The Rôle of Stock Prices in Business Cycles

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Abstract:

Stock prices slowly adjust after the peak of a business cycle. High stock prices during the months following the peak result in a lower cost of capital for firms. Investment is much higher than it would be otherwise. We estimate a dynamic macroeconomic model in four variables: investment, stock prices, GDP, and interest rates. Stock prices are shown to be exogenous to the system, and investment is positively related to the stock prices. Investment and GDP would be significantly lower during the recessions since 1969 if stock prices adjusted immediately. High stock prices cushion the blow of the recession.

JEL Classification Codes: E32, E43

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1. Introduction

During the business cycles of the last few decades, stock prices have declined just before and during the recession phase. But the decline is very slow, taking as long as 18 months before the minimum is reached. Investors are selling off their stocks very slowly. The decrease in stock prices and consequent negative returns have been well-documented by Boudoukh, Richardson, and Smith (1993) and McCown (1999). Investors may not know that the business cycle peak has passed until months or years after the fact, but can observe the inverted yield curve that occurs at, or just prior to, the peak. The high stock prices during the adjustment period keep the firms' equity cost of capital low. High stock prices on the secondary market can result in high demand for seasoned offerings, initial public offerings, venture capital and other private equity placements. The high stock prices can also act as a signal to lenders (banks, bond investors, etc.) to offer more favorable terms to the companies. This results in a lower cost of capital for firms, and a greater amount of direct business investment during the months following the business cycle peak than would be the case if investors immediately sell off their stocks when the yield curve inverts.

We estimate a dynamic macroeconomic model in four variables: GDP, investment, interest rates, and stock prices, in order to estimate the effect of the slow adjustment of stock prices. This is done in the form of a vector error correction (VEC) model, since all four variables follow an I(1) process and have one cointegrating vector. The VEC model reveals stock prices to be exogenous to the system. We then test for cointegration only between GDP, investment, and interest rates and also find one cointegrating vector. The VEC model is re-estimated with stock prices as a strictly exogenous variable. Both investment and GDP are found to be positively related to the change in lagged stock prices.

Using the VEC model, we run a simulation from 1968 to 2003, a period that covers six business cycles. We first estimate investment and GDP using the actual stock prices that prevailed over the period. We then re-estimate the numbers assuming stock prices immediately drop to their post-peak local minimum, upon the inversion of the yield curve. This results in a significant decrease in investment and GDP. The slow adjustment of stock prices cushions the impact of a recession.

Section 2 describes the phenomena that occur following a yield curve inversion. In section 3 we estimate the VEC model. Section 4 details the simulation of the effects of an immediate adjustment to stock prices. Section 5 concludes.

2. Stock Prices and Real Investment Over the Business Cycle

In Figure 1 we see the main component of the fall in real GDP during the 2001 recession was the decrease in real private nonresidential fixed investment. Unlike most previous recessions, there was no decline in consumption spending. Figure 2 shows investment and real stock prices on the same graph. There is a correlation between the two variables, with the stock prices leading investment. It is easy to imagine that this correlation between the two variables is the result of a causal relation. High stock prices on the secondary market can be an inducement for corporations to make additional seasoned stock offerings. Initial public offerings, venture capital financing, and other private equity placements are also stimulated by high stock prices. The high stock prices can also act as a signal to lenders (banks, bond investors, etc.) to offer favorable terms to the companies. The end result is a lower cost of capital for firms, and private nonresidential investment is much higher than it would be if stock prices were low.

In Table 1 and Figure 3 we see that stock prices drop after the peak of a business cycle. Due to the slow methods of reporting GDP data, and the numerous revisions, investors are often unaware that a business cycle peak has occurred until several months later. However, there is another indicator that coincides closely with a business cycle peak that is available immediately: An inverted yield curve. We see in Table 2 that inverted yield curves have occurred shortly before each of the last six business cycle peaks. Boudoukh, Richardson, and Smith (1992), and McCown (1999) have shown that U.S. stock prices fall after yield curve inversions.

The yield curve indicator gives investors a prompt signal that a downturn is coming. However, the sell off of stocks does not occur immediately. The drop in stock prices is gradual and can last up to 18 months, as can be seen in Table 1. It is not known why investors react slowly to the inversion of the yield curve, but most active investors and money managers are well aware of the implications of the phenomenon. Boudoukh, Richardson, and Smith (1992) have found that this effect has persisted since early in the nineteenth century.

In order to estimate the consequences of the slow adjustment of stock prices, we want to determine what would happen to investment and GDP if the sell-off were to occur immediately upon the inversion of the yield curve. See Figure 4 for the time series of the real S&P 500 for the 2001 recession, assuming that stock prices immediately dropped to their subsequent local minimum during the quarter following the yield curve inversion. If stock prices have an effect on investment, then investment should also drop considerably after the business cycle peak.

The first step is to estimate an investment function using stock prices as one of the arguments. This is done as part of a vector error correction model with four variables: Investment, GDP, stock prices, and interest rates.

3. Investment as a Function of Stock Prices

In most macroeconomic research, investment is modeled as a function of output and interest rates. We add stock prices as an additional argument. The first step is to test the four variables: Investment, GDP, stock prices, and interest rates, for stationarity. Table 3 shows the results of unit root tests using the DF-GLS method of Elliott, Rothenberg, and Stock (1996). The DF-GLS method tests for the null hypothesis of a unit root versus the alternate hypothesis of stationarity. Table 3 also shows the KPSS tests of Kwiatkowski, et al (1992), which test for the null hypothesis of stationarity versus the alternate hypothesis of a unit root. Both tests are run for all four variables in both levels and first differences. The results indicate that all four series follow an I(1) process.

Since all four variables have unit roots, we next test for cointegration. Table 4 shows the results of the Johansen tests for cointegration. Both the trace test and the maximum eigenvalue test indicate that there is one cointegrating vector. Since the variables are cointegrated we next estimate a vector error correction model, using four lags of the variables, shown in Table 5. The adjustment coefficients for the error correction term are statistically insignificant for both investment and stock prices. This tells us that when the system is out of equilibrium, only GDP and interest rates adjust to return to equilibrium. In addition, the coefficients on the lagged values of the variables are statistically insignificant for the equation that has the stock prices as the dependent variable, and the adjusted r-square shows that the equation explains only one percent of the variability of stock prices. This compares with r-squares of 0.547, 0.364, and 0.241, for the investment, GDP, and interest rate equations, respectively.

We conclude that stock prices are exogenous to this system. This gives us reassurance that it is reasonable to remove the stock prices from the set of endogenous variables. But it is also important to retain the lagged stock prices as an exogenous variable, because both investment and GDP respond positively to the first two lags of the changes in stock prices, and the coefficients are statistically significant. The next step is to test to see if the three remaining endogenous variable have a cointegrating relation. The tests are shown in

Table 6. Again, we find one cointegrating vector between investment, GDP, and the interest rate.

We estimate the VECM with stock prices as an exogenous variable in table 7. As in table 5, both investment and GDP are positively related to the first two lags of the changes of stock prices and the coefficients are statistically significant. Since stock prices are now an exogenous variable in the system, we can safely substitute a counterfactual series of stock prices, to determine what would happen if they were to immediately adjust to their local minimum when the yield curve inverts.

4. Effect of an Immediate Drop in Stock Prices

We run simulations of real investment and GDP with the dynamic system we estimated in Table 7, using the data beginning in 1968. We first compute investment and GDP, using our model, with the slow adjustment of stock prices that actually occurred over the period. We then run the simulations assuming stock prices immediate drop to the local minimum upon inversion of the yield curve, as shown in Figure 4. Then we compute the differences in both investment and GDP, which are shown in Tables 8A, 8B, and 8C.

According to our model, both investment and GDP would have been considerably lower had the stock prices adjusted immediately. The largest differences are for the 1973 and 2001 recessions. Had the adjustment occurred immediately upon the yield curve inversion of March, 1973, investment would have dropped by as much as $41 billion on an annualized basis and GDP by $106 billion. For the 2001 recession, immediate adjustment would have resulted in a decrease in investment as much as $197 billion and GDP by $304 billion. See the graphs in Figures 5 and 6 for the results for investment and GDP for the 2001 recession. The results for the other four recessions since 1970 are somewhat milder. Not surprisingly, this is due to the larger drops in stock prices that occurred during the 1973 and 2001 recessions.

5. Conclusion

The slow adjustment of stock prices that prevail during the months following a business cycle peak result in a significant cushion to the subsequent recession. If investors were to immediately sell their stocks when the yield curve inverts, the drop in stock prices would cause a much larger drop in investment and GDP than has been occurring. The computed difference of $304 billion for the 2001 recession is almost six times the actual decrease in GDP that occurred during that recession.

A coherent and comprehensive explanation of why the sell-off is so slow following the yield curve inversion has been elusive. Boudoukh, Richardson, and Smith (1993) speculate that investors are willing to accept the expected negative returns on stocks because the stocks can be used to hedge fluctuations in their consumption stream. McCown (1999) was not been able to confirm this empirically. Perhaps there is an unknown risk factor, other than consumption, that the investors are hedging against by retaining their stocks during the initial phase of a recession. Future research should attempt to determine what this risk factor is.

Table 1
Drop in Stock Prices after Business Cycle Peaks

NBER Business Cycle Peak	S&P 500 Index at Business Cycle Peak*	Date of Local Minimum of S&P 500 Index	Number of Months from Peak to S&P 500 Minimum	Local Minimum of S&P 500 Index after Business Cycle Peak	Percentage Drop
December, 1969	92.06	June, 1970	6	72.72	-21.01
November, 1973	95.96	September, 1974	10	63.54	-33.79
January, 1980	114.16	March, 1980	2	102.09	-10.57
July, 1981	130.92	July, 1982	12	107.09	-18.20
July, 1990	356.15	October, 1990	3	304	-14.64
March, 2001	1160.33	September, 2002	18	815.28	-29.74

* End of month

Table 2
Yield Curve Inversions Occurring At or Near Business Cycle Peaks

NBER Business Cycle Peak	Beginning of Yield Curve Inversion†	End of Yield Curve Inversion
December, 1969	June, 1969	December, 1969
November, 1973	March, 1973	October, 1974
January, 1980	September, 1978	April, 1980
July, 1981	October, 1980	September, 1981
July, 1990	March, 1989	October, 1989
March, 2001	August, 2000	December, 2000

†Yield curve inversion defined as a period in which the yield to maturity on a five year Treasury note is less than the yield on a one year Treasury bill.

Table 3
Unit Root Tests
Quarterly Data: 1955 - 2003

Panel A: Tests of Variables in Levels

	DF–GLS (with trend)	# lags	1% Critical Values	5% Critical Values
Real Investment	-1.333	2	-3.468	-2.937
Real GDP	0.018	2	-3.468	-2.937
Real S&P 500	-1.387	0	-3.466	-2.935
TBill Interest Rate	-1.689	3	-3.470	-2.938

	KPSS (with trend)	Bartlett Kernel Bandwidth	1% Critical Values	5% Critical Values
Real Investment	0.564	5	0.216	0.146
Real GDP	0.724	5	0.216	0.146
Real S&P 500	0.557	5	0.216	0.146
TBill Interest Rate	0.568	5	0.216	0.146

Panel B: Tests of Variables in First Differences

	DF–GLS (with trend)	# lags	1% Critical Values	5% Critical Values
Real Investment	-4.559	1	-3.468	-2.937
Real GDP	-6.576	1	-3.468	-2.937
Real S&P 500	-7.615	1	-3.468	-2.937
TBill Interest Rate	-7.944	2	-3.470	-2.938

	KPSS (with trend)	Bartlett Kernel Bandwidth	1% Critical Values	5% Critical Values
Real Investment	0.047	5	0.216	0.146
Real GDP	0.047	5	0.216	0.146
Real S&P 500	0.064	5	0.216	0.146
TBill Interest Rate	0.028	5	0.216	0.146

DF-GLS: Elliott, Rothenberg, and Stock (1996) GLS–corrected mean and trend, Dickey-Fuller test for the null hypothesis of a unit root. Number of lags selected using the Schwarz Information Criterion, with a maximum of 5 (integer part of cube root of the sample size).
KPSS: Kwiatkowski, et al (1992) test for the null hypothesis of stationarity against the alternative of a unit root.

Table 4
Johansen Tests for Cointegration Including Stock Prices
Quarterly Data: 1955 - 2003

Series: Real Investment, Real GDP, Real S&P 500, and TBill Interest Rate

Trace Test:

Hypothesized No. of CEs	Eigenvalue	Trace Statistic	0.05 Critical Value	P–value*
None	0.337	94.841	40.175	0.000
At most 1	0.056	15.039	24.276	0.452
At most 2	0.018	3.846	12.321	0.733
At most 3	0.002	0.316	4.130	0.636

Maximum Eigenvalue Test:

Hypothesized No. of CEs	Eigenvalue	Max–Eigen Statistic	0.05 Critical Value	P–value*
None	0.337	79.802	24.159	0.000
At most 1	0.056	11.193	17.797	0.368
At most 2	0.018	3.530	11.225	0.704
At most 3	0.002	0.316	4.130	0.636

Cointegrating Equation:

$$i_t - 0.372 y_t - 3.867 s_t - 85.710 r_t = 0$$

Both tests indicate one cointegrating equation at the 0.05 level.
*MacKinnon, Haug, and Michelis (1999) p–values
TBill interest rate is from the last business day of the preceding quarter.

Table 5
Estimation of Vector Error Correction Model with Stock Prices Endogenous
Quarterly Data: 1955–2003

	Dependent Variables:			
Independent Variables	Δi_t	Δy_t	Δs_t	Δr_t
CE	0.001 (1.341	-0.007 (-3.894)	0.000 (0.286)	0.000 (2.765)
Δi_{t-1}	0.128 (1.506)	0.255 (0.690)	-0.004 (-0.013)	0.022 (2.359)
Δi_{t-2}	0.212 (2.491)	0.482 (1.309)	0.524 (1.870)	0.005 (0.587)
Δi_{t-3}	0.058 (0.703)	-0.602 (-1.692)	0.172 (0.636)	0.003 (0.322)
Δi_{t-4}	-0.118 (-1.572)	-0.201 (-0.618)	-0.043 (-0.174)	-0.006 (-0.682)
Δy_{t-1}	0.062 (3.238)	0.102 (1.229)	0.072 (1.138)	0.004 (2.126)
Δy_{t-2}	0.037 (1.821)	0.135 (1.553)	-0.097 (-1.467)	0.003 (1.307)
Δy_{t-3}	0.027 (1.376)	0.017 (0.205)	-0.070 (-1.086)	0.000 (0.203)
Δy_{t-4}	0.003 (0.145)	0.181 (2.170)	0.081 (1.273)	-0.002 (-0.809)
Δs_{t-1}	0.126 (5.365)	0.219 (2.147)	-0.080 (-1.036)	-0.005 (-1.798)
Δs_{t-2}	0.101 (3.955)	0.343 (3.112)	0.074 (0.882)	-0.002 (-0.830)
Δs_{t-3}	0.032 (1.210)	0.093 (0.823)	-0.013 (-0.149)	-0.001 (-0.377)
Δs_{t-4}	-0.015 (-0.575)	-0.045 (-0.405)	0.054 (0.634)	-0.002 (-0.533)
Δr_{t-1}	-0.015 (-0.022)	-10.593 (-3.548)	-3.418 (-1.505)	-0.268 (-3.551)
Δr_{t-2}	0.588 (0.789)	-9.757 (-3.028)	-2.020 (-0.824)	-0.290 (-3.566)
Δr_{t-3}	0.645 (0.848)	-5.849 (-1.778)	-3.855 (-1.540)	0.199 (2.398)
Δr_{t-4}	-0.038 (-0.054)	-10.355 (-3.347)	-1.083 (-0.460)	-0.005 (-0.058)
Adj. R-squared	0.547	0.364	0.010	0.241

t-statistics in parentheses. CE is the residual of the cointegrating equation. i_t is real, private, nonresidential fixed investment. y_t is real GDP. s_t is the real S&P 500 index. r_t is the yield on a 90-day Treasury Bill, as of the last business day of the preceding quarter.

Table 6
Johansen Tests for Cointegration without Stock Prices
Quarterly Data: 1955 - 2003

Series: Real Investment, Real GDP, and TBill Interest Rate

Trace Test:

Hypothesized No. of CEs	Eigenvalue	Trace Statistic	0.05 Critical Value	P–value*
None	0.327	87.263	24.276	0.000
At most 1	0.051	10.372	12.321	0.104
At most 2	0.001	0.125	4.130	0.771

Maximum Eigenvalue Test:

Hypothesized No. of CEs	Eigenvalue	Max–Eigen Statistic	0.05 Critical Value	P–value*
None	0.327	76.891	17.797	0.000
At most 1	0.051	10.248	11.225	0.074
At most 2	0.001	0.125	4.130	0.771

Cointegrating Equation:

$$i_t - 0.744 y_t - 11.737 r_t = 0$$

Both tests indicate one cointegrating equation at the 0.05 level.
*MacKinnon, Haug, and Michelis (1999) p–values
TBill interest rate is from the last business day of the preceding quarter.

Table 7
Estimation of Vector Error Correction Model with Exogenous Stock Prices
Quarterly Data: 1955–2003

Dependent Variables:

Independent Variables	Δi_t	Δy_t	Δr_t
CE	0.000 (0.847)	-0.007 (-4.080)	0.000 (2.916)
Δi_{t-1}	0.144 (1.701)	0.220 (0.604)	0.023 (2.452)
Δi_{t-2}	0.220 (2.591)	0.458 (1.253)	0.006 (0.634)
Δi_{t-3}	0.058 (0.703)	-0.579 (-1.635)	0.002 (0.277)
Δi_{t-4}	-0.129 (-1.730)	-0.153 (-0.478)	-0.006 (-0.790)
Δy_{t-1}	0.058 (3.018)	0.095 (1.142)	0.005 (2.201)
Δy_{t-2}	0.033 (1.617)	0.131 (1.518)	0.003 (1.354)
Δy_{t-3}	0.024 (1.190)	0.012 (0.139)	0.001 (0.259)
Δy_{t-4}	0.000 (-0.003)	0.170 (2.034)	-0.001 (-0.705)
Δr_{t-1}	0.026 (0.038)	-9.901 (-3.292)	-0.281 (-3.689)
Δr_{t-2}	0.601 (0.801)	-9.151 (-2.836)	-0.301 (-3.692)
Δr_{t-3}	0.667 (0.871)	-5.327 (-1.618)	0.189 (2.277)
Δr_{t-4}	-0.075 (-0.105)	-10.041 (-3.263)	-0.010 (-0.130)
Δs_{t-1}	0.126 (5.318)	0.231 (2.277)	-0.005 (-1.888)
Δs_{t-2}	0.100 (3.905)	0.361 (3.287)	-0.003 (-0.950)
Δs_{t-3}	0.031 (1.178)	0.121 (1.068)	-0.002 (-0.553)
Δs_{t-4}	-0.015 (-0.571)	-0.022 (-0.197)	-0.002 (-0.681)
Adj. R-squared	0.544	0.369	0.245

t-statistics in parentheses. CE is the residual of the cointegrating equation. i_t is real, private, nonresidential fixed investment. y_t is real GDP. s_t is the real S&P 500 index. r_t is the yield on a 90-day Treasury Bill, as of the last business day of the preceding quarter.

Table 8A
Estimation of the Effects of Immediate Stock Price Adjustment on Investment and GDP

1970 Recession: Yield Curve Inverted From June, 1969 to December, 1969

Year: Quarter	Decrease in Investment	Decrease in GDP
1969:3	0	0
1969:4	8	14.7
1970:1	15.5	42.4
1970:2	20.3	56.3
1970:3	17.1	40.8
1970:4	12.8	17.9

1973 Recession: Yield Curve Inverted from March, 1973 to October 1974

Year: Quarter	Decrease in Investment	Decrease in GDP
1973:3	13.9	27.1
1973:4	29.1	78.5
1974:1	38.1	106.7
1974:2	41.0	94.2
1974:3	39.6	77
1974:4	30.0	46.9
1975:1	19.4	8.5
1975:2	10.6	-14.0

All numbers in billions of annualized dollars.

Table 8B
Estimation of the Effects of Immediate Stock Price Adjustment on Investment and GDP

1980–1982 Recession: Yield Curve Inverted from September, 1978 to April, 1980, and from October, 1980 to September, 1981

Year: Quarter	Decrease in Investment	Decrease in GDP
1979:1	2.0	2.8
1979:2	4.2	10.3
1979:3	5.8	15.7
1979:4	7.3	16.8
1980:1	7.8	17.1
1980:2	6.2	12.3
1980:3	4.2	3.5
1980:4	2.5	-1.6
1981:1	7.2	8.0
1981:2	11.9	28.1
1981:3	14.9	39.1
1981:4	14.0	31.8
1982:1	13.4	23.5
1982:2	11.1	16.3
1982:3	7.9	8.1
1982:4	4.7	-1.4

1990 Recession: Yield Curve Inverted from March, 1989 to October, 1989

Year: Quarter	Decrease in Investment	Decrease in GDP
1989:1	0	0
1989:2	0	0
1989:3	3.6	6.6
1989:4	10.3	25.0
1990:1	16.5	44.5
1990:2	19.2	49.1
1990:3	21.9	46.1
1990:4	18.1	36.0
1991:1	12.8	15
1991:2	7.6	-3.5

All numbers in billions of annualized dollars.

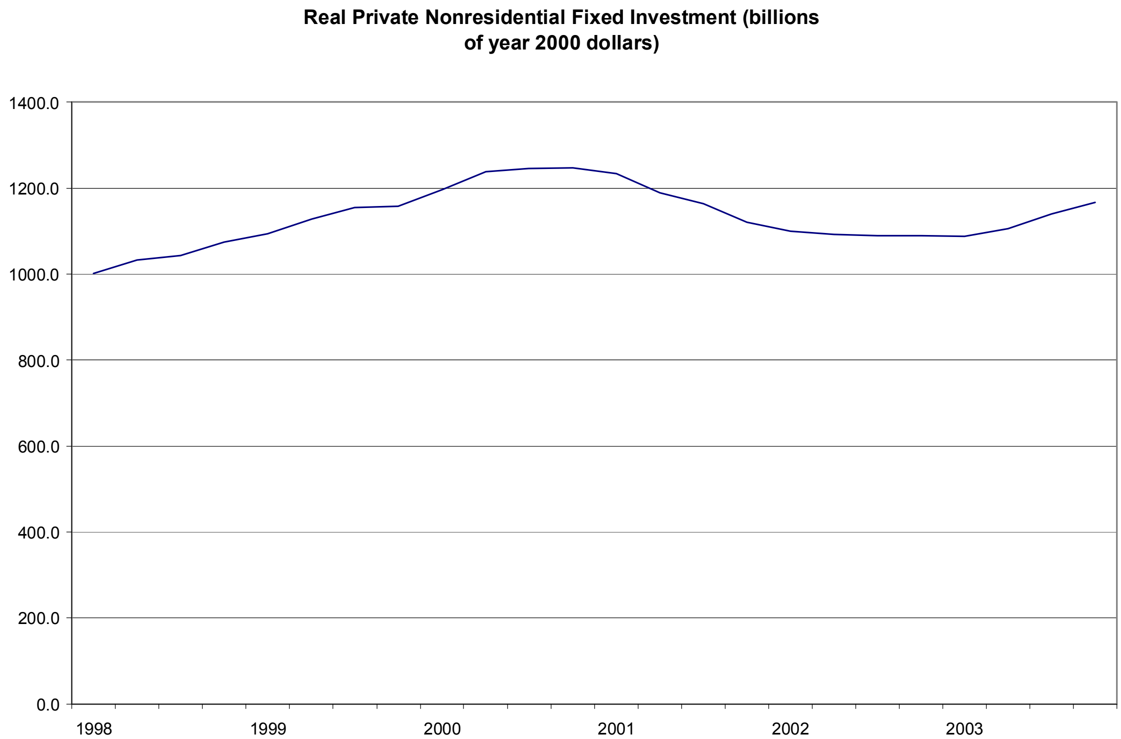
Table 8C
Estimation of the Effects of Immediate Stock Price Adjustment on Investment and GDP

2001 Recession: Yield Curve Inverted From August 2000 to December 2000

Year: Quarter	Decrease in Investment	Decrease in GDP
2000:1	0	0
2000:2	0	0
2000:3	0	0
2000:4	47.4	87.0
2001:1	88.3	244.5
2001:2	197.8	304.1
2001:3	118.6	255.3
2001:4	113.7	223.6
2002:1	111.0	182.8
2002:2	104.9	154.5
2002:3	89.6	131.4
2002:4	59.7	55.6

All numbers in billions of annualized dollars.

Figure 1



Real Private Nonresidential Fixed Investment (billions of year 2000 dollars)
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
1998
1999
2000
2001
2002
2003

Figure 2

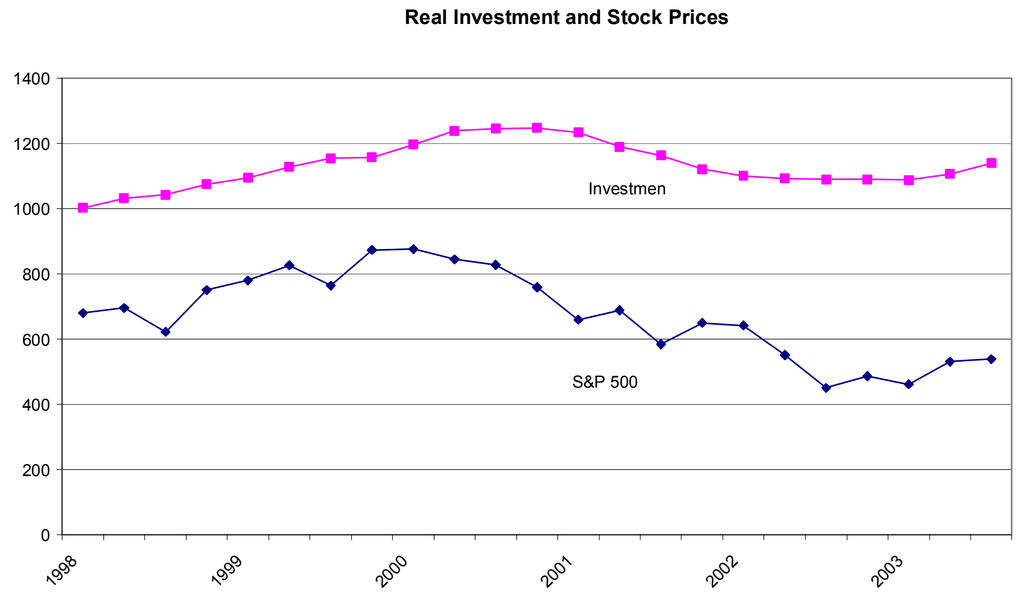

Real Investment and Stock Prices
1400
1200
1000
800
600
400
200
0
Investmen
S&P 500
1998
1999
2000
2001
2002
2003

Figure 3

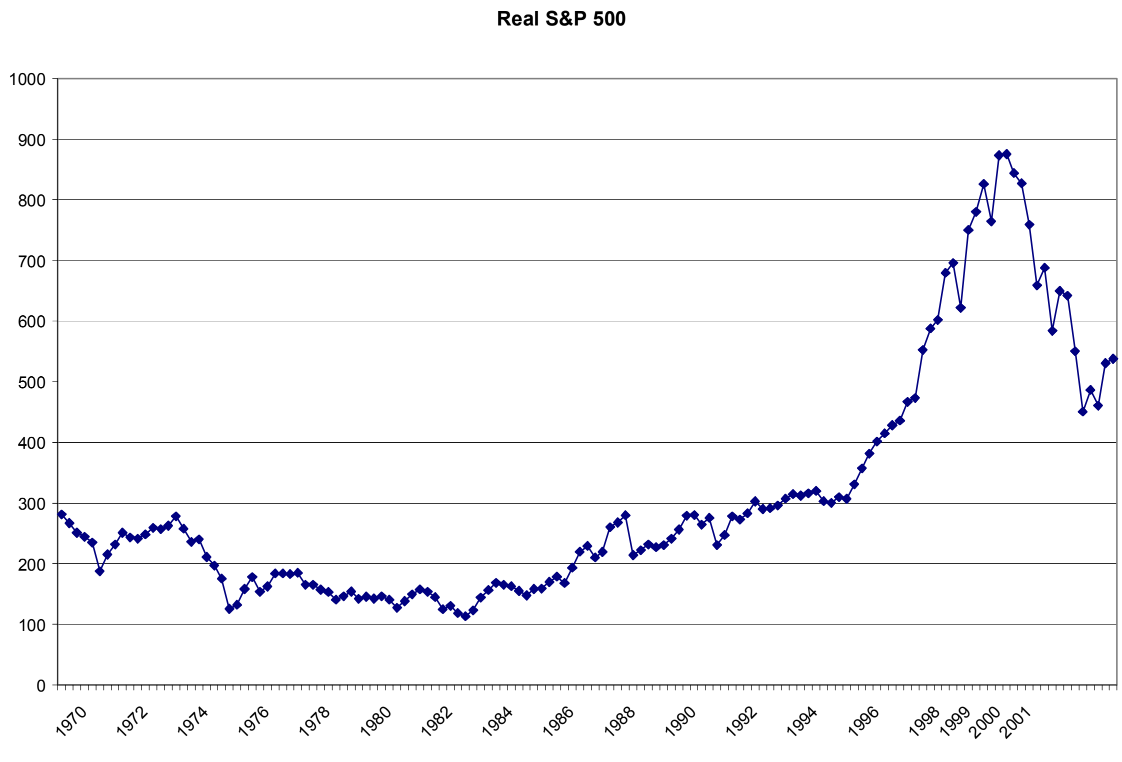

Real S&P 500
1000
900
800
700
600
500
400
300
200
100
0
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
1999
2000
2001

Figure 4

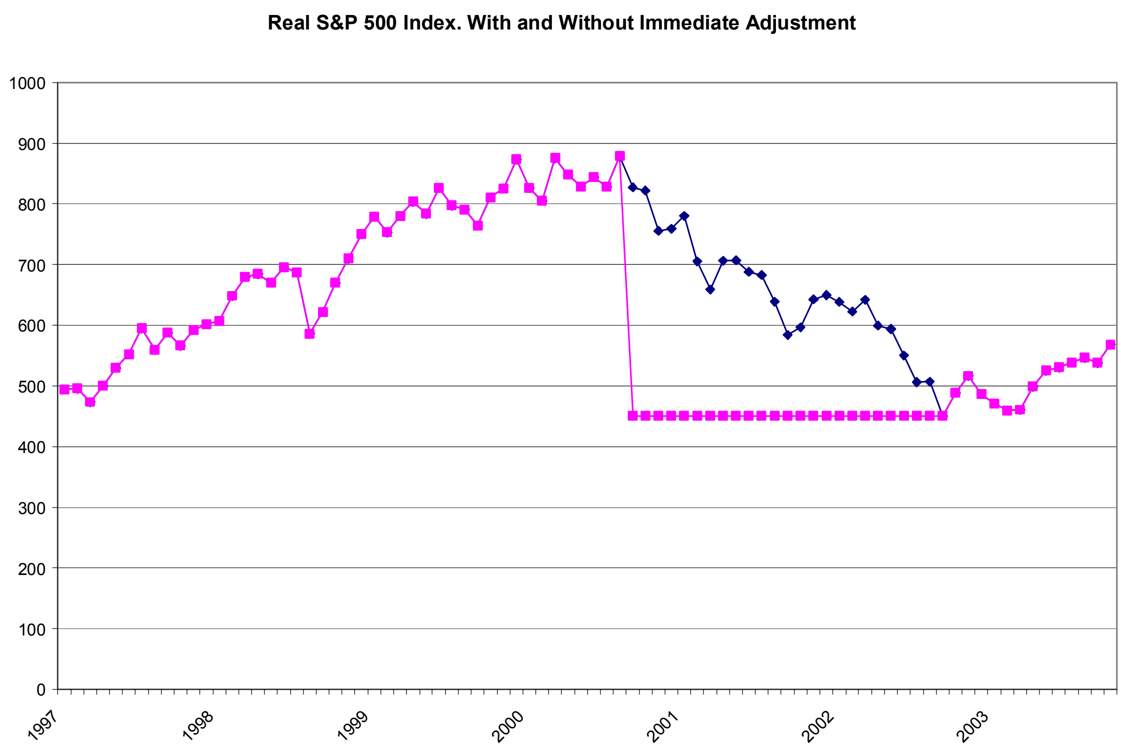

Real S&P 500 Index. With and Without Immediate Adjustment
1000
900
800
700
600
500
400
300
200
100
0
1997
1998
1999
2000
2001
2002
2003

Figure 5

Computed Effect of Immediate Adjustment on Investment

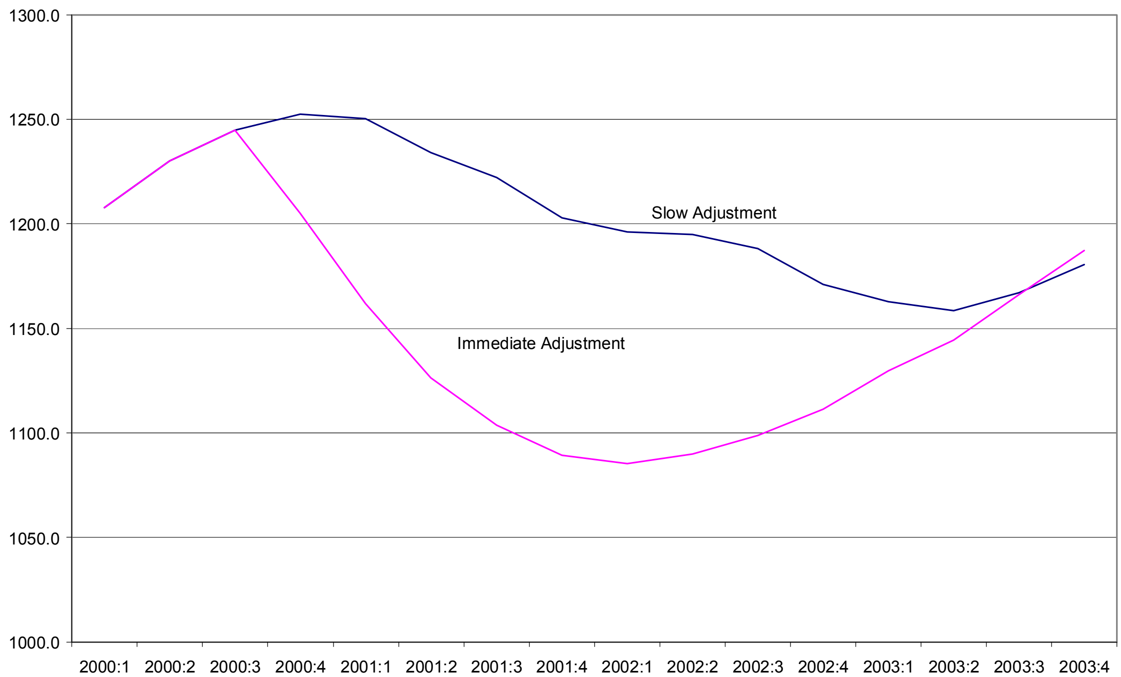
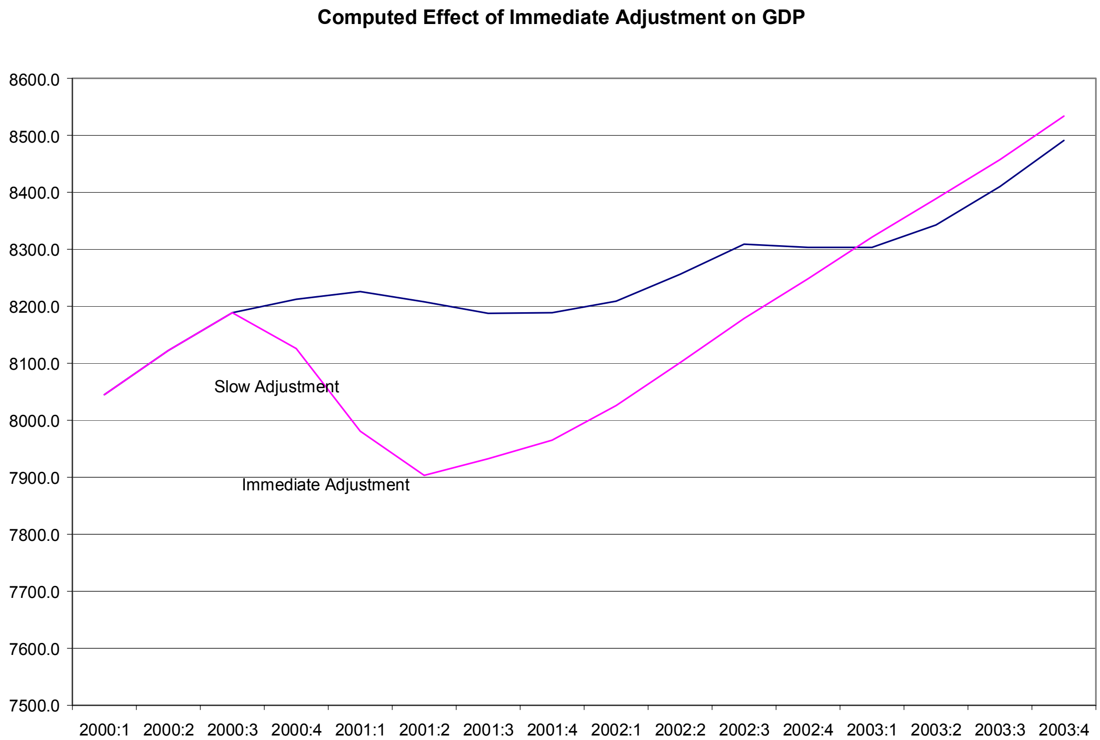


Figure 6


Computed Effect of Immediate Adjustment on GDP
8600.0
8500.0
8400.0
8300.0
8200.0
8100.0
8000.0
7900.0
7800.0
7700.0
7600.0
7500.0
Slow Adjustment
Immediate Adjustment
2000:1
2000:2
2000:3
2000:4
2001:1
2001:2
2001:3
2001:4
2002:1
2002:2
2002:3
2002:4
2003:1
2003:2
2003:3
2003:4

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