Does Uncertainty Affect Investment Expenditure? A Comment

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"Does Uncertainty Affect Investment Spending?: A comment and an update"

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This is a theoretic and econometric assessment of Peter Ferderer's seminal paper published in the Journal of Post Keynesian Economics with the same title in 1993. New data shows that high forecaster discords coincide with a decrease in Investment expenditure. Specifically, the forecaster discord about the aggregate level of employment explains an important part of the fluctuations in investment. Even if the forecaster discords are included in models based on Tobin's q, they play an important role.

Key words: Macroeconomics, Uncertainty, Expectations.

1- Introduction

This paper is an empirical evaluation on the robustness of the seminal work by Ferderer "Does Uncertainty affect Investment Spending?"published in the Journal of Post Keynesian Economics in 1993. The main purpose is to test whether the relationship between uncertainty and investment expenditure that Ferderer found apply to a more resent sample.

In the first section I will make an exposition of the theoretical models used by Ferderer. In the second section I will present the econometric methodology used in the present paper. I will compare that methodology with the one employed by Ferderer.

In the fourth section I will show the results of the estimations and the respective analysis.

There are two main findings: First, only two of the forecaster discords calculated by Ferderer remain significant as explanatory variables of the level of investment: The forecaster discord of the rate of unemployment and the forecaster discord of the inflation rate. However, only the first of these variables was significant after correcting for autocorrelation. The second main finding, which follows from the first one, is that Barro's theoretical explanation based in the Tobin's q fits better at the empirical level under the present methodology.

2- Theoretical Framework:

Two main explanations of the fluctuations of aggregate investment are used in Ferderer (Ferderer, 1993). The firs, is the one developed by Barro (Barro, 1989) and originated by Tobin (Tobin (Barro, 1989) (Tobin, 1969), 1969). According to Tobin's q, fluctuations in aggregate investment expenditure are mainly explained by the difference (Tobin's q) between the market valuation of the stock of capital and its reproduction cost. Since this difference is not directly observable, Tobin proposes to use the value of the stock market capitalization as a signal.

Barro (Barro, 1989) proposes that the stock market prices serve well as a proxy for the marginal increase in the expected stream of income caused by investment. In the long run q would be equal to 1. Thus, if q is larger than 1, the market price of the stock of capital is larger than its production cost. This would create an incentive for a decrease in the demand for capital assets. His thesis is valid only under a restrictive set of assumptions: Product and factor markets are perfectly competitive, production and adjustment cost technologies are homogeneous and the market's efficiency hypothesis holds (Baddeley, 2003). Under

these conditions an increase in the stock market prices signals that the market value is below the production cost of capital. This situation would make more worth the while to spend in additions to the capital stock. Barro's empirical analysis concludes that stock price returns explain the fluctuations in investment expenditures. Current and lagged values of these variables are used to capture the rational formation of expectations about the future profitability of investment.

The second theoretical explanation used by Ferderer was the one presented in Clark (Clark, 1979). Clark makes an explanation and a theoretical comparisson of different models of Investment. Ferderer makes specific reference to the accelerator model of investment. In the accelerator model Investment depends on current and lagged values of the level of output. Lagged values of output enter in the analysis as a way to include static expectations in the model of investment. This inclussion has also an empirical justification. Historically the level of investment changes with the level of output but not immediatelly. The change in investment due to variations in income occur with a lag because enterprises need time in order to adjust their business plans. In addition, new investment plans take time to develop in full.

Ferderer makes use of these two theoretical approaches to propose a model of investment capable of tasting the influence of the degree of uncertainty in the economy. The theoretical support of these assertion is found in the Post keynesian literature. Specifically Ferderer refers to the works by Keynes, and George Shackle. According to Keynes, the increase in the level of uncertainty in the economy makes investors prefer cash instead of accumulation of capital. Investors wait for more information before deciding to invest. This

process of posponing decisions of investment has to do with the permanent lack of information in a non ergodic world. According to Shackle this lack of information is unsalvable because the future is not to be discovered (as in Barro's model) but to be created. Therefore an increase in incertainty in a period of time should cause a decrease in the level of investment.

3- Methodology:

The two aforementioned theoretical approaches to the behavior of investment(Barro and Clark) used by Ferderer are the basis for two out of four econometric models estimated in the present paper. Following the methodology presented in Ferderer, I include a proxy for the level of uncertainty in both models. All variables in the present paper quarterly variables.

3.1- Barro's model with Uncertianty:

As was mentioned above, Barro includes the stock price returns as an explanatory variable for investment. The stock price returns calculated by Ferderer are the first difference of the logarithm of the Standard and Poor's stock's price Index. The inflation rate is subtracted from it [1].

The dependent variable in Ferderer's version of Barro's model is the quarterly investment divided by its corresponding stock of capital lagged one quarter. The author takes measures of these variables in real terms. I use nominal values as the change in prices

[1] See Appendix 1 for a detailed description of the source of each variable.

affects in simmilar ways both investment and the sotock of capital. Ferderer asserts that both measures are provided by the US Bureau of Economic Analysis. However, he is not very specific as to which table he is using.

There is no measurement for the real gross stock of capital in the NIPA accounts. For this reasson I had to infer that the measurement of the stock of capital adequate for this analysis is the one presented in table 5.9 in the NIPA accounts (Account: Private-Produced assets). NIPA accounts define Investment as the amount of produced assets in a period of time. Table 5.9 shows the annual change in the stock of produced assets and their accumulation over time. Since I am working with quarterly data, I used the interpolation proposed by Ferderer[2].

Ferderer is not very specific about the NIPA account used for Investment. Hence, I used the account that was the most compatible with changes in the stock of capital registered in table 5.9[3]. The level of nominal investment can be found in table 1.1.5. The dependent variable is calculated by dividing investment by the stock of capital lagged one period.

As a proxy for the level of uncertainty in the economy Ferderer uses the forecaster discord. The latter consists in the standard deviation of the forecasts made over a set of variables in the economy. The statistical justification made by Ferderer at this respect is that, from a

[2] See appendix 2.

[3] The USBEA mentions that the stocks presented in table 5.9 are compatible with the flows presented in other tables in the NIPA accounts. However I could not find explicit a relationship between each of the entries in 5.9 and other accounts. Hence, the stock of capital compatible with the level of investment that I am using is an approximation that should be tested and compared in a further research.

Bayesian perspectiive, at each point in time the standard deviations of the point forecasts (Forecaster discord) *' provides a good proxy for group uncertiany 'p22* .

Ferderer uses the Blue Ship Economic Indicators. This survey is not used here. However, the advantages that Ferderer highglits regarding this survey are also met by the Survey of Professional Forecasters(SPF) provided by the FED. These advantages are mainly the measurement of a wide viriety of variables and its quarterly character. As a possible negative point about the (SPF) is that it is conducted over the phone and in a three days period like the Blue Ship. Questionaries are sent and answered in a period of two weeks. However as an advantage over the Blue ships, the (SPF) is collected in a quarterly basis. Ferderer had to calculate the average of the past four months in order to get quarterly data and he had to correct for seasonal heteroskedasticity as the time horizon changed twice a year. There is no change in the time horizon in the (SPF). All forecasts correspond to a one year ahead forecast. I excluded the forecaster discord of the long term interest rate or ten year treasury bond because it is not consistent in the (SPF). The models are run beginning in the second quarter 1982 because that is the thresshold from which the survey's forecasts are readily available.

3.2- Accelerator's Model with Uncertainty:

In this model the aggregate level of output and the interest rate are included as explanatory variables of variations of Investment. Ferderer inserts in his model a measure of the real GNP. I use nominal GDP. According to NIPA manuals, GDP replaced GNP as the main measure of the economic activity in the United Sates from 1992. The reasson is because the

influence of the variation of prices cancels out when the rate of growth is calculated. The GDP is compatible with the aforementioned measurement of investment. It comes from the same table (1.1.5) in the NIPA accounts. In order to make it exclusive of Investment expenditure, following Ferderer I subtracted Fixed Investment from the Gross Domestic Product.

It is not common in the literature that the interest rate is used as explanatory variable in the accelerator model. It is not presented in that way by (Clark, 1979). However, its inclussion is plausible in the light of a keynesian conception of investment. Ferderer considers two possible models that include interest rate. One uses a calculation for the real interest rate, and the other uses a nominal interest rate. The interest rate is the BAA corporate bond interest rate that assumed to measure the cost of capital for firms. The interest rate used is the end-of-quarter interest rate. Since those rates are one year interest rates, I calculated the effective quarterly interest rate by using a simple transformation (See apendix 3). Estimates do not change too much with this transformation. The real interest rate is calculated following Ferderer by subtracting the weighted average of past inflation over the quarter from the nominal interest rate. The weighted average aims to denote expectations of inflation. However Ferderer recognizes that this measure is problematic.

In accordance with Ferderer's methodology, in order to detrend the variables I calculate first differences of: 1) The forecaster discords, 2) Nominal and real interest rates and 3)Investment divided by its capital stock lagged one quarter(Dependent variable). First

difference of the logarithm of the GDP[4] is calculated in order to obtain the rate of change. In both models each each explanatory variable consists of a sum of lags. Those lags are calculated after the transformations mentioned above. This procedure is justified by the Akaike AIC criterion. The present paper uses the calculations in Ferderer's paper, hence the lag structure is the same as presented there.

The variables used the estimations below are constructed in the following way:

SLSPR: Sum of current and past 5 values of the stock price returns.

SLIP: Sum of current and past 2 values of the Forecaster Discord of Industrial Production.

SLUN: Sum of current and past 4 values of the forecaster discord of unemployment.

SLSTR: Sum of current and past 6 values of the forecaster discord of the short term Interest rate.

SLCPI: Sum of current and past 8 values of the forecaster discord of the Inflation rate.

SLGDP: Sum of current and past 2 values of the Gross Domestic Product.

SLRBAA: Sum of current and past 2 values of the real corporate bond interest rate.

SLBAA: Sum of current and past 2 values of the nominal corporate bond interest rate.

[4] NIPA accounts present the value of the GDP and Investment multiplying by four the value obtained for these two variables in the quarter.

INV: Current value of investment for each quarter as explained above. It is the dependent variable.

4- Analysis and Estimation:

The results of the estimations are shown in tables 1, 2 and three. Table 1/model1 shows the estimations for Barro's model. Table 2/model2 shows the estimations for the Accelerator's model using the real interest rate (SLRBAA). Table 3/model3 shows the calculations for the accelerator's model using the nominal interest rate. For each of the three models I ran estimations of the forecaster discords: SLIP, SLUN, SLSTR, SLCPI. This is the same procedure used by Ferderer. Ferderer used the Cochrane-Orchutt procedure in order to correct for autocorrelation. Since this method is nowadays obsolete, I replaced with the Yule-Walker method known also as the two step full transform method.

In Table 1 we can see that the variable for stock price returns (SLSPR) is significant in all models and has a positive sign supporting the hypothesis that an increase in Tobin's q leads to an increase in investment. It is also interesting to observe that the forecaster discord has the expected sign (Negative) implying that increases in the uncertainty in the economy causes a reduction in investment. However, this effect is only significant for the forecaster discord of the unemployment rate (SLUN). In addition, in the case of the forecaster discord of the inflation rate (SLCPI), the coefficient is significant in the model

without correction for autocorrelation[5]. This gives an indication that the thesis regarding the importance of price stability for investment must be taken into account.

Table 1
Barro's Model with Uncertainty

	1	2	3	4
Const	-0.00011	-0.000108	-0.000118	-0.000123
Aprox Pr>t	0.0501	0.0385	0.0319	0.0089
SLSPR	0.000971	0.000933	0.000935	0.00093
Aprox Pr>t	<.0001	<.0001	<.0001	<.0001
SLIP	-0.00004			
Aprox Pr>t	0.186			
SLUN		-0.000488		
Aprox Pr>t		0.0141		
SLSTR			-0.00019	
Aprox Pr>t			0.2059	
SLCPI				-0.000114
Aprox Pr>t				0.2027
DW	2.2121	2.1937	2.2144	1.9796
Total R-Sq	0.4989	0.5178	0.4811	0.4538

This findings are different from (Ferderer, 1993). He asserted that the forecaster discords of all variables where significant and that the stock price returns was only significant in model 1. However, the results presented in table 1 are more compatible with those found in Barro (Barro, 1989) where stock price returns are fundamental in explaining changes in investment.

[5] This result is not presented here.

Table 2 shows the results for the accelerator model with real interest rate. As we can see, the level of output exclusive of investment expenditure (SLGDP) is significant in all models confirming the results generally found in the literature for this model. The interest rate however does not seem to have a big impact under this framework. In addition the forecaster discord is not significant for any of them and the signs are not consistent. Ferderer has a caveat regarding the measurement of the real interest rate and for that reason he runs another model including the nominal interest rate. The analogous calculations for that model are shown in tabl3.

Table 2
Accelerator's model with Uncertainty (Real Interest rate)

	1	2	3	4
Const.	-0.000436	-0.000447	-0.000431	-0.000429
Aprox Pr>t	0.0071	0.0052	0.0074	0.0074
SLGDP	0.009107	0.009394	0.009044	0.008958
Aprox Pr>t	0.0104	0.0074	0.0109	0.0138
SLRBAA	0.0000335	0.0000353	0.0000273	0.0000299
Aprox Pr>t	0.3197	0.2954	0.4212	0.3834
SLIP	-3.62E-06			
Aprox Pr>t	0.9075			
SLUN		0.0000565		
Aprox Pr>t		0.7456		
SLSTR			-0.000167	
Aprox Pr>t			0.2829	
SLCPI				-0.000018
Aprox Pr>t				0.8439

DW	2.2588	2.263	2.316	2.1915
Total R-Sq	0.4455	0.4459	0.4364	0.4128

Although table three does not show significance regarding the forecaster discord, it is interesting to note that at least there is more consistency in the negative sign for the forecaster discord; only the unemployment rate shows a positive sign. This again contrasts with Ferdrer's findings in which the forecaster discord is negative and significant for all variables.

Table 3
Accelerator's model with Uncertainty (Nominal Interest rate)

	1	2	3	4
Const.	-0.00046	-0.00047	-0.000466	-0.000462
Aprox Pr>t	0.0045	0.0034	0.0036	0.0044
SLGDP	0.009577	0.009859	0.009759	0.009618
Aprox Pr>t	0.0067	0.0048	0.0056	0.0084
SLBAA	-0.00031	-0.000324	-0.000648	-0.000714
Aprox Pr>t	0.7719	0.7626	0.564	0.5249
SLIP	-6.97E-06			
Aprox Pr>t	0.8246			
SLUN		0.0000387		
Aprox Pr>t		0.8252		
SLSTR			-0.000183	
Aprox Pr>t			0.2423	
SLCPI				-0.00002
Aprox Pr>t				0.827

DW	2.1904	2.2035	2.2653	2.1766
Total R-Sq	0.4391	0.4392	0.4331	0.4089

This implies that Stock price return, the level of output, and the forecaster discord of the unemployment rate are important variables in explaining changes in investment. Table 4 shows the results for a model in which I included these variables.

Table 4
Proposed Model

	1
Const.	-0.000309
Aprox Pr>t	0.0265
SLSPR	0.000812
Aprox Pr>t	0.0002
SLUN	-0.000459
Aprox Pr>t	0.0232
SLGDP	0.004986
Aprox Pr>t	0.1241
DW	2.2098
Total R-Sq	0.5264

As we can see, stock price returns, and the forecaster discord of the unemployment rate remain significative. The Aggregate output however, is not significative in this case. This is an indication that Barro's model explains better the fluctuations in investment. The fact that the forecaster discord of unemplyment remains significative shows the facta that for investors labor stability is a fundamental factor affecting their decisions of investment.

5- Conclussions:

The previous calculations show that uncertainty explains part of the fluctuations in Investment. Labor instability is more important than any other type of uncertainty in the economy. Hence, a possitive driver of investment is the reduction in the fluctuations in the unemployment rate along with the stimulus in stock price returns. Aggregate output is also important in order to understand fluctuations in investment. However its influence is captured better by the combination of policies of labor stabilization and prosperity in the financial markets. Labor stability does not imply a permanent rate of unemployment. A permanent decrease in this indicator would also be compatible with increase in investment spenditure. The influence of uncertainty in the economy however, cannot be infered from the present calculations. A further research correcting possible mistakes in the measurement of the interest rate would be necessary.

Apendix 1:

Inflation:

Source: USBureau of Labor Statistics.

Consumer Price Index - All Urban Consumers
3-Month Percent Change

Series Id:	CUSR0000SA0
Seasonally Adjusted	
Area:	U.S. city average
Item:	All items
Base Period:	1982-84=100
Years:	1980 to 2010

Standard and Poor's Price index 500

Source: S&P

Index key: SPUSA-500-USDUF--P-US-L--

Capital Stock:

Source: USBEA

NIPA Accounts

Table 5.9. Changes in Net Stock of Produced Assets
(Fixed Assets and Inventories)
[Billions of dollars]
Annual data from 1969 To 2009
Bureau of Economic Analysis
Data published August 05, 2010
File created 10/28/2010 9:45:21 AM
Line 3: Private produced Assets

Forecasts:

Source: Federal Reserve Bank of Philadelphia –Survey of Provessional Forecasters – Individual Forecasts.

The following are the codes of the variables in the survey.

Industrial Production: INDPRODA

Unemployment Rate: UNEMPA

Three Months Treasury Bill interest rate (Short Term Rate): TBILLA

Inflation: CPIA

Investment:

Source: USBEA
Table 1.1.5. Gross Domestic Product
[Billions of dollars]; Seasonally adjusted at annual rates
Quarterly data from 1969 To 2010
Bureau of Economic Analysis
Line 8: Fixed Investment

Gross Domestic Product:

Source: USBEA
Table 1.1.5. Gross Domestic Product
[Billions of dollars]; Seasonally adjusted at annual rates
Quarterly data from 1969 To 2010
Bureau of Economic Analysis
Line 1

Interest Rate:

Source: FED's web page.

	H.15 Selected Interest Rates for Nov 10, 2010
Series	MOODY'S YIELD ON SEASONED CORPORATE
Description	BONDS - ALL INDUSTRIES, BAA
Unit:	Percent:_Per_Year

Apendix2:

Interpolation:

This formula is found in (Ferderer, 1993) foot note 13:

$$K_{i,j} = \left(\frac{\sum_{z=1}^{j} I_{i,z}}{\sum_{z=1}^{4} I_{i,z}}\right)\left[K_{i,4} - K_{i-1,4}\right] + K_{i-1,4}$$

"where $K_{i,j}$ is the real gross capital stock in the j^{th} quarter of the i^{th} year, $K_{i,4}$ is the annual (end-of-fourth-quarter in year i) real gross capital stock series provided by the Bureau of Economic Analysis, and $I_{i,z}$ is the investment expenditure flow during quarter z." (Ferderer, 1993, p28)

Apendix 3:

Quarterly rate = $(1 + \text{annual rate})^{(1/4)} - 1$

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