similar although the negative correlation between future discounted profits and investment is weaker for investment which isn't, according to theory, positively correlated with future expected discounted profits.

Discussion.

I think the informative part of this note is, as usual, the figure. Basically it shows extremely high levels of nonresidential fixed capital investment during the Carter administration in the late 70s. Clearly

managers did not anticipate the huge negative shock to discounted profits which followed the inauguration of Ronald Reagan due both to low rates of profit and especially high real interest rates caused by the combination of tight monetary and loose fiscal policy. Then, in a less dramatic but better remembered period, extremely high investment in the late 90s was not justified by profits earned in the 21st century.

The first episode not only has been forgotten but was little noticed at the time. There was little discussion of the extraordinarily high levels of fixed capital formation during the Carter years. The extremely low levels of discounted profits weren't even noticed by investors during the Reagan years. The second episode corresponds clearly to a bubble due to over optimistic expectations. It was widely suspected that this was occuring at the time, even though the claim that the internet had changed all the rules of economics was even more widely held.

The pattern of high investment followed by low returns corresponds to stories about manias panics and crashes told by Hyman Minsky, Charles Kindleberg and various Austrians. It is plainly in the data and also was plainly reported in newspapers and news magazines. It is very odd that it is still news to the macroeconomics profession.