Dynamic and Asymmetric Impacts of Macroeconomic Fundamentals on an Integrated Stock Market*

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Abstract

A large body of evidence indicates that macroeconomic and financial variables are dynamically interrelated. In an international setup, we analyze the transmission mechanisms of macroeconomic shocks on the stock market of a small open economy in an increasingly integrated world. We use a time-varying VECM model that allows analysis of asymmetric impacts that depend on the state of the business cycle. A special focus is directed on monetary policy surprises, where we find that foreign shocks exert a strong influence on an integrated stock market, and that the stage of the business cycle heavily affects the signals of the shocks.

JEL codes: E32, E44, F36, G15
Keywords: International transmission of economic shocks, stock market responses, VECM, asymmetric effects, Markov switching.

1 Introduction

The causal dynamics between real activity, inflation and asset returns have become the subject of intensive research by financial economists to explain asset prices (see, e.g., Fama, 1990, Lee, 1992) whereas macroeconomists have made considerable progress on this issue by using new approaches, especially to study the real effects of monetary policy (see, e.g., Sims, 1992, Bernanke and Blinder, 1992). Economists have long understood that asset markets are heavily influenced by fundamentals, but only in recent years have they attempted to reconcile the different views of financial economists and macroeconomists.

The impact of output and inflation shocks on the stock market has been the focus of research for many years. While the impact of an output shock on stock returns seems to be well explained, the reason for the negative relation between inflation and stock returns has never been conclusively discussed. More recently however, the work of researchers has shifted to analyzing the role of

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monetary policy shocks in the process of asset pricing. As stock prices represent claims to expected future cash flows, Thorbecke (1997) interprets the significant effects on stocks as an indication of real effects of monetary policy. Patelis (1997) shows that money supply shocks affect equity prices primarily affected via the risk premium.

However, empirical evidence about the impact of macroeconomic surprises on the stock market is not conclusive because different models produce conflicting results. While there seems to be agreement about the negative reaction of stock prices to inflation shocks, the expected positive reaction to output shocks has never been robustly reported. With respect to monetary shocks, no general pattern in the response of stock markets has been observed. One obvious reason may be the use of different monetary policy measures, a heavily debated issue in the literature (see, e.g., Strongin, 1995, Bernanke and Mihov, 1998). We believe that the existing literature in this field neglects at least two other important issues: asymmetric dynamics, and international economic and financial integration. This study addresses all three issues.

The literature provides enough evidence that standard methods may yield erroneous results due to the omission of asymmetric dynamics in the relationships. Cover (1992) argues that real activity responds only to negative money supply shocks because of the downward rigidity of nominal wages. Ravn and Sola (1997) find size asymmetry of monetary shocks due to relatively large menu costs for firms to adjust prices in response to moderate shocks and Garcia and Schaller (2002) argue that macroeconomic reactions to monetary policy vary with the state of the economy. This type of asymmetry relies on two theoretical arguments. First, a number of authors (see, e.g., Kiyotaki and Moore, 1997) show the existence of credit and liquidity constraints in recessions. Second, Ball and Mankiw (1994), analyze price adjustment rules which lead to a convex aggregate supply curve. Both arguments imply that monetary policy will have stronger real effects in recessions than in expansions.

Vector autoregression (VAR) models are widely used to analyze the relationship between macroeconomic and financial variables. However, most studies consider economies in isolation of the world and neglect the effect of growing integration of markets (see, e.g., Lee, 1992, Thorbecke, 1997), or they use an international model with exclusively large countries (Canova and De Nicoló, 2000) in which, not surprisingly, the signal-to-noise ratios for international shock transmission are small. Surprisingly, the VAR literature in this field lacks studies of small open economies even though the international finance literature suggests that this is where one should look (see, e.g., Baxter and Crucini, 1995). In addition, it ignores theoretical cointegrating relationships advocated by King et al. (1991).

This paper analyzes and explains time-varying dynamic linkages between domestic and foreign macroeconomic conditions, economic policy surprises, and financial markets in an open economy environment, and contributes to the literature in three directions. First, to highlight the international transmission mechanisms and comply with the usual assumptions of the international finance literature we analyze two closely connected countries, Germany and Switzerland. Both economies exhibit a very high degree of trade openness, international capital flows and business cycle comovement. These economies fit the neoclassical open economy theory assumptions, i.e., different in size and perfectly integrated. To overcome the limitations of existing research, this study takes the tight cross-country links into account by modeling a common trend within a vector error correction model (VECM) framework. Second, to explain the obscured and nonsignificant responses produced by standard studies that are unable to disentangle contrarian movements in the course of time, we propose a state-dependent VECM conditioned on business cycle regimes that are identified by the Markov Switching algorithm proposed by Hamilton (1989). Furthermore, as different monetary
indicators may produce different results, we use various measures, thereby taking recent advances in the measurement of monetary policy into account.

The results show a significant and asymmetric impact of domestic monetary surprises on stock prices. While the standard closed economy, time-invariant analysis does not show any sensitivity to output shocks a more detailed analysis displays positive stock market reactions to domestic shocks during recessions and to foreign shocks during expansions. The generally high sensitivity of Swiss stocks to foreign output and other economic shocks underpins Germany’s ‘locomotive’ function. The heterogeneity of significant results over the business cycle, however, suggests that there is no predominant transmission channel.

The paper is organized as follows. In section 2, we present the methodology of the regime dependent VAR model. Section 3 motivates and describes the variables. Section 4 presents and discusses the results of the closed and open economy analyses, and section 5 concludes.

2 Methodology

Let \( x_t \) be an \((N \times 1)\) vector containing a set of endogenous variables that are \( I(0) \) when differenced once. Assume that \( x_t \) follows an VAR process containing \( p \) lagged values.

\[
x_t = c + \sum_{i=1}^{p} \Gamma_{is} x_{t-i} + e_t, \quad t = 1, 2, \ldots
\]

(1)

where \( \Gamma_{is} \) are \((N \times N)\) coefficient matrices, conditioned on discrete states \( s \). The VECM representation is

\[
\Delta x_t = c + \sum_{i=1}^{p} \Phi_{is} \Delta x_{t-i} + \sum_{i=1}^{r} A_{is} \Theta_{t-i} + e_t
\]

(2)

where \( \Phi \) is a parameter matrix, \( \Delta \) is a difference operator, \( A_i \) denotes a vector of impulses which represent the unanticipated movements in \( x_t \) where \( \Theta \) contains the \( r \) individual error-correction terms derived from the \( r \) long run cointegrating vectors via the Johansen MLE procedure and \( e_t \sim Niid(0, \Sigma_s) \).

To investigate asymmetric stock market reactions we identify the regimes \( s \) by a Markov-switching model with unobserved states by Hamilton (1989) in which real activity growth, measured by log GDP difference, follows the following stochastic process

\[
y_t - \mu_{s_t} = \phi_1(y_{t-1} - \mu_{s_{t-1}}) + \phi_2(y_{t-2} - \mu_{s_{t-2}})
+ \phi_3(y_{t-3} - \mu_{s_{t-3}}) + \phi_4(y_{t-4} - \mu_{s_{t-4}}) + \varepsilon_t
\]

(3)

with \( \varepsilon_t \sim Niid(0, \sigma_{s_t}^2) \) and \( s_t \in \{0,1\} \).

The smoothed conditional state probability \( \Pr (s_t = j | y_T, \theta) \) that results from the estimation of equation (3) represents the conditional information for the VECM. \( \theta \) denotes a vector of coefficients and \( y \) denotes monthly GDP growth. In order to avoid mixture regimes we segregate the states at a cutoff point of \( \Pr (s_t = j | y_T, \theta) = 0.5 \) and subdivide the sample into a period of low and high growth\(^1\). Economically, this implies that the agents actually know the present regime by attributing the conditional probability \( \Pr (s_t = j | y_T, \theta) = 1 \) to the state \( s_t = j \) which is the most probable at time \( t \).

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\(^1\)The fact that in the international setup we restrict to the regimes of the Swiss business cycle is not too much of a limitation because it is highly synchronized with the German cycle. This procedure is required as there do not exist any official recession dates in either of the countries.
3 Variables and Data

3.1 Empirical Interrelations

The influence of inflation on stock prices has been outlined by Geske and Roll (1983), among others. Their reversed causality model shows that a negative real shock increases the budget deficit at a given level of government expenditures. If it is ‘monetized’ inflation increases while stock markets plunge. The effect of a positive output shock on stock prices is not clear a priori as the positive discount rate change may offset the increase in future dividends. This may be a reason for the frequently reported non-significance. Nevertheless, Flannery and Protopadakis (2002) show that real activity variables are priced risk factors for stock returns. Studies describing the influence of monetary policy on financial markets have produced results that are not unanimous. Patelis (1997) reports that expansionary monetary shocks predict higher expected returns initially and lower returns thereafter, and primarily affect prices via the risk premium.

The above arguments suggest that real GDP ($y^g$), price level measured by CPI ($p^g$), a monetary policy indicator ($m^s$) measured as term spread or a VAR-based composite index, and deflated equity prices in local currency ($s^g$) should be used together in a VECM setup to describe broad economic dynamic relationships. To investigate the nature of external influences on a small open and integrated economy such as Switzerland, we augment the vector by the German counterpart variables $y^g$, $p^g$, $m^g$, and $s^g$. We also include the exchange rate ($q$) to account for the change in purchasing power and to capture external nominal influences.

The choice of the countries is based on two basic assumptions of neoclassical theory, market integration and difference in size. The assumptions allow for international transmission of shocks and describe the behavior of business cycles, and are both ideally represented by Germany and Switzerland. Baxter and Crucini (1995) show the importance of financial integration and Crucini (1997) argues that while large economies are unaffected by foreign shocks, small open economies strongly react to foreign shocks and have a stronger tendency for investment booms associated with changes in interest rates and other shocks (see Blankenau et al., 2001). Finally, the analysis of integrated and developed countries should reveal stronger links because of lower market frictions than in distant, large, closed or underdeveloped economies2.

We perform the dynamic structural analysis using a recursive method that depends on the order of variables in the vector. Due to the relative openness of the countries, we consider German variables as contemporaneously exogenous to the corresponding Swiss variables. Real variables are exogenous to financial variables because stock markets or interest rates adapt much faster to news than do output or goods prices. As Switzerland experienced a large period of exchange rate targeting (see Cuche, 2000), we consider German monetary policy to be exogenous to the Swiss monetary policy. These arguments lead to the variable ordering $y^g$, $y^s$, $p^g$, $p^s$, $q$, $m^g$, $s^g$, $m^s$, and $s^s$ which will undergo a robustness check.

3.2 A Composite Monetary Policy Indicator

Many authors have criticized the use of monetary aggregates or interest rates as monetary policy indicators because they fail to distinguish between policy and non-policy influences, and have proposed constructed monetary policy measures (see e.g., Christiano and Eichenbaum, 1995, Strongin, 1995). Bernanke and Mihov (1998) suggest a composite indicator that represents the operating

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2 Dellas and Hess (2002) show that stock markets are more sensitive to foreign impacts as countries move up the ladder of financial development.
procedure of the central bank which we choose as our main measure of monetary policy because it eliminates the need to identify a priori a proxy variable\(^3\). This indicator also accounts for the insight of Gilchrist and Leahy (2002) that asset prices react differently to different monetary policy rules.

The indicator is based on a VAR system with a vector subdivided into a block exogenous vector \(\text{m}_t\) of \(m\) macroeconomic variables and a vector \(\text{p}_t\) of \(n\) policy variables (i.e., a monetary aggregate, a short term interest rate, and the exchange rate),

\[
\begin{pmatrix}
\text{m}_t \\
\text{p}_t
\end{pmatrix} = \begin{pmatrix}
B_0 & 0 \\
D_0 & G_0
\end{pmatrix}
\begin{pmatrix}
\text{m}_t \\
\text{p}_t
\end{pmatrix} + \sum_{i=1}^{k} \begin{pmatrix}
B_i & C_i \\
D_i & G_i
\end{pmatrix}
\begin{pmatrix}
\text{m}_{t-i} \\
\text{p}_{t-i}
\end{pmatrix} + \begin{pmatrix}
A^m & 0 \\
0 & A^p
\end{pmatrix}
\begin{pmatrix}
\text{v}^m_t \\
\text{v}^p_t
\end{pmatrix}.
\]

(4)

One element of the structural VAR disturbance vector \(\text{v}^p_t\) may be interpreted as a money supply shock\(^4\).

### 3.3 Data Description

In the empirical analysis we use data from 1975:01 to 2000:12. We choose monthly frequency to maximize the number of observations for a robust estimation of the model under each regime. As monthly GDP for Switzerland is unavailable, and as the industrial production series has serious empirical flaws, we adapt the model of Cuche and Hess (2000) to disaggregate GDP with a Kalman filter procedure with related variables\(^5,6\). We calculate the term spread by subtracting the 1-month Euro interest rate from an index for a yield of confederation bonds with maturity greater than 5 years, and from the yield of an index of 7 to 15 years public sector bond index for Germany. Stock prices are deflated and expressed in local currency.

Figure 1 displays the composite monetary policy indicator described in section 3.2. Values around 0 indicate a neutral policy, and positive and negative values represent expansionary and contractionary money supply, respectively. Shaded periods represent times of low output growth identified by the binomial distribution of the smoothed conditional probabilities from the two-state Markov switching process (3), \(\Pr (s_t = 1|y_T, \theta)\).

Figure 1: Monetary Policy and Recessions

There are three recession phases in the sample - the end of the oil shock in 1975, the world wide recession at the beginning of the 1980’s and the long home grown standstill in the 1990’s, which together make up for one third of the total number of observations\(^7\). The respective monthly GDP mean growth in the two states are -0.08% and 0.25% per month.

To determine the order of integration of the variables in the empirical analysis, we use both the augmented Dickey-Fuller Test (ADF) and the test by Kwiatkowski et al. (1992) (KPSS), and

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\(^3\)To check for robustness we use the term spread as an alternative monetary indicator.

\(^4\)See Cuche (2000) for the definition of the operating procedures of a central bank of a small open economy, and for the method to derive the unobserved structural residuals \(\text{v}^p_t\).

\(^5\)In order to approximate the information set of the monetary authorities, we use GDP nowcasts instead of official data.

\(^6\)For comparability reasons we apply the same methodology to German GDP.

\(^7\)The smoothed conditional probabilities are occasionally not well identified but sensitivity analyses show that the switching dates are robust for different disaggregation models of Cuche and Hess (2000).
include an intercept and a linear trend in the test equations. We run the analysis over the whole sample and for the subperiods of economic prosperity and slowdowns, respectively.

Table 1: Unit Root Tests

Table 1 indicates that all level series exhibit non-stationary behavior in all subsamples according to the ADF test. Only during recessions does the KPSS procedure not reject stationarity for $m^8$. To verify that the series are not integrated of higher order, we also run the test on first differences. In some instances, the KPSS test indicates that inflation is weakly non-stationary, and both tests coincide on weak nonstationarity for $m^8$ during expansions. However, given the consistency of most test results and following common use, we consider all series to be $I(1)$, a requisite for cointegration analysis.

We then test for the existence of multiple cointegrating vectors in separate analyses for the four Swiss variables in the closed economy model and for the nine variables in the open economy model. For this, we use the method proposed by Johansen (1988) and Johansen and Juselius (1990) who consider a model arranged in an unrestricted error-correction form as in equation (2) and check for robustness by using the Lagrange Multiplier-based test by Lütkepohl and Saikkonen (LS) (2000). All tests include an intercept and a trend using an $n$-dimensional time series $y_t = (y_{1t}, ..., y_{nt})'$, $t = 1, ..., T$, generated by

$$y_t = \mu_0 + \mu_1 t + x_t, \quad t = 1, 2, ..., (5)$$

where $\mu_0 (n \times 1)$ and $\mu_1 (n \times 1)$ are unknown parameters, and assume that $x_t$ follows the $p$th-order VAR process of equation (1). Both tests in Table 2 report cointegration among the series.

Table 2: Cointegration Tests

For the closed economy model, the Johansen tests identify at least two cointegrating equations at a 5% level for the overall sample whereas the LS test identifies just one. During periods of expansion, all tests identify one cointegration equation at the 5% level, whereas during recessions, the tested setup does not show any cointegrating relation. However, eliminating the trend from the regression or replacing the term spread by the composite monetary indicator the tests report one cointegration relation.

In the open economy model the number of cointegration equations increases as expected, but due to the lower test power in large models and reasonable samples, the results diverge significantly across both Johansen tests. Based on the lesson from the closed economy results and on economic intuition, we may assume that there exist three cointegration equations. Economically, this means a common trend within each country plus one fixed cross-border relation. Given the limited number of observations, a low number of cointegration equations is preferable for robust dynamic inferences.

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8 The results tend to indicate a higher number of cointegrating equations if the optimal lag length is based on the Hannan-Quinn criterion.
4 Results

4.1 Closed Economy Analysis

4.1.1 Impulse Responses

Panel A of Figure 2 displays the impulse responses of Swiss stock prices to shocks in domestic fundamental variables from a VECM (2) for the standard time-invariant model. While stock prices react negatively to a shock in consumer prices as expected, the reaction to output and monetary policy shocks are insignificant. However, it would be premature to claim independence as the figures in panels B and C show asymmetric responses of the stock market over the business cycle.

Figure 2: Impulse Response Functions in the Closed Economy Model

The relation between inflationary surprises and the stock market tends to be negative. This reflects investors’ expectations of an upcoming tightening of the money supply and hence, of higher dividend discount rates. While there is no clear response of stock prices in slowdowns, surprisingly it is positive in prosperous periods. This seems to indicate that the expected tightening of monetary policy during expansions is likely to prevent an economy from overheating.

Innovations to the composite monetary policy indicator do not exert any systematic impact on equities over the whole sample. Again, this non-significance is due to different reactions over the business cycle. In recessions, we observe a positive stock market response to a loosening of monetary policy as investors seem to be aware of the stimulating effects of an anticyclical policy. During expansions, however, stock markets do not seem to significantly respond to monetary policy since it tends to be smoother and therefore the signal weaker.

Real activity shocks do not exert any significant influence on stock prices in the overall period, and is the result of two offsetting effects: the lower expected future dividends caused by a negative output shock and the lower discount rates caused by both reduced future demand for funds and the expectation of a loose monetary policy. There is a positive response of stocks to output shocks during recessions while there is no significant response in a well running economy, indicating that signs of better prospects of the economy are much more valuable at low output rates and therefore more than outweigh the discount rate argument.

4.1.2 Variance Decompositions

Overall stock return variance is predominantly explained by innovations to itself which account for roughly 91.8% of total variance (see Table 3). This figure is lower than for other countries in a comparable sample (see Canova and De Nicoló, 2000) and suggests that macroeconomic surprises have a non-negligible influence on the stock market. While in the overall sample shocks to consumer

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9 For all extensions of this basic setup we reject including more than the two lags identified by the Akaike information criterion because of the loss of degrees of freedom that arises with the inclusion of international variables or because of limited observations in subsamples.

10 Another reason for the weak significance may be the omission of foreign variables. This aspect will be addressed in a separate section.

11 Moreover, Kaul (1990) points out that procyclical monetary policy may lead to a positive relationship between unexpected inflation and stock returns.

12 When we measure the stance of monetary policy by the term spread (not displayed), the positive sign in recessions persists but becomes less significant.

13 All results in this section prove robust when assuming that consumer prices are contemporaneously exogenous to all other variables.
prices exert a significant influence with a robust explanatory power of the stock market forecast error variance of 7.3%, real activity and monetary policy shocks do not seem to matter.

Table 3: Variance Decomposition in the Closed Economy Model

Table 3 shows asymmetric influences across the stages of the business cycle with only 64.3% of the variation in stock prices caused by innovations to itself during recessions as compared to 88.5% during expansions. The higher degree of uncertainty for the firms in downturns makes it necessary to more closely monitor macroeconomic data for stock price valuation.

While output and monetary shocks account for 15.2% and 11.2% of stock price variation during crises, their influence becomes much smaller when the economy produces at high capacity. On a statistical level, one may also be willing to speculate about the possibility that monetary and output shocks tend to be more pronounced in recessions whereas in good times they are much smoother and therefore less distinguishable from noise.

4.2 Open Economy Analysis

4.2.1 Impulse Responses

The impulse response functions in Figure 3 show that in the international setup, the signs of the reactions of stock prices to domestic macroeconomic variables over the whole sample are similar to the closed economy analysis with small deviations in terms of significance. In such cases of deviating results (e.g., insensitivity to output and CPI shock in expansion) the open economy analysis is able to disentangle the incompletely described closed economy responses into a German and a Swiss origin.

Figure 3: Impulse Response Functions in the Open Economy Model

The impulse responses during expansions in panel B reveal that due to the high interrelations between the two countries the significant reaction of the stock market to consumer prices in the closed economy setup indeed reflects German news. The international importance of German variables is illustrated by their strong influence on stock prices whereas shocks to domestic inflation and output exerts no impact. While the positive reaction to foreign output shocks is expected, we may speculate whether similar forces as in the closed economy model cause stock prices to respond positively to foreign CPI. Panel C again highlights the importance of German news showing a significantly negative reaction to foreign consumer price shocks during recessions. Together with the positive reaction to domestic shocks they may falsely lead to the conclusion that, if analyzed in a closed economy setup, stocks do not seem to react to inflation shocks.

Overall, the strong stock market response to foreign shocks reveals further indications about the 'locomotive' function of Germany. On impact, Swiss stocks respond positively to German output surprises generating good business prospects. The fact that they react to domestic shocks during economic slowdowns seems to suggest that business cycles may influence the direction of the responses and also matter for the relative impact of domestic and foreign shocks.

14 Although the effects become more important as a variable is placed higher in the vector, the economic interpretation of the results does not change. The term spread exhibits an asymmetric but lower impact than the composite indicator which seems to measure monetary policy more appropriately.

15 An ongoing debate is whether shocks of 'locomotive' countries are transmitted to smaller countries (as assumed here) or whether the countries are affected by common shocks (see e.g., Kwark, 1999).

16 The stock market responses to domestic output shocks are the only ones that are sensitive to different model setups. Alternatively, placing foreign macrovariables or consumer prices first, the impulse response function becomes insignificant.
The figures also show asymmetric reactions to foreign price shocks over the business cycle. The reaction to domestic and foreign monetary surprises is mostly insignificant, except for a positive reaction on impact to monetary expansions during recessions indicating better firm prospects\textsuperscript{17}. Finally, the tight links in the financial sector are supported by the almost entire transmission of foreign stock price innovations to Swiss stocks.

### 4.2.2 Variance Decomposition

The variance decompositions in Table 4 reveal important cross-country effects and a high degree of financial integration. Only 33.5\% of the variation in Swiss stock returns is explained by own innovations whereas German stock market shocks account for 54.2\%. In the overall period, most fundamentals matter somewhat for stock prices with domestic output being the most important influence. The relative impacts of domestic variables across the stages of the business cycle resemble the closed economy results\textsuperscript{18}.

#### Table 4: Variance Decomposition in the Open Economy Model

The strong impact of consumer prices in expansions and monetary policy in recession becomes much less pronounced in the open economy model. The large values of their respective foreign counterparts (i.e., $p^g: 11.08$, $m^g: 6.49$) indicate that the closed economy model is imprecise by attributing foreign influence to domestic variables. As all foreign variables exert a significant influence during one of the regimes, there does not exist a unique international transmission channel (e.g. trade, monetary channel). German output surprises strongly impact the stock market variance during expansions and illustrate the incompleteness of the closed economy analysis suggesting that in this subperiod investors do not react to real activity news. Surprises in the other foreign variables significantly influence the Swiss stock market during recessions. The value of 6.49\%, for instance, reflects the stimulating effect of an unexpected loosening of Bundesbank policy.

### 5 Conclusions

The rapidly growing literature on the interdependencies between macroeconomic fundamentals and financial variables reports mixed evidence concerning the degree of predictability of stock prices and the speed of information processing by equity markets. To highlight the transmission channels and to maximize the signal-to-noise ratio in the characterization of the international dynamic propagation of fundamental shocks, we choose a small open economy and a close trade partner. Taking cointegration into account and directing a special focus on the impact of monetary surprises, we analyze intuitive but yet overlooked asymmetric interrelations that depend on the stages of the business cycle.

As in other studies, there is significant evidence of stock market sensitivity to macroeconomic news. We show that traditional models substantially underestimate the impacts as different and sometimes offsetting effects of shocks to fundamentals across the states of the economy obscure the true impact of fundamental news on equity prices. For instance, we show that positive output and monetary shocks represent good news to investors during recessions but do no have any impact, or even slightly negative impacts, in economic expansions. Notably, because of the uncertainty\textsuperscript{17}\textsuperscript{18}.

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\textsuperscript{17} When measured by the term spread, shocks to domestic monetary policy continue exerting a strongly positive impact even during expansions.

\textsuperscript{18} The robustness check by changing the variable ordering shows a change in magnitude of the relative impact but leads to exactly the same conclusion about international and business cycle dependent influences.
about future firm prospects in turbulent times analysts tend to rely more strongly on the economic environment and this leads stocks to react more susceptible to fundamental shocks. Augmenting the system by international variables reveals a high degree of sensitivity of a small open economy to foreign shocks whereby transmission channels prove to change across the regimes. The magnitude of the foreign impacts on Swiss stocks demonstrates the 'locomotive' function of the German economy.

There are two important tasks ahead. The first is to develop theoretical models linking the international transmission of macroeconomic shocks to the state of the economy since the existing literature does not provide sufficient ground for describing the relative importance of domestic and foreign shocks over the business cycle. The second is to produce empirical analyses for other small open economies in order to corroborate our results and to extend the analysis to common shocks. This will provide a complete picture of the impacts of the international propagation of shocks to fundamentals.
References


Notes: The solid line displays the monetary policy indicator identified by the operating procedures of the central bank. It is an update of the original indicator by Cuche (2000). The shaded bars display recession periods in Switzerland.
Figure 2: Impulse Response Functions in the Closed Economy Model

Panel A: Overall Sample

Panel B: Expansion
Panel C: Recession

Notes: The solid lines display the responses of Swiss stock prices to a one standard deviation shock to each of the following variables: \( y \) = gross domestic product, \( p \) = consumer price index, \( m \) = composite monetary policy indicator, and \( s \) = stock market index. Superscript \( s \) denotes shock originating in Swiss variables. The broken lines indicate the 95% bootstrap confidence interval (100 replications) proposed by Hall (1992) and discussed by Benkwitz et al. (2000). The recursively identified impulse responses are calculated from a VECM(2) with 1 cointegrating relation. The optimal lag length in the time-invariant setup is identified by the Akaike information criterion. They are estimated for the overall sample period 1975:01-2000:12 and for the regime subperiods displayed in Figure 1.
Figure 3: Impulse Response Functions in the Open Economy Model

Panel A: Overall Sample

Panel B: Expansion
Notes: The solid lines display the responses of Swiss stock prices to a one standard deviation shock to each of the following variables: $y$ = gross domestic product, $p$ = consumer price index, $m$ = composite monetary policy indicator, $q$ = exchange rate CHF/100 DEM, and $s$ = stock market index. Superscripts * and § denote originating shock in Swiss and German variables, respectively. The broken lines indicate the 95% bootstrap confidence interval (100 replications) proposed by Hall (1992) and discussed by Benkwitz et al. (2000). The recursively identified impulse responses are calculated from a VECM(1) with 3 cointegrating relations (2 in subperiods). The optimal lag length in the time-invariant setup is identified by the Akaike information criterion. They are estimated for the overall sample period 1975:01-2000:12 and for the regime subperiods displayed in Figure 1.
Table 1: Unit Root Tests

<table>
<thead>
<tr>
<th>Variables in Levels</th>
<th>( y^g )</th>
<th>( p^g )</th>
<th>( m^g )</th>
<th>( s^g )</th>
<th>( q )</th>
<th>( y^s )</th>
<th>( p^s )</th>
<th>( m^s )</th>
<th>( s^s )</th>
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<td><strong>ADF</strong> overall sample</td>
<td>-1.83</td>
<td>-1.36</td>
<td>-2.17</td>
<td>-1.03</td>
<td>-3.31</td>
<td>-2.35</td>
<td>-1.88</td>
<td>-1.77</td>
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<tr>
<td>expansion</td>
<td>-1.07</td>
<td>-2.68</td>
<td>-1.66</td>
<td>-2.18</td>
<td>-2.63</td>
<td>1.11</td>
<td>-3.08</td>
<td>-1.92</td>
<td>-0.03</td>
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<tr>
<td>recession</td>
<td>-2.31</td>
<td>-0.95</td>
<td>-1.01</td>
<td>-1.15</td>
<td>-1.64</td>
<td>-1.26</td>
<td>-2.02</td>
<td>-1.03</td>
<td>-0.03</td>
</tr>
<tr>
<td><strong>KPSS</strong> overall sample</td>
<td>0.86**</td>
<td>1.09**</td>
<td>0.90**</td>
<td>1.13**</td>
<td>0.96**</td>
<td>0.26**</td>
<td>0.22**</td>
<td>0.28**</td>
<td>0.60**</td>
</tr>
<tr>
<td>expansion</td>
<td>0.52**</td>
<td>0.22*</td>
<td>0.25**</td>
<td>1.02**</td>
<td>0.97**</td>
<td>0.34**</td>
<td>0.17*</td>
<td>0.20*</td>
<td>0.39**</td>
</tr>
<tr>
<td>recession</td>
<td>0.26**</td>
<td>0.89**</td>
<td>0.63**</td>
<td>0.90**</td>
<td>0.29**</td>
<td>0.41**</td>
<td>0.23**</td>
<td>0.11</td>
<td>1.44**</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables in first differences</th>
<th>( y^g )</th>
<th>( p^g )</th>
<th>( m^g )</th>
<th>( s^g )</th>
<th>( q )</th>
<th>( y^s )</th>
<th>( p^s )</th>
<th>( m^s )</th>
<th>( s^s )</th>
</tr>
</thead>
<tbody>
<tr>
<td>recession</td>
<td>-7.96**</td>
<td>-8.92**</td>
<td>-5.72**</td>
<td>-4.69**</td>
<td>-5.41**</td>
<td>-16.09**</td>
<td>-6.70**</td>
<td>-3.72**</td>
<td>-10.43**</td>
</tr>
<tr>
<td><strong>KPSS</strong> overall sample</td>
<td>0.02</td>
<td>0.16*</td>
<td>0.05</td>
<td>0.05</td>
<td>0.06</td>
<td>0.09</td>
<td>0.21*</td>
<td>0.14</td>
<td>0.12</td>
</tr>
<tr>
<td>expansion</td>
<td>0.02</td>
<td>0.12</td>
<td>0.04</td>
<td>0.04</td>
<td>0.05</td>
<td>0.04</td>
<td>0.11</td>
<td>0.15*</td>
<td>0.06</td>
</tr>
<tr>
<td>recession</td>
<td>0.06</td>
<td>0.16*</td>
<td>0.07</td>
<td>0.11</td>
<td>0.14</td>
<td>0.02</td>
<td>0.20*</td>
<td>0.12</td>
<td>0.06</td>
</tr>
</tbody>
</table>

**Notes:** The displayed figures represent unit root test results for the following variables: \( y \) = gross domestic product, \( p \) = consumer price index, \( m \) = composite monetary policy indicator, \( q \) = exchange rate CHF/100 DEM, and \( s \) = stock market index. Superscript * and ** denote Swiss and German variables, respectively. The augmented Dickey Fuller Test and the Kwiatkowski et al. (1992) tests are denoted by ADF and KPSS, respectively. For both tests the number of included lags is identified by the Akaike information criterion. The test regressions contain an intercept and a trend. The MacKinnon critical values for ADF at a 5% and 10% level are: overall period -3.41 and -3.13, expansion -3.43 and -3.14, recession -3.46 and -3.16. The critical values for the KPSS test are 0.15 and 0.22 a 5% and 10% level, respectively. Significance at a 5% and 10% level is denoted by ** and *, respectively. Term spread as alternative monetary indicator for Switzerland is I(1) in a 95% confidence interval. The tests are performed for the overall sample period 1975:01-2000:12 and for the regime subperiods displayed in figure 1.
Table 2: Cointegration Tests

<table>
<thead>
<tr>
<th></th>
<th>Closed Economy Model</th>
<th></th>
<th>Open Economy Model</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>overall sample</td>
<td>expansion</td>
<td>recession</td>
<td>overall sample</td>
</tr>
<tr>
<td>CE</td>
<td>TR</td>
<td>ME</td>
<td>LS</td>
<td>TR</td>
</tr>
<tr>
<td>0</td>
<td>90.67**</td>
<td>38.34**</td>
<td>59.79**</td>
<td>71.52**</td>
</tr>
<tr>
<td>&lt;1</td>
<td>52.33**</td>
<td>31.17**</td>
<td>14.00</td>
<td>36.90</td>
</tr>
<tr>
<td>&lt;2</td>
<td>21.17</td>
<td>13.03</td>
<td>6.89</td>
<td>13.17</td>
</tr>
<tr>
<td>&lt;3</td>
<td>8.14</td>
<td>8.14</td>
<td>0.51</td>
<td>2.53</td>
</tr>
</tbody>
</table>

Notes: The displayed figures represent cointegration test results for the closed and open economy model, respectively. The trace and the maximum eigenvalue test results of Johansen (1988) and the Lütkepohl and Saikkonen (2000) test are denoted by TR, ME and LS, respectively. Johansen and Juselius (1990, table A2) report asymptotic critical values for the TR and ME. The number of hypothesizes cointegration equations is denoted by CE. For all tests the number of included lags is identified by the Akaike information criterion. The test regressions contain an intercept and a trend. Critical values by Lütkepohl and Saikkonen (2000, table 1) are simulated for small systems up to five variables only from 20,000 replications. Significance at a 5% and 10% level is denoted by ** and *, respectively. The tests are performed for the overall sample period 1975:01-2000:12 and for the regimes displayed in figure 1.

Table 3: Variance Decomposition in the Closed Economy Model

<table>
<thead>
<tr>
<th></th>
<th>VD of s^2 caused by</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>overall sample</td>
<td>expansion</td>
</tr>
<tr>
<td>y^s</td>
<td>0.75</td>
<td>7.25</td>
</tr>
<tr>
<td>p^s</td>
<td>0.09</td>
<td>7.30</td>
</tr>
<tr>
<td>m^s</td>
<td>15.23</td>
<td>9.24</td>
</tr>
</tbody>
</table>

Notes: The figures represent percentages of the 24-month forecast error variance explained by innovations in each variable: y = gross domestic product, p = consumer price index, m = composite monetary indicator, and s = stock market index. Superscript * denotes values for Switzerland. When measured as term spread innovations, the influence of monetary news on stock prices is 1.46, 2.62 and 5.04 in the three samples, respectively. The overall sample period is 1975:01-2000:12. The regime subperiods are displayed in Figure 1.
Table 4: Variance Decomposition in the Open Economy Model

<table>
<thead>
<tr>
<th>VD of $s^2$ caused by</th>
<th>$y^g$</th>
<th>$y^s$</th>
<th>$p^g$</th>
<th>$p^s$</th>
<th>$q$</th>
<th>$m^g$</th>
<th>$s^g$</th>
<th>$m^s$</th>
<th>$s^s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Sample</td>
<td>2.02</td>
<td>3.58</td>
<td>2.48</td>
<td>1.92</td>
<td>0.07</td>
<td>2.08</td>
<td>54.18</td>
<td>0.18</td>
<td>33.50</td>
</tr>
<tr>
<td>Expansion</td>
<td>18.79</td>
<td>2.73</td>
<td>11.08</td>
<td>0.65</td>
<td>2.82</td>
<td>0.13</td>
<td>20.69</td>
<td>2.66</td>
<td>40.45</td>
</tr>
<tr>
<td>Recession</td>
<td>0.59</td>
<td>18.24</td>
<td>7.13</td>
<td>7.98</td>
<td>3.59</td>
<td>6.49</td>
<td>25.69</td>
<td>2.53</td>
<td>27.75</td>
</tr>
</tbody>
</table>

Notes: The figures represent percentages of the 24-month forecast error variance explained by innovations in each variable: $y$ = gross domestic product, $p$ = consumer price index, $m$ = composite monetary indicator, $s$ = stock market index, and $q$ = exchange rate CHF/100 DEM. Superscripts $^s$ and $^g$ denote values for Switzerland and Germany, respectively. When measured as term spread innovations the influence of monetary news on stock prices is 1.65, 10.01 and 0.11 in the three samples respectively. The overall sample period is 1975:01-2000:12. The regime subperiods are displayed in Figure 1.