# Asset prices and monetary policy in Sweden

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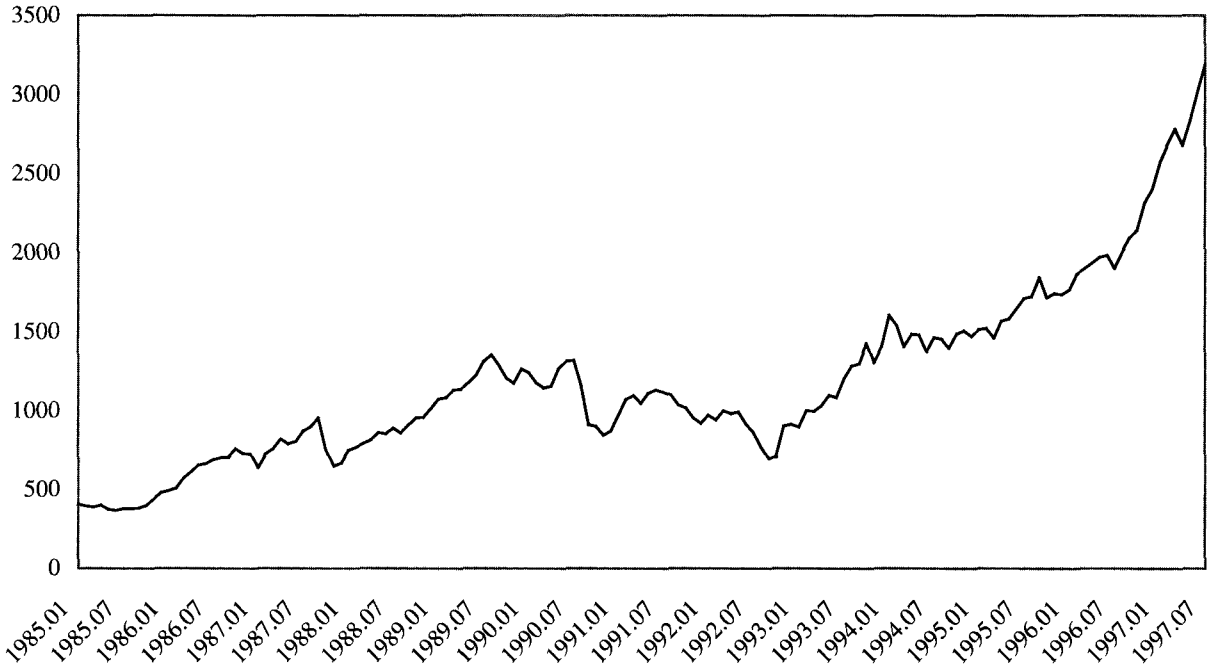
## Introduction

Up until 7th August 1997 the Swedish stock market had risen without a major correction since Sweden abandoned the fixed exchange rate system in November 1992. The recent correction has been around 8% as in most European stock markets. Figure 1 shows the Affärsvärlden's General Index (AFGX) for the period January 1985 to July 1997. During this period there have been three major setbacks. The first was in 1987 when the market fell by 32% in just two months. The second major reversal in stock prices came in 1990 when the market dropped by 36% between July and November. The third correction occurred in 1992 with a 30% decrease from May to September.

Figure 1

**AFGX monthly index 1985 to 1997**




Looking at this recent history it is only natural to wonder when (not if) the next major correction will occur. However, this may not be correct. It could be that the 1980's is an exceptional period and that today's stock prices actually reflect strong underlying fundamentals. We address this question in Section 1 by adopting a longer perspective to model the underlying fundamentals in a simple real asset-pricing framework. Substantial deviations from the fundamental price are found. However, it is recognised that the deviations from fundamentals could be related to monetary policy. In Section 2 we consider a model where monetary policy has real effects, and Section 3 investigates whether various policy actions by Sveriges Riksbank have had any impact on the stock market.

## 1. Do equity prices reflect fundamental values?[1]

We use a simple exchange economy of the Lucas (1978) type with a representative agent with constant relative risk aversion utility. Assuming a (real) dividend process of the form

$$D_{t+1} = D_t e^{\alpha+\varepsilon_{t+1}} \tag{1}$$

where $\alpha > 0$ and $\varepsilon_t \approx N(0,\sigma^2)$, this model can be shown to have as solution the following fundamental price,

$$P_t^* = \rho D_t \tag{2}$$

where $\rho$ is a constant (and a function of parameters of the dividend process and the utility function). Hence, we get a very convenient solution, with the fundamental price as linear function of today's dividend.

We use an annual index of Swedish stock returns constructed by Frennberg and Hansson (1992a, 1992b) and later updated. This is a value-weighted index that includes dividends. It is constructed along the same principles as in the standard work by Ibbotson and Sinquefield (1989) and spans the period from 1919 to 1996. A dividend series and an index of consumer prices, which are also part of the Frennberg-Hansson data set, were also used, with the latter applied to compute real returns and real dividends.

Using the average price-dividend ratio for the whole sample as a proxy for $\rho$ we can derive a fundamental price series. This series is plotted along with the actual price series in Figure 2. The corresponding series in real terms are shown in Figure 3. Three distinct subperiods can be distinguished. Up until a few years after the second world war the actual price was consistently below the fundamental price. In the post-war period up until the early 1980s the actual price fluctuated around the fundamental. In the 1980s and 1990s the actual price has been above the fundamental price. There have been three partial collapses of the price bubble during this latter period. The third of these almost brought the price back to its fundamental value. During 1992-93 the two price series drastically part company when the fundamental price drops significantly while the actual price rises. During the two previous episodes, when the fundamental price dropped dramatically in the early 1920s and early 1930s, the actual price followed the fundamental. This was not the case in 1992-93. The explanation for this is the following. Between the summers of 1990 and 1993, GDP dropped by a total of 6%, dealing a heavy blow to Swedish companies' earnings and to the fundamental price.

During the currency turmoil in the autumn of 1992, Sweden had to abandon the fixed exchange rate on 19th November. This resulted in an immediate de facto devaluation of 12% against the dollar.[2] This was, of course, expected to lead to an improved competitive situation for the export-oriented Swedish manufacturing industry. This is one reason for the rising equity prices after November 1992. Another reason is that Sveriges Riksbank started lowering interest rates. A third reason is the abandonment of restrictions on foreign ownership of Swedish equity on 1st January 1993.[3]

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[1] This section draws on Nydahl and Sellin (1997). See also Sellin (1997a) for a similar analysis of the US stock market.

[2] Close on 20th November compared to close on 19th November.

[3] See Sellin (1996) on the effects of lifting these exchange controls.

Figure 2

**Actual and fundamental equity prices**

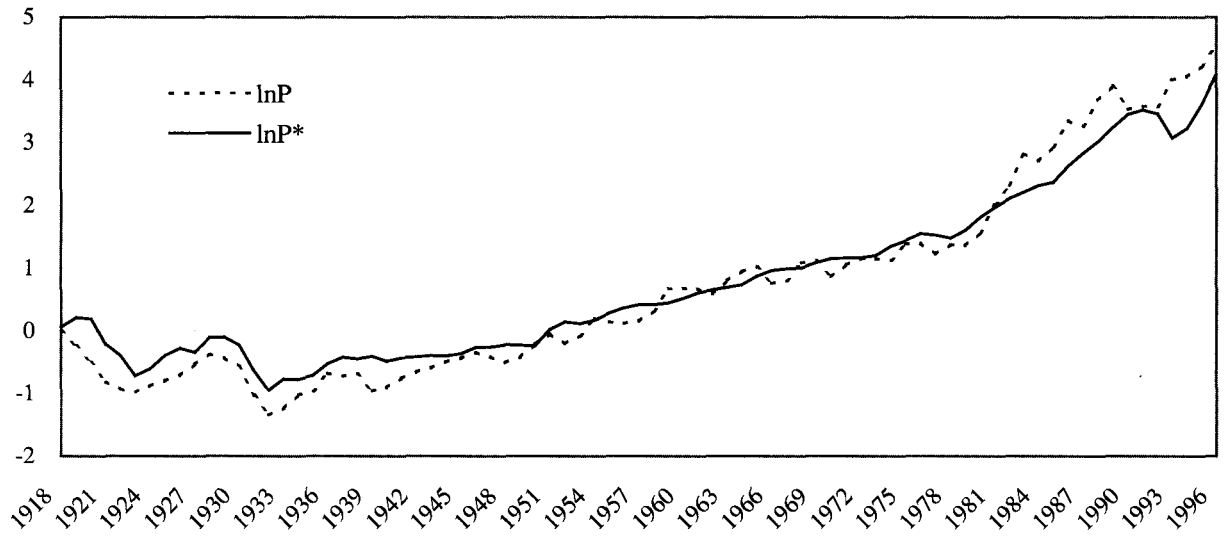
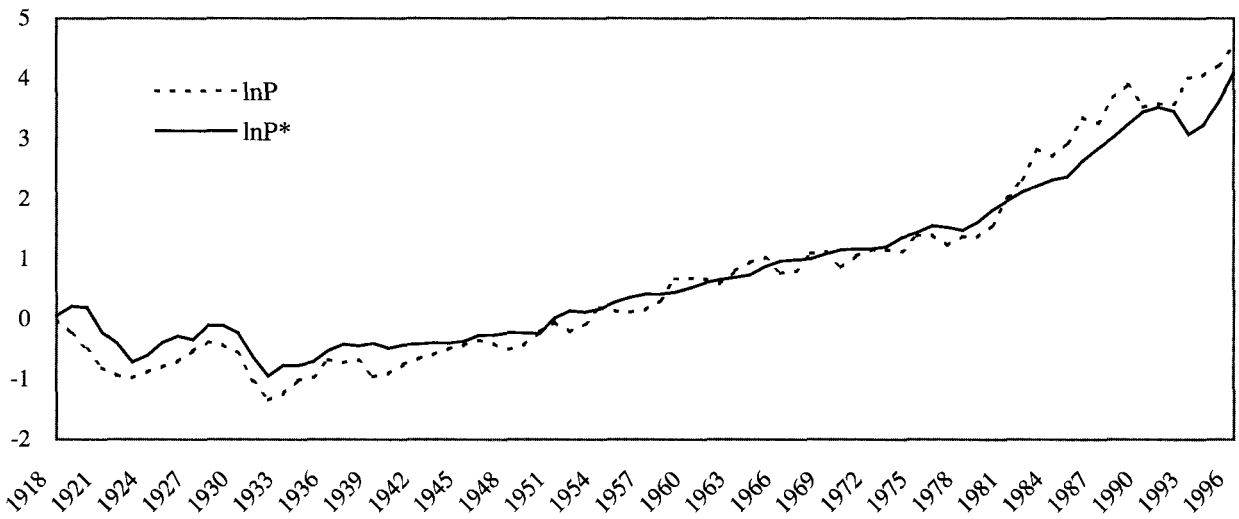



Figure 3

**Real actual and fundamental equity prices**




Towards the end of the sample period there is a strong rebound in the fundamental price but not a closing of the gap, since the actual price also rises quite significantly during this period. However, it looks as if the fundamentals are on their way to catching up with the expectations driving the actual price.

It seems unlikely that the stock market has been undervalued from 1919 to 1945. It is more likely that we have overestimated the fundamental price up until 1945. The gap at the very end

of the sample could likewise be due to the fundamental price being underestimated. A higher growth rate or variance in the dividend process would imply a higher ρ and thereby a higher fundamental price. Our model uses the same ρ for the whole sample period. These issues are discussed more fully in Nydahl and Sellin (1997), where the model is also estimated. In that paper, to formally test for the existence of bubbles we adapt a switching regime approach suggested by van Norden and Schaller (1994). The results are somewhat mixed and most of the testable implications from our theoretical model fail to find significant support in the data. There is some evidence of a bubble in equity prices in the 1980s. From Figure 2 it looks as if the bubble economy has continued into the 1990s. However, in a model where monetary policy has real effects a different interpretation could be given to the deviations from the "fundamental price". We examine this possibility in the next section.

## 2. Nominal asset pricing models[4]

Introducing money into a general equilibrium asset-pricing model is not a trivial undertaking. We will follow Lucas (1980, 1982) and require that the agent has to meet a cash-in-advance constraint for purchasing the consumption good.

The model is set up in the following way. The representative agent enters a period with money and equity shares carried over from the previous period. He receives a helicopter drop of money and the securities market opens for trading. The security market closes and the goods market opens for trading. Goods must be bought with money (currency). The goods market closes and the agent collects dividends in the form of currency, which is carried into the next period.

The agent's problem is to choose consumption, $c$, money holdings, $M$, and equity shares, $z$, given the price of the good, $p$, and the real price of equity, $q$, so as to maximise:

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t)$$

subject to a budget constraint,

$$\frac{M_t}{p_t} + q_t z_t \leq \left( q_t + y_{t-1} \frac{p_{t-1}}{p_t} \right) z_{t-1} + \frac{M_{t-1} - p_{t-1} c_{t-1}}{p_t} + \frac{M^s_{t+1} - M^s_t}{p_t}, \qquad t \geq 0,$$

and a cash-in-advance constraint,

$$M_t \geq p_t c_t \qquad t \geq 0.$$

The restrictions will be binding at the optimum solution. In equilibrium we also require that for every $t \geq 0$:

$$c_t = y_t, \; z_t = 1, \text{ and } M_t = M^s_{t+1}.$$

Using the binding cash-in-advance constraint and substituting it and the equilibrium conditions into the binding budget constraint, we can derive a theoretically determined price level:

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4 This section draws on Sellin (1997b).

$p_t = M^s_{t+1}/y_t$ .

Substituting this price level and the equilibrium condition for consumption into the Euler equation for the equity price, we end up with the equilibrium price of equity:

$$q_t = \beta E_t\left[\frac{u'(y_{t+1})}{u'(y_t)}(q_{t+1} + y_{t+1}/\mu_{t+1})\right],$$

where $\mu_t = M^s_{t+1}/M^s_t$ is the growth rate of money. Assuming that the money supply process is independent of the endowment process, we get

$$q_t = \beta E_t\left[\frac{u'(y_{t+1})}{u'(y_t)}q_{t+1}\right] + \beta E_t\left[\frac{u'(y_{t+1})}{u'(y_t)}y_{t+1}\right]E_t\left[\frac{1}{\mu_{t+1}}\right].$$

From this equation it is clear that the effect of increased expectations of a (temporary) monetary tightening will have a positive effect on the real equity price,

$$\frac{\partial q}{\partial E_t\left[1/\mu_{t+1}\right]} > 0.$$

A monetary tightening is expected to lead to lower inflation and a higher purchasing power of the dividend sum carried over to the next period.

Boyle (1990) gets the opposite result to the one derived above, for an agent with low constant relative risk aversion.[5] For an agent with higher risk aversion the effect is ambiguous in Boyle's model. He uses a money-in-the-utility-function model with variable velocity of money. Marshall (1992) derives a similar result in a model where money economises on transactions costs. The intuition is the same in the two models. Expectations of monetary easing leads the agent to substitute out of money and into equities, thus raising the real price of equity. Hence, whether expectations of a monetary tightening/easing has a positive or negative effect on real equity prices is an empirical question. We turn to this in the next section.

## 3. The impact of Swedish monetary policy on the stock market

There have been a number of studies of the impact of monetary policy on asset prices. Most of these look at the ability of monetary policy to influence money market interest rates.[6] The earlier literature is reviewed in Reichenstein (1987). More recent studies have been made using US data (Cook and Hahn (1989), Tarhan (1995)), UK data (Dale(1993)), and data for the G10 countries (BIS (1997)). However, there are few studies that have considered the impact of monetary policy on equity prices. Tarhan (1995) considers the impact of Federal Reserve open market operations on financial assets other than interest rates (in a study mainly focusing on interest rates). He finds no evidence that the Fed influences stock prices. Thorbecke (1997), on the other hand, finds a significant negative effect on the percentage change in the Dow Jones Industrial Average from policy-induced

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5 A CRRA parameter of less than one.

6 For the Swedish case see Lindberg, Mitlid and Sellin (1997).

changes in the federal funds rate. The different choice of policy instrument in these two studies follow naturally from the choice of sample period.[7]

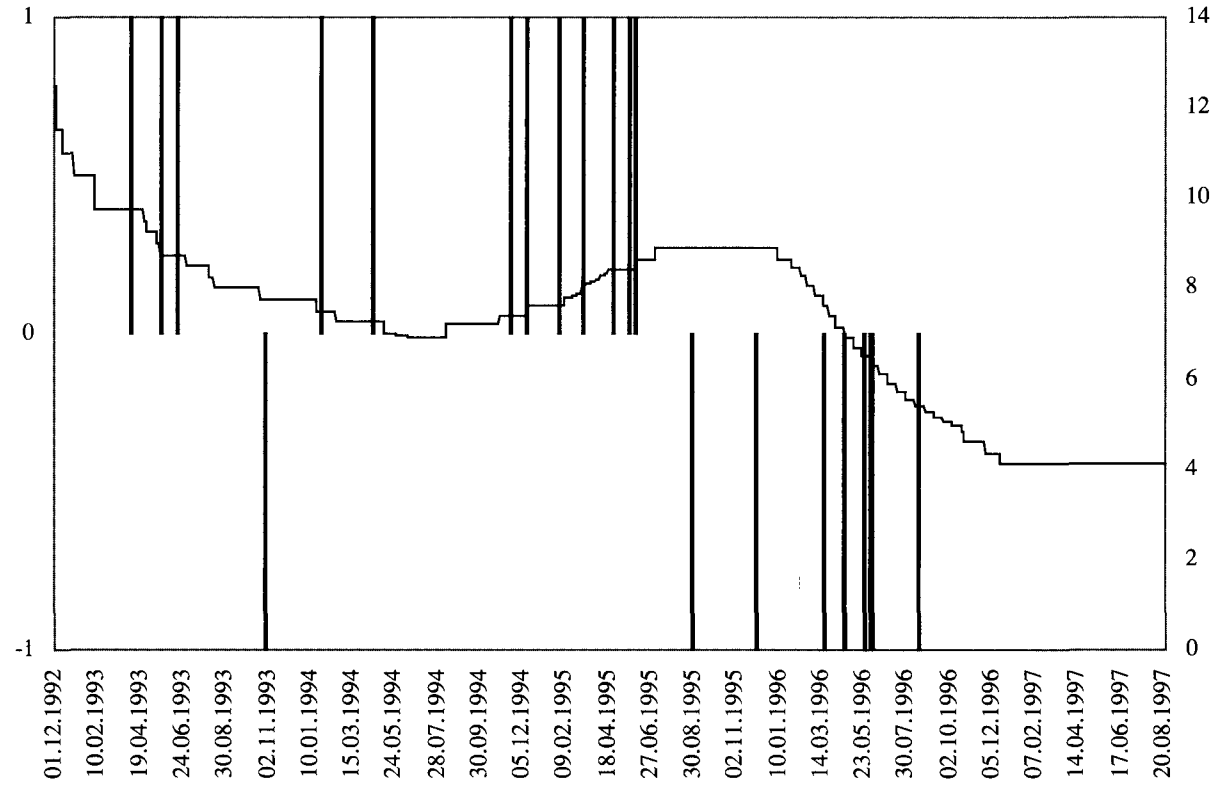
In this section we will focus on the impact of the Sveriges Riksbank policy instruments on the stock market. We will consider a wider set of instruments than have been used in any previous study. We start with a description of these instruments.

The Swedish system for the practical management of monetary policy was introduced in June 1994. It provides one deposit and one lending facility. The deposit and lending rate are set by the Governing Board of the Riksbank and form a corridor within which the repo rate – the Riksbank's primary instrumental rate – is set by the Governor in accordance with monetary policy guidelines established by the Governing Board. The interest rate corridor provides the Riksbank with a tool for signalling its long-term intentions concerning the repo rate.

The repo rate is the rate at which, as a means of managing the liquidity of the banking system, securities with a maturity of one week are bought or sold by the Riksbank under a repurchase agreement. The repo rate may be interpreted as the Riksbank's target for the level of the overnight rate in the interbank market. Repos or reversed repos are placed by tender every Tuesday. Repos are normally offered at a fixed rate, leaving the Riksbank's counterparties to tender the volumes they are interested in depositing or borrowing for one week at that rate.

Figure 4

**Speeches and the repo rate**



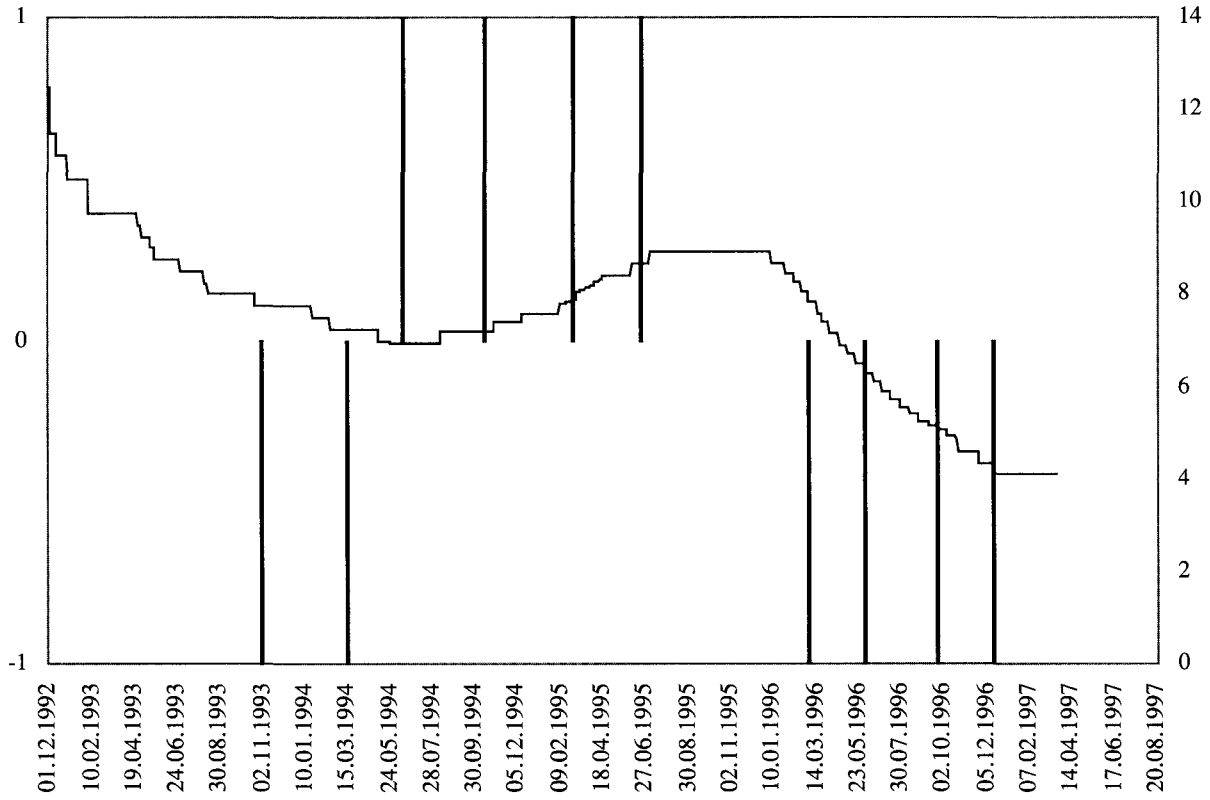

[7] Tarhan studies the period 2nd October 1979 to 31st December 1984 when the growth rate of money was the target. Thorbecke focuses attention on periods when the federal funds rate was targeted. He uses Cook and Hahn's (1989) 1974-79 fed funds data and adds a similarly constructed series for the period 11th August 1987 to 31st December 1994.

The Riksbank's intention has been to be transparent in its monetary policy considerations since the explicit inflation target was introduced in January 1993. There are various ways in which a central bank can influence expectations about monetary policy. The traditional channel of information is speeches and lectures by the Governor and staff of the Riksbank. The Riksbank also issues an inflation report four times a year to present its assessment of future inflation and the implications for monetary policy to the financial markets and to the public. In this way, the markets get an indication of the Riksbank's intentions and changes in monetary policy will not come as a surprise.

We will be looking at any potential impact on the stock market from any of these monetary policy instruments. In order to assess effects from inflation reports and speeches by the governor and deputy governors of the Riksbank, these have been coded 1(-1) if the report/speech was interpreted (by the author) as foreboding monetary tightening (easing) and the value zero if the report/speech was neutral. These dummy variables are shown along with the repo rate in Figures 4-5.[8] During the first phase of monetary easing the speeches seem to have served mostly as warnings that the lowering of the repo rate may not proceed at the pace expected by the market. During the next two phases the speeches seem to have served rather to prepare the market for coming repo rate changes. The inflation reports in Figure 5 have also been in line with subsequent changes in the repo rate.

Figure 5

**Inflation reports and the repo rate**




When investigating whether monetary policy has an impact on the stock market, it may be interesting to consider the impact on both returns and volatility. We can do this simultaneously by

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[8] The dates for the inflation reports and for announcing changes in the repo and lending rates can be found in the Appendix.

using a model of the ARCH family (see Engle, Chou and Kroner (1992) for an overview of these types of models). Not only the conditional mean but also the conditional variance, $h_t$, is modelled. The latter is modelled as a function of lagged squared residuals, $u^2_{t-1}$. It is also possible to include exogenous or predetermined variables in both the mean and variance equations. We will include our policy variables in the mean equation and the absolute values of the policy variables in the variance equation.

Table 1

**Policy impact on stock and bond markets**

| **Variable** | $R_t^{AFGX}$ | | $\Delta r_t^{SE}$ | |
|---|---|---|---|---|
| Mean equation intercept | 0.081 | (3.198) | -0.006 | (2.557) |
| Dependent variable ($t$-1) | 0.020 | (0.731) | 0.058 | (1.791) |
| Dependent variable ($t$-5) | | | -0.099 | (3.469) |
| $R_{t-1}^{SP500}$ | 0.420 | (11.500) | | |
| $\Delta r_{t-1}^{GE}$ | | | 0.091 | (1.885) |
| $\Delta REPO_t$ | -1.195 | (2.226) | 0.081 | (2.209) |
| $\Delta REPO_{t-1}$ | | | 0.072 | (1.471) |
| $\Delta LEND_t$ | 0.197 | (0.553) | 0.055 | (1.322) |
| $SPEECH_t$ | 0.081 | (0.533) | 0.018 | (1.143) |
| $REPORT_t$ | -0.340 | (1.118) | -0.010 | (0.328) |
| Variance equation intercept | 0.042 | (2.448) | 0.001 | (4.948) |
| $u_{t-1}^2$ | 0.055 | (2.485) | 0.201 | (7.909) |
| $h_{t-1}$ | 0.890 | (23.270) | 0.700 | (22.220) |
| $\lvert\Delta REPO_t\rvert$ | 0.569 | (1.668) | 0.002 | (0.457) |
| $\lvert\Delta LEND_t\rvert$ | -0.385 | (1.744) | 0.010 | (1.804) |
| $\lvert SPEECH_t\rvert$ | -0.216 | (2.979) | 0.002 | (1.273) |
| $\lvert REPORT_t\rvert$ | 0.177 | (0.918) | 0.001 | (0.516) |
| Ljung-Box Q(10) | 11.719 | [0.3043] | 9.744 | [0.4632] |
| Ljung-Box Q*(10) | 4.618 | [0.9152] | 9.388 | [0.4958] |
| Bera-Jarque | 0.477 | [0.7877] | 164.5 | [0.0000] |

Notes: t-values are reported within parentheses and probability values within square brackets. The variable *REPORT/SPEECH* is a dummy variable that takes the value 1 (-1) if the inflation report/speech was interpreted (by the author) as foreboding monetary tightening (easing) and the value 0 if the report/speech was neutral. Ljung-Box tests for autocorrelation in the standardised residuals Q and the squared standardised residuals Q* respectively. Bera-Jarque tests the assumption that the standardised residuals are normally distributed.

In Table 1 we report the results from estimating a GARCH(1,1) model for the daily return on the AFGX equity index, $R_t^{AFGX}$. As a comparison, the same type of model has also been estimated for the change in the five-year government bond yield, $\Delta r_t^{SE}$. The foreign influence has been considered by including the lagged return on the S&P 500 index in the AFGX model and the change in the German five-year government bond yield in the interest rate model. Both foreign influences are

positive and significant as expected.[9] The Bera-Jarque statistic warns us that the standardised residuals from the interest rate model are not normally distributed so we have to be a bit careful with drawing strong conclusions with regard to the inference from this model.

We consider the effect on the conditional mean first. A change in the repo rate has the expected negative effect on equity returns and positive effect on the interest rate. There is no evidence of a lagged effect of the repo rate on stock returns, which is why the model was re-estimated without the lagged repo variable. The lending rate and speeches have the wrong sign in the AFGX model but are not statistically significant. The inflation report has the right sign but is not significant either.

Turning to the conditional variance, the GARCH parameters are highly significant and volatility displays the high persistence, usually found in daily data (the sum of the parameters is close to one). As expected, there is a positive effect on volatility from the announcement of a change in the repo rate (significant at the 10% level). There is a significant *negative* effect from changes in the lending rate and from speeches, while the inflation report has no effect. One way to interpret these results is that both changes in the lending rate and speeches by the governor and deputy governors remove uncertainty about the future path of monetary policy, which results in lower volatility in the market. This interpretation, of course, begs the question as to why the effect on volatility is not the same in the bond as in the stock market, though, as far as the speeches are concerned, only the effect on stock market volatility is significant (1% level).

## Conclusions

The Swedish stock market has risen in value with no major correction since November 1992. Our question is if we should expect to see a major decline in the near future and whether prices still reflect fundamental values? In this paper, a measure of fundamental value was computed from a simple asset-pricing model and compared with the actual prices. The actual price since 1992 has been above the fundamental; but there has also been a strong increase in the fundamentals in the past few years and the gap could be closing.

A follow-up question is if the central bank can influence the stock market. The impact on the stock market from changes in the monetary policy instruments of Sveriges Riksbank was examined. It was found that Sveriges Riksbank indeed influences the level of equity prices as well as the volatility in the market. Whether it is desirable use these instruments to cool off the stock market, in view of the uncertainty regarding the difference between fundamental and actual values, is a different question.

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[9] For an analysis of US and German interest rate and volatility transmission to the Swedish money and bond markets see Dahlquist, Hördahl and Sellin (1997).

## Appendix: Changes in policy instruments, December 1992 to August 1997

| No. | Announcement Date | Repo rate | Repo rate change | Lending rate change | Inflation report code |
|---|---|---|---|---|---|
| 1 | 1992-12-03 | 11.50 | -1.00 | | |
| 2 | 1992-12-14 | 11.00 | -0.50 | | |
| 3 | 1992-01-05 | 10.50 | -0.50 | | |
| 4 | 1993-02-05 | 9.75 | -0.75 | | |
| 5 | 1993-04-23 | 9.50 | -0.25 | | |
| 6 | 1993-04-29 | 9.25 | -0.25 | | |
| 7 | 1993-05-13 | 9.00 | -0.25 | | |
| 8 | 1993-05-19 | 8.75 | -0.25 | | |
| 9 | 1993-07-01 | 8.50 | -0.25 | | |
| 10 | 1993-08-05 | 8.25 | -0.25 | | |
| 11 | 1993-08-12 | 8.00 | -0.25 | | |
| 12 | 1993-10-21 | 7.75 | -0.25 | | |
| 13 | 1993-10-29 | | | | -1 |
| 14 | 1994-01-20 | 7.50 | -0.25 | | |
| 15 | 1994-02-17 | 7.25 | -0.25 | | |
| 16 | 1994-03-14 | | | | -1 |
| 17 | 1994-05-05 | 7.00 | -0.25 | | |
| 18 | 1994-05-26 | 6.95 | -0.05 | | |
| 19 | 1994-06-14 | 6.92 | -0.03 | | 0 |
| 20 | 1994-08-11 | 7.20 | 0.28 | 0.50 | |
| 21 | 1994-10-18 | | | | 1 |
| 22 | 1994-11-01 | 7.40 | 0.20 | | |
| 23 | 1994-12-13 | 7.60 | 0.20 | | |
| 24 | 1995-02-09 | 7.80 | 0.20 | 0.50 | |
| 25 | 1995-02-21 | 7.83 | 0.03 | | |
| 26 | 1995-02-28 | 7.90 | 0.07 | | 1 |
| 27 | 1995-03-07 | 8.05 | 0.15 | | |
| 28 | 1995-03-14 | 8.10 | 0.05 | | |
| 29 | 1995-03-21 | 8.15 | 0.05 | | |
| 30 | 1995-03-28 | 8.20 | 0.05 | | |
| 31 | 1995-04-04 | 8.27 | 0.07 | | |
| 32 | 1995-04-11 | 8.34 | 0.07 | | |
| 33 | 1995-04-12 | | | 0.50 | |
| 34 | 1995-04-18 | 8.41 | 0.07 | | |
| 35 | 1995-06-06 | 8.66 | 0.25 | | |
| 36 | 1995-06-20 | | | | 1 |
| 37 | 1995-06-29 | | | 0.50 | |
| 38 | 1995-07-04 | 8.91 | 0.25 | | |
| 39 | 1995-11-16 | | | | 0 |
| 40 | 1996-01-09 | 8.66 | -0.25 | | |
| 41 | 1996-01-30 | 8.45 | -0.21 | | |
| 42 | 1996-02-13 | 8.30 | -0.15 | | |
| 43 | 1996-02-22 | 8.05 | -0.25 | -0.50 | |
| 44 | 1996-03-04 | | | | -1 |
| 45 | 1996-03-05 | 7.85 | -0.20 | | |
| 46 | 1996-03-19 | 7.60 | -0.25 | | |
| 47 | 1996-03-21 | | | -0.75 | |
| 48 | 1996-03-26 | 7.40 | -0.20 | | |
| 49 | 1996-04-09 | 7.15 | -0.25 | | |

| No. | Announcement Date | Repo rate | Repo rate change | Lending rate change | Inflation report code |
|---|---|---|---|---|---|
| 50 | 1996-04-23 | 6.90 | -0.25 | | |
| 51 | 1996-04-25 | | | -0.75 | |
| 52 | 1996-05-07 | 6.70 | -0.20 | | |
| 53 | 1996-05-21 | 6.50 | -0.20 | | |
| 54 | 1996-06-04 | 6.30 | -0.20 | | |
| 55 | 1996-06-05 | | | | -1 |
| 56 | 1996-06-18 | 6.10 | -0.20 | | |
| 57 | 1996-06-20 | | | -0.75 | |
| 58 | 1996-07-02 | 5.90 | -0.20 | | |
| 59 | 1996-07-16 | 5.70 | -0.20 | | |
| 60 | 1996-07-30 | 5.55 | -0.15 | | |
| 61 | 1996-08-13 | 5.40 | -0.15 | | |
| 62 | 1996-08-15 | | | -0.50 | |
| 63 | 1996-08-27 | 5.25 | -0.15 | | |
| 64 | 1996-09-10 | 5.15 | -0.10 | | |
| 65 | 1996-09-24 | 5.05 | -0.10 | | -1 |
| 66 | 1996-10-08 | 4.95 | -0.10 | | |
| 67 | 1996-10-22 | 4.85 | -0.10 | | |
| 68 | 1996-10-24 | 4.60 | -0.25 | -0.50 | |
| 69 | 1996-11-26 | 4.35 | -0.25 | | |
| 70 | 1996-12-05 | | | -0.50 | |
| 71 | 1996-12-17 | | | | -1 |
| 72 | 1996-12-18 | 4.10 | -0.25 | | |
| 73 | 1997-03-20 | | | | 0 |
| 74 | 1997-06-05 | | | | 0 |

Notes: The change in the deposit rate has been the same as for the lending rate except on two occasions. On 11th August 1994 the deposit rate was not changed and on 12th April 1995 it was raised by twice as much. The inflation report code takes the value 1 (-1) if the report was interpreted (by the author) as foreboding monetary tightening (easing) and the value zero if the report was neutral. The same procedure was used in coding the speeches by the governor and deputy governors of Sveriges Riksbank (not reported here).

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