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Monetary Policy and Real Estate Prices: A Disaggregated Analysis for Switzerland

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Abstract

Most empirical studies found that monetary policy has a significant effect on house prices while stock markets remain unaffected by interest rate shocks. In this paper we conduct a more detailed analysis by studying various sub-segments of the real estate market. Employing a new dataset for Switzerland we estimate vector autoregressive models and find substitution effects between house and apartment prices on the one hand and rental prices on the other. Interestingly enough, commercial property prices do not react on interest rate variations.

Keywords: monetary policy, interest rate shocks, real estate, stock market

JEL-classification: E43, E52, R21

1. Introduction

Central banks control their monetary policy instruments in efforts to reach their policy goals. While the primary goal of most central banks is price stability, many central banks also care about real activity (output, unemployment).[1] Moreover, contributing or even guaranteeing domestic financial stability often belongs to the catalogue of objectives of numerous modern central banks, such as the Federal Reserve Bank (Bernanke [2002]). While the objectives of central banks are not too controversial, there is much less agreement on the question whether central banks should try to employ their monetary policy instruments to contribute to financial stability, especially in as far as asset markets (i.e. stock and real estate markets) are concerned.

The traditional view[2] is in strong opposition to monetary policy rules reacting on asset market developments. Building up on a dynamic New Keynesian framework Bernanke and Gertler [1999,2001] argue that central banks should view price and financial stability as complementary and almost consistent goals.[3] Their advice is that monetary policy should focus on price stability and respond to changes in asset prices only when they signal changes in expected inflation. Bernanke [2002] renewed this view in his speech before the New York Chapter of the National Association for Business Economics arguing on the basis of a division of labour argument (''Use the right tool for the job''). While monetary policy should be used to reach macroeconomic goals, regulatory, supervisory and lending of last resort power should be employed to guarantee financial stability (see also Schwartz [2002] for a similar line of argument). Christiano et al. [2008] basically argue that bubbles arise from misperceived technology shocks and thus asset prices should not be targeted by monetary policy. Kohn [2009] argues that monetary policy has little ability to influence the speculative component of asset prices and ''leaning against the wind'' will likely result in suboptimal economic performance in the medium term.

However, various economists take a different point of view and advocate reacting to movements in asset prices stronger than these changes imply to stabilize aggregate de-

[1] Loayza and Schmidt-Hebbel [2002], p. 1.
[2] See Bordo and Wheelock [2004], p. 21.
[3] A similar view is expressed in Bordo, Dueker and Wheelock [2002,2003].

mand and inflation. While Borio and Lowe [2002], Bordo, Dueker and Wheelock [2002,2003], Detken and Smets [2004] and Ahearne et al. [2005] deduce this conclusion from empirical observations of asset market bubbles in the past, there is also a considerable number of theoretical papers coming to similar results. Smets [1997] shows that in a comparatively simple macroeconomic framework, asset prices turn out to be part of an optimal monetary policy reaction function whenever aggregate demand depends positively on real asset prices. Cecchetti et al. [2000] and Cecchetti, Genberg and Wadhwani [2002] argue that reacting to asset price movements might be advantageous due to the fact that asset prices have implications for price stability at a different horizon from that of a typical inflation forecast. Bordo and Jeanne [2002] study monetary policy in a New Keynesian framework with collateral constraints in the productive sector and find the optimal monetary policy rule to depend not only on the output gap and inflation but also on the prospective developments in the asset markets. Dupor [2005] analyzes in how far central banks should react to irrational expectation shocks to future returns to capital in a sticky price model with investment adjustment costs. Since these shocks generate inefficient investments there is a trade-off between stabilizing nominal prices and non-fundamental asset price movements. Given the central bank has at least some information on the nature of occurring shocks, the monetary policy should always react on these shocks. Using a dynamic portfolio approach Platen and Semmler [2009] show that the optimal monetary policy rule should react, among other variables, to the amount of wealth invested into risky assets.

The most important prerequisite[4] for monetary policy to be successful in the task of guaranteeing financial stability is that it has a systematic and predictable effect on asset prices. Various studies have tackled this issue empirically.[5] Although the results vary to some degree between sample countries and periods, one might conclude from the literature that stock markets remain broadly unaffected by monetary policy measures while real estate markets tend to react to central banks' instruments. However, in as far as real estate mar-

[4] Assenmacher-Wesche and Gerlach [2009], Bean [2004] and Kohn [2009] discuss various prerequisites for a successful "leaning against the wind"-strategy of monetary policy.

[5] We review this literature in more detail in the section 2.

kets are concerned, the empirical evidence is somewhat limited since the empirical studies almost exclusively focus on house prices and thus cover only a sub-segment of the real estate market. In this paper we aim at filling this gap in the empirical literature and conduct a disaggregated analysis of the effects of monetary policy on various sub-segments of the real estate market (as well as the real estate market as a whole). Employing a new dataset for Switzerland we estimate vector autoregressive models (VAR) to study the impulse responses of house and apartment prices, the private rental market and various sub-segments of the market for commercial real estate to interest rate shocks.

The paper is structured as follows: The second section briefly reviews the already existing empirical literature on the effects of monetary policy on stock and real estate markets. After outlining our empirical approach in section 3 we turn to a description of the employed dataset in section 4. Section 5 reports and discusses the empirical results. As usual, the paper closes with a summary of the main findings and some conclusions.

2. Brief Review of the Empirical Literature

The empirical literature on the influence of monetary policy on asset prices has grown significantly over the last decade. From a methodological point of view, the empirical literature is dominated by vector-autoregressive models studying the interaction of indicators of the current stance of monetary policy, various macroeconomic variables (e.g. inflation, output or unemployment) and asset prices. The predominance of the VAR approach might be attributed to the fact that VARs are capable of dealing with possible endogeneity problems in an adequate way (Dreger and Wolters [2009a]).

The empirical literature tackles the question in how far monetary policy has an influence on asset prices in two different ways. A first strand of the literature studies in how far aggregate liquidity affects asset prices (see e.g. Baks and Kramer [1999], Rüffer and Stracca [2006], Greiber and Setzer [2007], Roffia and Zaghini [2007], Adalid and Detken [2007], Giese and Tuxen [2007], Belke, Orth and Setzer [2008,2010], Goodhart and Hofmann [2008] or Dreger and Wolters [2009b]). However, while aggregate liquidity is influenced by monetary policy decisions, it is obviously not under complete control of the central bank. The second strand of the literature studies the link between central banks' interest rate decisions and asset prices and thus focuses more directly on the influence monetary authorities exert on asset markets. Since we aim at studying in how far central banks are capable of influencing asset prices, we focus the following brief review of the empirical literature on the second strand of the literature.

Rüffer and Stracca [2006] construct an aggregate asset market index, consisting of residential and commercial property prices and stocks. When studying the effects of interest rate shocks on the aggregate asset index in a global VAR covering the U.S., Japan and Europe they find a significantly negative effect on the asset market.

There are also some studies focusing exclusively on the real estate sector or, more precisely, house prices. Giuliodori [2005] runs individual VARs for 9 OECD countries and finds interest rate shocks to have significant effects on house prices. Demary [2009] comes to the same result for 10 slightly differing sample countries. Jarocinsky and Smets [2008] and Goodhart and Hofmann [2008] confirm this finding in their studies. While Jarocinsky and Smets [2008] apply the Bayesian VAR technique to U.S data, Goodhart and Hofmann [2008] conduct a panel VAR analysis for 17 countries. Greiber and Setzer [2007] present supporting evidence of the hypothesis that monetary policy influences house prices or at least property wealth.

Similar as Rüffer and Stracca [2006], Belke, Orth and Setzer [2008] construct a global data-set (consisting of the Euro Area and 9 countries). However, instead of using an aggregate asset market index they study house prices and stocks separately. While they find interest rate shocks to have no effect on the development of the stock market, house prices react (inversely) to these shocks. Dreger and Wolters [2009a] arrive at the same result when running individual VARs for the U.S., the Euro-area, Japan and the United Kingdom. Assenmacher-Wesche and Gerlach [2009] conduct both, individual VARs and a panel VAR. Their results confirm the influence of interest rate shocks on house prices. However, Assenmacher-Wesche and Gerlach [2009] also find a significant influence of interest rate shocks on stock markets. Because the timing of the different asset classes is quite different, the authors nevertheless refrain from proposing to use monetary policy to influence asset prices.

Summing up, one might conclude that the existing empirical evidence points into the direction that interest rate shocks have little effect on stock markets while increasing interest rates seem to depress house prices and vice versa. While the empirical results are not too controversial, the results for the real estate market are somewhat incomplete. Almost all studies focus on housing prices and thus only a sub-segment of the real estate sector. Often, owner-occupied apartments are not included in the analysis. The same holds true for the rental market. Moreover, the market for commercial real estate is almost completely neglected in the empirical literature. To the best of our knowledge, the only study focusing on commercial property was conducted by Gruber and Lee [2008]. However, this study is concerned with the effect of bank lending on commercial property prices and thus stands only in somewhat loose connection with the described monetary policy literature.

3. Data

In order to learn about the effects of monetary policy on the various sub-segments of the real estate market we employ data from Switzerland. Our data sample consists of quarterly data ranging from 1987:Q4 to 2008:Q4.

First we employ macroeconomic data on inflation (p) and the gross domestic product (gdp). The data were taken from the OECD Main Economic Indicators database.

Second, we need data on the central monetary policy instrument. Since the three-month target libor rate (i) is the primary monetary policy instrument of the Swiss National Bank (SNB) we employ this variable in our study. The referring time series was provided by SNB. Since monetary aggregates have served as important intermediate target of Swiss monetary policy we also add broad money M3 (m) to our data sample. The referring data comes from the OECD Main Economic Indicators database.

Finally, we are in need of appropriate data on asset prices. As far as the stock market is concerned, we use the Swiss Performance Index (s) provided by Swiss Exchange. For the aggregate real estate market in Switzerland we make use of the Real Estate Performance Index (realestate) which was constructed by the Swiss Real Estate Institute (IZI-AG – CIFI SA). The index covers both the net cash flow from Swiss real estate and changes in the value of Swiss property. It is appropriate to evaluate the impact of interest rate decisions by the Swiss National Bank on aggregate property prices due to the fact that it covers all sub-segments of the real estate market. More precisely it consists of 30 % commercially used and 50 % privately used property while the remaining 20 % is mixed usage.[6]

Disaggregated indices for the sub-segments of the Swiss real estate market were provided by Wuest & Partner, a private real estate company operating in all Swiss regions. Wuest & Partner measure the price developments of six different real estate sub-segments of the Swiss national market: prices for rented apartments (rental), owner-occupied dwellings (flat), detached houses (house), industrial real estate (industry), office space (office) and sales areas (sale). Due to the confined availability of data for sales area, the sample period here ranges from 1996:Q1 to 2008:Q4. All disaggregated indices base upon a random evaluation of 100.000 real estate offers per year where the most important price-setting parameters such as size, position and condition of the property are included. The resulting data are then merged into almost homogenous groups by means of these features. The indices are weighted averages of these groups. Since 1996 the calculation bases upon a complete sampling including of about 500.000 offers per year which makes the indices even more meaningful. Price indices for commercial real estate base upon current rental prices. Regarding the private real estate sector, dwellings and detached houses are both owner-occupied so here price indices reflect current purchase prices for owner-occupied dwellings and detached houses. Whenever acquired houses respectively dwellings are let by the owner, rents are included in the price index for rented apartments.

All employed variables are seasonally adjusted, deflated by the consumer price index and taken in logs except inflation and the interest rate.

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[6] These numbers coincide with the shares reported by the private real estate company Wuest & Partner for Switzerland. Similar sizes of the real estate sub-segments are reported e.g. for Germany (BulwienGesa [2009]).

4. Estimation Approach

To analyze the linkage between interest rate decisions of SNB and asset prices, we use a vector-autoregressive model (VAR), originally introduced by Sims [1980]. As outlined in section 2, this econometric framework is typically employed for the empirical analysis of the effects of monetary policy instruments on macroeconomic variables. In VAR estimations every endogenous variable is regressed on its own lags and the lags of all other variables in the model. More precisely we estimate the following unrestricted VAR in reduced form:

$$x_t = c + \sum_{i=1}^{p} A_i \cdot x_{t-i} + u_t$$

where x_t is the vector of the n endogenous variables at time t, A_i are the $n \times n$ matrices of parameters which can be estimated using the reduced form and c is a $n \times 1$ vector of constants. u_t denotes a $n \times 1$ vector of unobservable error terms where

$$Eu_t = 0,$$

$$Eu_t u_t^{`} = V.$$

The VAR residuals cannot be interpreted as simple shocks because they are generally correlated. In order to identify monetary policy shocks (i.e. interest rate shocks) correctly, the shocks have to be independent across equations so that we can trace their isolated effect on the endogenous variables. To get observable and orthogonal shocks we reformulate the VAR in structural form, i.e.

$$A \cdot x_t = c + \sum_{i=1}^{p} A_i^* \cdot x_{t-i} + B \cdot \varepsilon_t$$

Here, ε_t denotes the $n \times 1$ vector of disturbances which are now uncorrelated and can be interpreted as structural shocks where

$$E\varepsilon_t = 0,$$

$$E\varepsilon_t \varepsilon_t^{`} = D,$$

The relationship between the VAR residuals and these structural shocks can be written as

$$\varepsilon_t = B^{-1} \cdot u_t$$

To obtain the structural shocks we have to impose restrictions on matrix B. In line with most of the literature we use Cholesky-decomposition to identify the system. In line with the monetary transmission literature (see Christiano et al. [1999]) we order the variables as follows: $x_t = (p, gdp, i, m, e, s)$, where e denotes the particular real estate price index. Real estate prices and stock prices may react immediately on the policy instrument, inflation and gross domestic product react only with a lag to interest rate shocks.[7] As the central bank's policy instrument is the main refinancing rate we order money supply directly behind the interest rate (see Favero [2001]).

We specify all estimated VARs in levels. Unit-root tests reveal that all time series except rental prices turn out to be non-stationary where a linear time trend or at least a constant are included in the test equation. Regarding the VAR for sales area prices with time series ranging from 1996:Q1 to 2008:Q4, time series for inflation, gdp, interest rate and the Swiss Performance Index are non-stationary. Estimating the VAR model with some unit root variables leads to spurious regression problems. As an alternative approach one might estimate the model in first differences. Indeed, this solution implies a loss of information contained in level variables. However, as Sims, Stock and Watson [1990] show, VAR estimations containing some unit-root variables lead to consistent OLS estimators when there are cointegration relations among the variables. Since the Johansen cointegration tests reveal that there are at least two cointegration vectors in every of our seven VAR specifications, estimating the VARs in levels seems to be justified.[8]

After applying the described identification scheme we generate impulse responses to a one-time interest rate shock. We are specifically interested in the effect of an interest rate variation on real estate and stock prices. Since in VAR models impulse responses are estimated imprecisely when using a large number of parameters we generate confidence bands using Monte Carlo simulations with 2000 Bootstrap repetitions to obtain one standard error confidence bands.

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[7] The same ordering is used e.g. in Assenmacher-Wesche and Gerlach [2009].

[8] For a complete documentation of all unit root and cointegration tests, see the appendix.

4. Empirical Results

Altogether, we estimate seven different VAR models.[9] While inflation (p), the gross domestic product (gdp), the three-month target libor rate (i), the money stock (m) and the Swiss Performance Index (s) enter all regressions as endogenous variables, we use different measures for the real estate market. In a benchmark specification we start out with an aggregate measure of the real estate market, the earlier described Real Estate Performance Index (realestate). We then repeat the estimations with the available indices of the six sub-segments of the Swiss real estate market. The lag structure of the VARs was determined on the basis of the Schwarz information criterion, whereas we considered a maximum lag length of six. The optimal lag length turned out to be 1 for the VARs including office, flat, house, industry and realestate. For rental the optimal lag length was 2, for sale it was 6.

In the benchmark specification we use the Swiss Performance Index as stock market indicator and the Real Estate Performance Index as indicator for the aggregate real estate market including all sub-segments. In line with most of the previous empirical literature we find that monetary policy remains without any effect on the stock market. As the impulse response function shown in figure 1 clearly depicts, there is no significant effect of interest rate shocks on the stock market performance indicator.[10]

[9] Instead of presenting and discussing all impulse response functions of the 7 VARs, we concentrate on the effects of monetary policy on the asset market indicators, here. A complete documentation of the results can be found in the appendix.

[10] The reaction of the stock market indicator to interest rate shocks turns out to be insignificant in all VAR specifications. We therefore refrain from reporting the results here in length. The complete set of impulse responses is provided in the appendix.

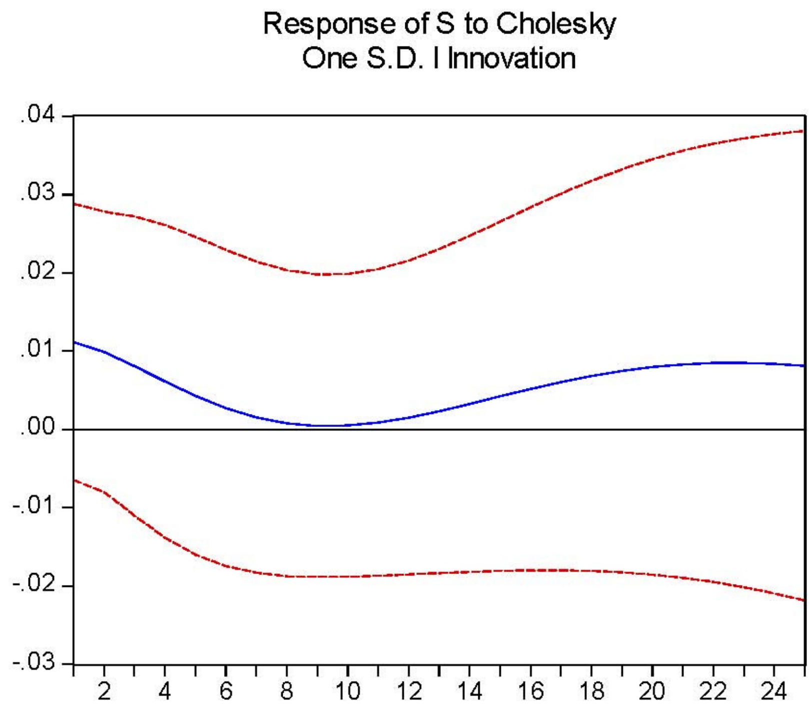

Figure 1: Response of Swiss Performance Index to Interest Rate Shock

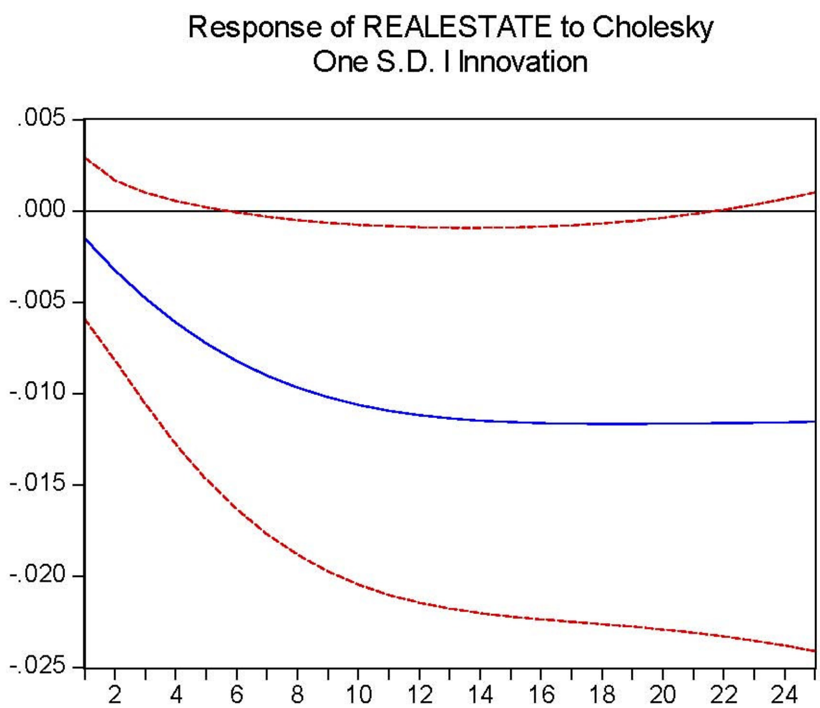

Figure 2: Response of Swiss Real Estate Performance Index to Interest Rate Shock

However, as figure 2 reveals, monetary policy has a significant effect on the aggregate real estate market. A tighter monetary policy depresses real estate market performance with a time-lag of 6 quarters and diminishes after roughly 5 years.

Switching to the disaggregated perspective shows that the different sub-segments of the real estate market react quite different to monetary policy.

The private sub-segment of the real estate market broadly consists of houses and apartments. We have two indicators available measuring the actual purchase prices of houses (house) and apartments (flats). We also have an indicator measuring the actual rents to be paid for apartments (rental).

In figure 3 and 4 we show the impulse responses of house and flat prices to interest rate shocks. Not too surprisingly, both sub-segments react quite similar. An increase in the Swiss key interest rate leads to both a significant decrease in house and flat prices. While flat prices react after one quarter, the effect on house prices becomes significant after half a year. After two and a half years, the effects reach their maximum strengths. The effects disappear after roughly 4 years. The likely interpretation of these results is that higher interest rates lead to an increase of credits costs making acquisitions of one's own property less attractive. Thus assuming fixed supply, the decreasing demand depresses purchase prices of both houses and flats. Altogether, these results broadly coincide with former empirical studies (see e.g. Guilidori [2004], Demary [2009] or Jarocinsky and Smets [2008]) which, however, exclusively concentrate on the house market.

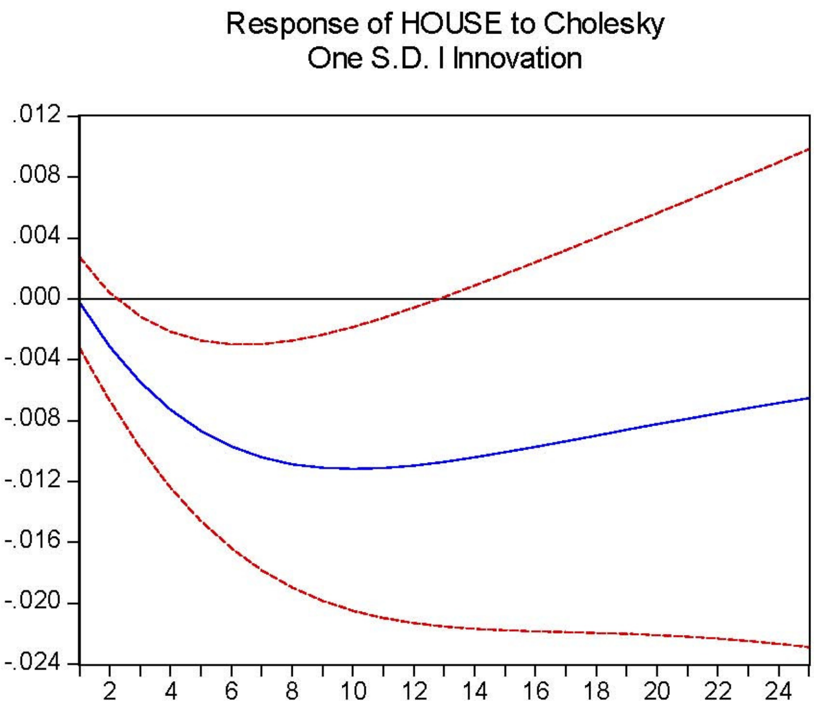

Figure 3: Response of House Prices to Interest Rate Shock

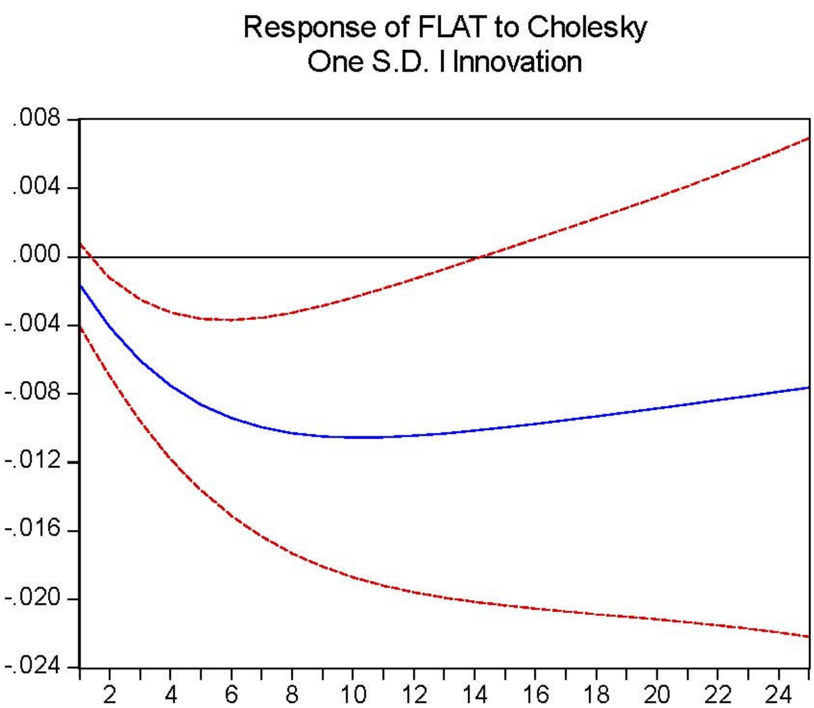

Figure 4: Response of Flat Prices to Interest Rate Shock

In order to get a richer picture of the effects of monetary policy on the private real estate market we also study the effects of interest rate shocks on rental prices of apartments. In figure 5 we show the impulse response function of apartment rental prices to interest rate shocks. Obviously, there is an adverse effect of monetary policy on rental prices. An increase in the Swiss libor rate is quickly followed by increasing rental prices. This effect lasts about 5 quarters before it diminishes.

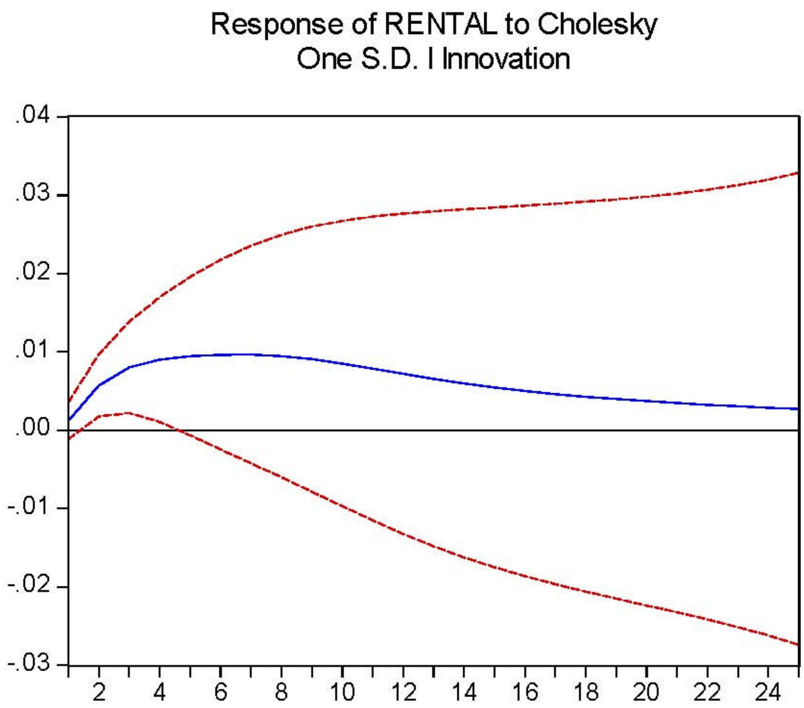

Figure 5: Response of Apartment Rental Prices to Interest Rate Shock

Interestingly enough, there seem to be two contrary effects of monetary policy on privately used real estate. On the one hand, a contractive monetary policy leads to decreasing prices for both houses and flats. On the other hand, there is a reverse effect with respect to rental prices of apartments. One might interpret this result as some kind of substitution effect between buying or renting. Whenever the monetary authority decides to loosen monetary policy by decreasing the libor rate, private borrowing for financing privately owned houses or flats becomes more attractive. For renters considering buying property, such a situation is a favourable point of time to switch from a rented house or flat to credit-financed privately owned home. Thus, the demand for houses and flats is supposed to increase in consequence of decreasing interest rates, resulting in higher property prices (provided the supply remains fixed). At the same time the vacancy rate of rented apartments and houses increases thereby causing decreasing rental prices. Our empirical results indicate that – at least in Switzerland – this sort of substitution effect seems to be empirically relevant.

While privately used property prices react significantly to monetary policy, commercial property prices do not. Figure 6 and 7 show the impulse responses of industrial real estate prices and office space prices to interest rate shocks, figure 8 the one of sales area prices to interest rate shocks. None of the reactions turns out to be significantly different from zero.[11]

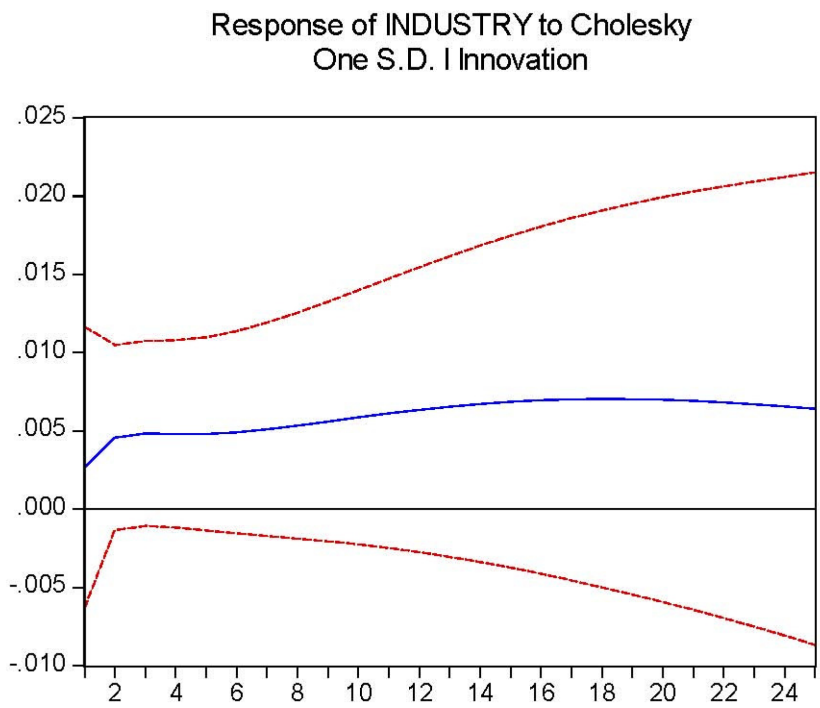

Figure 6: Response of Industrial Real Estate to Interest Rate Shock

[11] Impulse responses of prices for sales area to interest rate shocks lead to exploding confidence bands when estimating the VAR including 6 lags. We also studied impulse responses using only one respectively two lags. The results did not change.

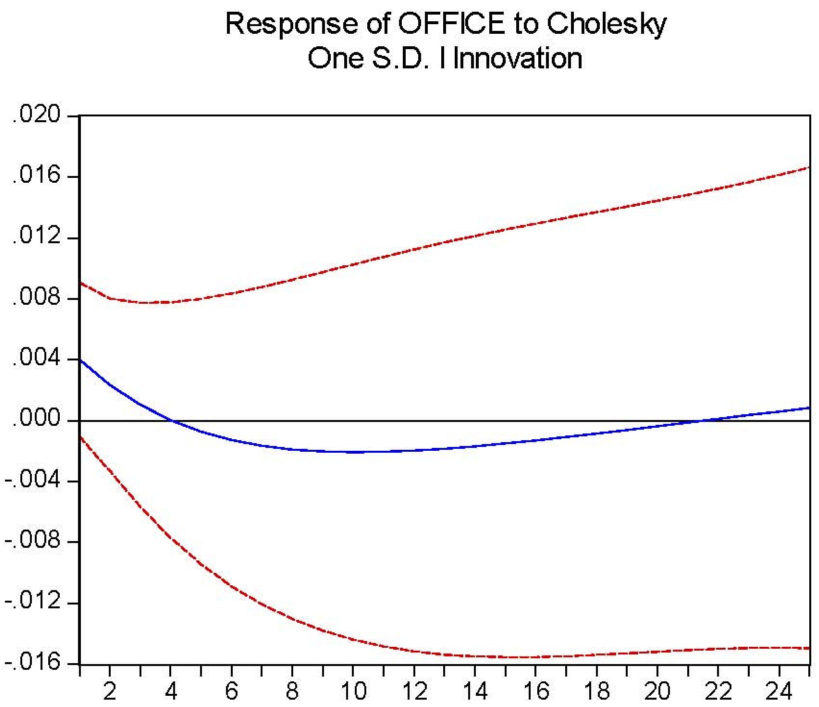

Figure 7: Response of Office Space Prices to Interest Rate Shock

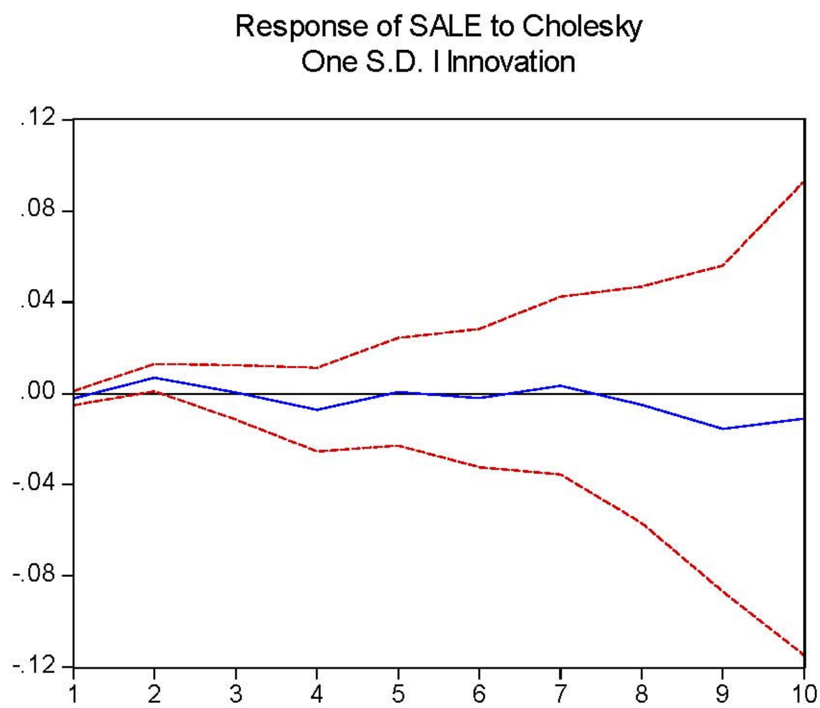

Figure 8: Response of Sales Area Prices to Interest Rate Shock

One might speculate about the reasons for this finding. A possible explanation is that the decision to open up a new production site, office or branch does not primarily depend on external refinancing conditions but primarily on (expected) aggregate demand. However, in boom times when firms might be willing to expand their capacities central banks tend to raise interest rates, thereby increasing credit costs and making these investments less attractive. Since both effects interfere, commercial property indices tend not to react to monetary policy. Moreover, prospering firms have the possibility to finance expansions of capacities via retained earnings and are thus independent of financing conditions.

To check for robustness of our results we checked in how far the impulse responses are sensitive to the ordering of the variables. In a first step we changed the order of monetary policy instruments, i.e. ordering the monetary aggregates before the interest rate. Second, we exchanged inflation and gdp. Third, we changed the asset market variables, i.e. the real estate price index e and the Swiss Performance Index s. These variations did not change the results indicating that they do not primarily depend on the specific ordering of the variables.

5. Summary and Conclusions

A necessary precondition to employ monetary policy to stabilize asset markets is that monetary policy has a significant and predictable effect on asset prices. Most empirical studies find stock markets to remain unaffected by interest rate shocks. With respect to real estate markets, the empirical evidence is somewhat limited in as far as the literature almost exclusively focused on house prices and thus a sub-segment of the private real estate market. However, most empirical studies found house prices - different from stocks - to react significantly to monetary policy instruments.

Employing a new dataset for Switzerland we find empirical evidence which is broadly in line with the literature in as far as the aggregate level is concerned. As the majority of earlier analysis did, we find no influence of variations of the central monetary policy instrument of SNB on the Swiss stock market while the Swiss Real Estate Performance Index as a measure of the whole real estate market reacts significantly to monetary policy. However, the various sub-markets react quite differently to monetary policy shocks. While we find substitution effects between house and apartment prices on the one hand and rental prices on the other, commercial property prices show no significant reaction to interest rate variations. One might therefore suggest that monetary policy might be effective in stabilizing the private real estate market, but not the commercial property market, accounting for almost 40 percent of real estate values. One might also conclude that a tightening of monetary policy tends to decrease house and flat prices, however at the same time contributes to increasing rental prices and thus consumer inflation.

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Appendix

Results of Unit Root Tests (ADF-Test; for every time series a constant is included, for some time series a deterministic linear time trend is regarded.)

Table A1: Unit Root Test of *p*.

Null Hypothesis: P has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.332253	0.6113
Test critical values:	1% level	-3.510259	
	5% level	-2.896346	
	10% level	-2.585396	

*MacKinnon (1996) one-sided p-values.

Table A2: Unit Root Test of *gdp*.

Null Hypothesis: GDP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 11 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.358690	0.3977
Test critical values:	1% level	-4.088713	
	5% level	-3.472558	
	10% level	-3.163450	

*MacKinnon (1996) one-sided p-values.

Table A3: Unit Root Test of *i*.

Null Hypothesis: I has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.908222	0.7812
Test critical values:	1% level	-3.510259	
	5% level	-2.896346	
	10% level	-2.585396	

*MacKinnon (1996) one-sided p-values.

Table A4: Unit Root Test of *m*.

Null Hypothesis: M has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 11 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.794620	0.2040
Test critical values:	1% level	-4.088713	
	5% level	-3.472558	
	10% level	-3.163450	

*MacKinnon (1996) one-sided p-values.

Table A5: Unit Root Test of *s.*

Null Hypothesis: S has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 11 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.863934	0.6628
Test critical values:	1% level	-4.090602	
	5% level	-3.473447	
	10% level	-3.163967	

*MacKinnon (1996) one-sided p-values.

Table A6: Unit Root Test of *Realestate.*

Null Hypothesis: REALESTATE has a unit root
Exogenous: Constant
Lag Length: 11 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.074505	0.9477
Test critical values:	1% level	-3.522887	
	5% level	-2.901779	
	10% level	-2.588280	

*MacKinnon (1996) one-sided p-values.

Table A7: Unit Root Test of *House.*

Null Hypothesis: HOUSE has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.628676	0.0914
Test critical values:	1% level	-3.513344	
	5% level	-2.897678	
	10% level	-2.586103	

*MacKinnon (1996) one-sided p-values.

Table A8: Unit Root Test of *Flat.*

Null Hypothesis: FLAT has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.109702	0.7088
Test critical values:	1% level	-3.511262	
	5% level	-2.896779	
	10% level	-2.585626	

*MacKinnon (1996) one-sided p-values.

Table A9: Unit Root Test of *Rental.*

Null Hypothesis: RENTAL has a unit root
Exogenous: Constant
Lag Length: 11 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.980383	0.0415
Test critical values:	1% level	-3.522887	
	5% level	-2.901779	
	10% level	-2.588280	

*MacKinnon (1996) one-sided p-values.

Table A10: Unit Root Test of *Office.*

Null Hypothesis: OFFICE has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 9 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.455147	0.0519
Test critical values:	1% level	-4.085092	
	5% level	-3.470851	
	10% level	-3.162458	

*MacKinnon (1996) one-sided p-values.

Table A11: Unit Root Test of *Industry*.

Null Hypothesis: INDUSTRY has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 9 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.361879	0.8641
Test critical values:	1% level	-4.085092	
	5% level	-3.470851	
	10% level	-3.162458	

*MacKinnon (1996) one-sided p-values.

Table A12: Unit Root Test of *p* (Dataset 1996:Q1-2008:Q4).

Null Hypothesis: P has a unit root
Exogenous: Constant
Lag Length: 10 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.350707	0.5967
Test critical values:	1% level	-3.600987	
	5% level	-2.935001	
	10% level	-2.605836	

*MacKinnon (1996) one-sided p-values.

Table A13: Unit Root Test of *gdp* (Dataset 1996:Q1-2008:Q4).

Null Hypothesis: GDP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 10 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.949263	0.1586
Test critical values:	1% level	-4.198503	
	5% level	-3.523623	
	10% level	-3.192902	

*MacKinnon (1996) one-sided p-values.

Table A14: Unit Root Test of *i* (Dataset 1996:Q1-2008:Q4).

Null Hypothesis: I has a unit root
Exogenous: Constant
Lag Length: 10 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.918678	0.3208
Test critical values:	1% level	-3.600987	
	5% level	-2.935001	
	10% level	-2.605836	

*MacKinnon (1996) one-sided p-values.

Table A15: Unit Root Test of *m* (Dataset 1996:Q1-2008:Q4).

Null Hypothesis: M has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 10 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.758744	0.0293
Test critical values:	1% level	-4.198503	
	5% level	-3.523623	
	10% level	-3.192902	

*MacKinnon (1996) one-sided p-values.

Table A16: Unit Root Test of *s* (Dataset 1996:Q1-2008:Q4).

Null Hypothesis: S has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 10 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.315950	0.4163
Test critical values:	1% level	-4.198503	
	5% level	-3.523623	
	10% level	-3.192902	

*MacKinnon (1996) one-sided p-values.

Table A17: Unit Root Test of *Sale* (Dataset 1996:Q1-2008:Q4).

Null Hypothesis: SALE has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.180596	0.0275
Test critical values:	1% level	-3.577723	
	5% level	-2.925169	
	10% level	-2.600658	

*MacKinnon (1996) one-sided p-values.

Results of the Johansen Cointegration Tests for all 7 VAR specifications.

Table A18: Cointegration Test for the VAR including *Realestate.*

Sample (adjusted): 1988Q3 2008Q4
Included observations: 82 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: P GDP I M REALESTATE S
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.491616	168.3167	117.7082	0.0000
At most 1 *	0.410299	112.8422	88.80380	0.0003
At most 2 *	0.283550	69.53474	63.87610	0.0155
At most 3	0.204119	42.19207	42.91525	0.0590
At most 4	0.164531	23.47099	25.87211	0.0967
At most 5	0.100998	8.730535	12.51798	0.1976

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table A19: Cointegration Test for the VAR including *House.*

Sample (adjusted): 1988Q3 2008Q4
Included observations: 82 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: P GDP I M HOUSE S
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.554917	181.8230	117.7082	0.0000
At most 1 *	0.407471	115.4445	88.80380	0.0002
At most 2 *	0.325189	72.52933	63.87610	0.0078
At most 3	0.214035	40.27682	42.91525	0.0896
At most 4	0.149314	20.52772	25.87211	0.2003
At most 5	0.084812	7.267344	12.51798	0.3174

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table A20: Cointegration Test for the VAR including *Flat.*

Sample (adjusted): 1988Q3 2008Q4
Included observations: 82 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: P GDP I M FLAT S
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.510074	170.7036	117.7082	0.0000
At most 1 *	0.388464	112.1965	88.80380	0.0004
At most 2 *	0.312379	71.87045	63.87610	0.0091
At most 3	0.222169	41.15997	42.91525	0.0741
At most 4	0.157322	20.55781	25.87211	0.1990
At most 5	0.076454	6.521849	12.51798	0.3971

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table A21: Cointegration Test for the VAR including *Rental.*

Sample (adjusted): 1988Q4 2008Q4
Included observations: 81 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: P GDP I M RENTAL S
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.527101	172.9478	117.7082	0.0000
At most 1 *	0.363050	112.2891	88.80380	0.0004
At most 2 *	0.298388	75.75290	63.87610	0.0036
At most 3 *	0.260629	47.04850	42.91525	0.0183
At most 4	0.147761	22.59010	25.87211	0.1215
At most 5	0.112193	9.639114	12.51798	0.1445

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table A22: Cointegration Test for the VAR including *Industry.*

Sample (adjusted): 1988Q3 2008Q4
Included observations: 82 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: P GDP I M INDUSTRY S
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.386827	142.1908	117.7082	0.0006
At most 1 *	0.379848	102.0840	88.80380	0.0040
At most 2	0.304136	62.90520	63.87610	0.0602
At most 3	0.202665	33.17190	42.91525	0.3279
At most 4	0.121479	14.60056	25.87211	0.6078
At most 5	0.047381	3.980290	12.51798	0.7450

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table A23: Cointegration Test for the VAR including *Office.*

Sample (adjusted): 1988Q3 2008Q4
Included observations: 82 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: P GDP I M OFFICE S
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.445044	137.8148	117.7082	0.0015
At most 1 *	0.385469	89.52774	88.80380	0.0443
At most 2	0.256864	49.60223	63.87610	0.4316
At most 3	0.116347	25.25843	42.91525	0.7767
At most 4	0.108215	15.11580	25.87211	0.5649
At most 5	0.067428	5.724326	12.51798	0.4961

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table A24: Cointegration Test for VAR including *Sale* (Dataset 1996:Q1-2008:Q4).

Sample (adjusted): 1996Q2 2008Q4
Included observations: 51 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: P GDP I M SALE S
Lags interval (in first differences): No lags

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.542948	131.5159	117.7082	0.0050
At most 1 *	0.463224	91.58506	88.80380	0.0310
At most 2	0.391395	59.85417	63.87610	0.1040
At most 3	0.314185	34.52833	42.91525	0.2650
At most 4	0.204387	15.29382	25.87211	0.5502
At most 5	0.068758	3.633059	12.51798	0.7943

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Documentation of the impulse-responses of all 7 VAR specifications.

Figure A1: VAR including *Realestate.* Impulse Responses to the interest rate shock.

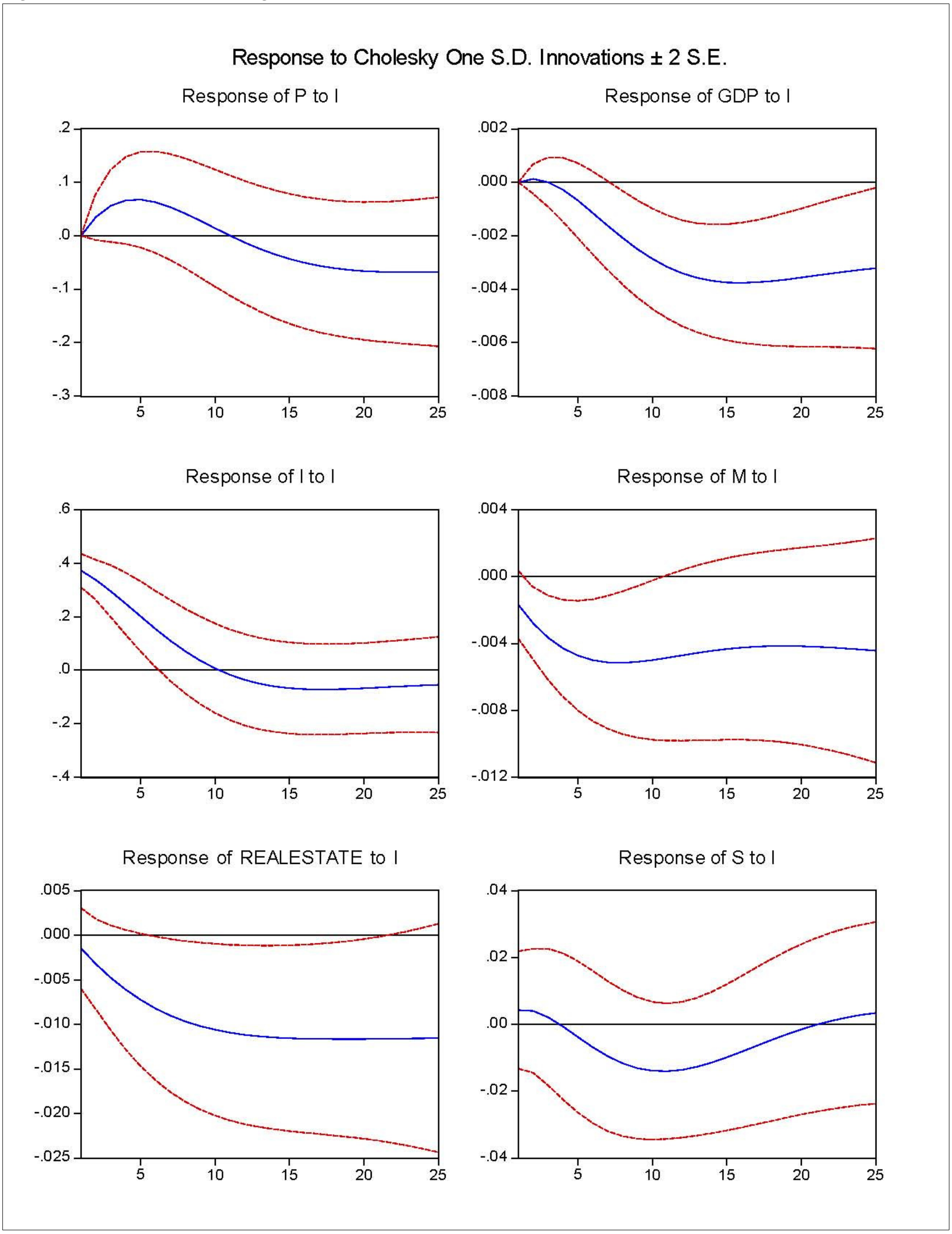


Figure A2: VAR including *House.* Impulse Responses to the interest rate shock.

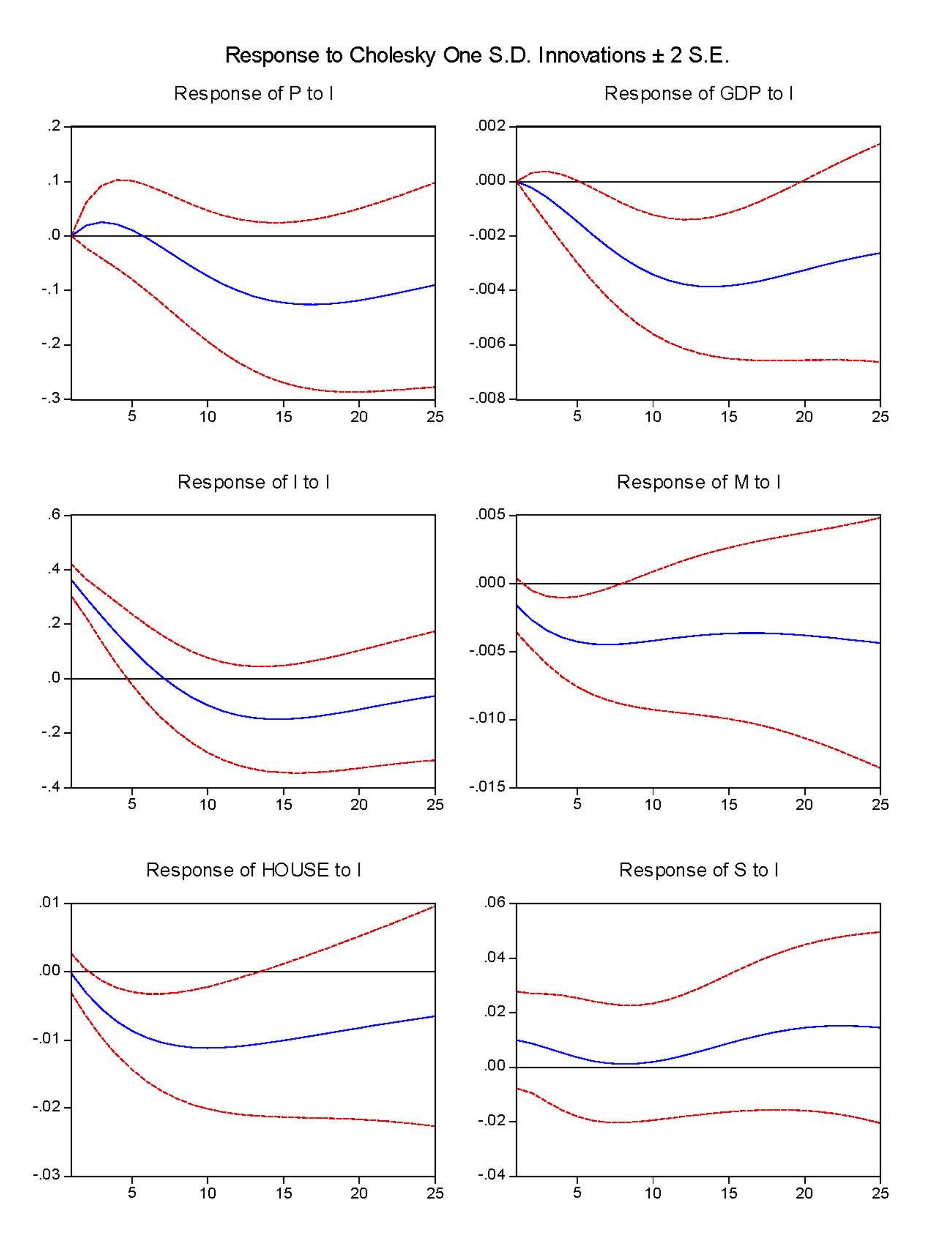


Figure A3: VAR including *Flat.* Impulse Responses to the interest rate shock.

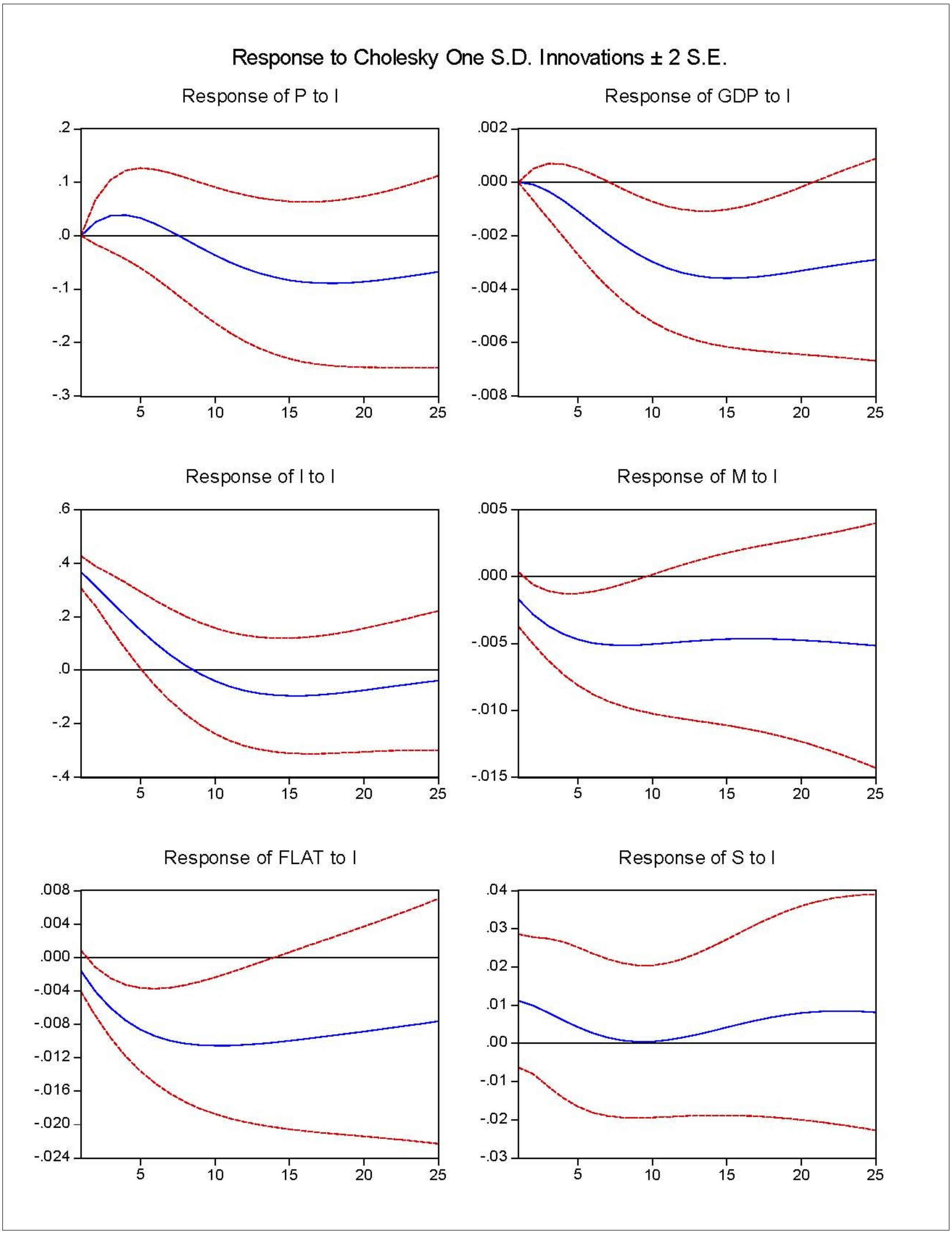


Figure A4: VAR including *Rental.* Impulse Responses to the interest rate shock.

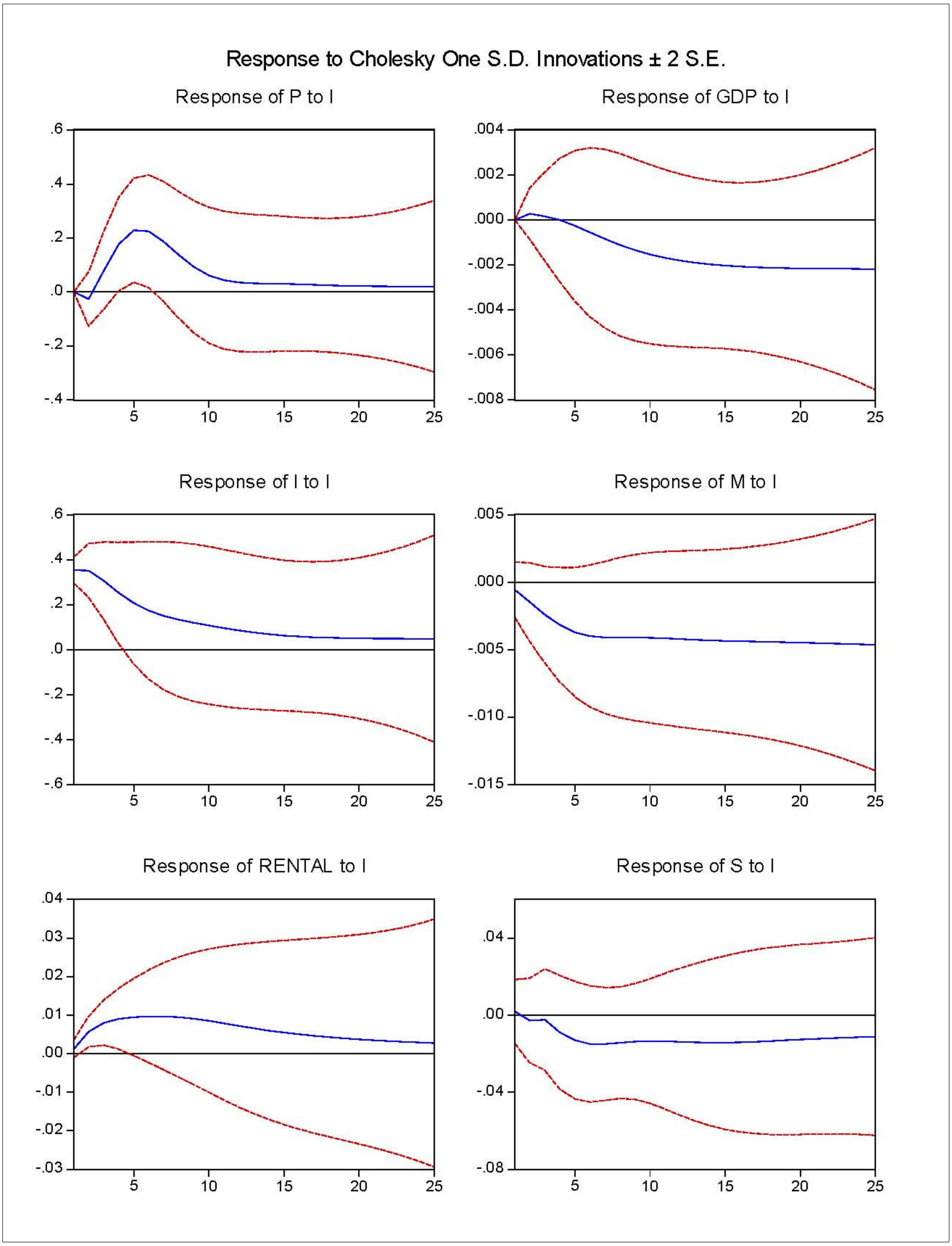


Figure A5: VAR including *Industry*. Impulse Responses to the interest rate shock.

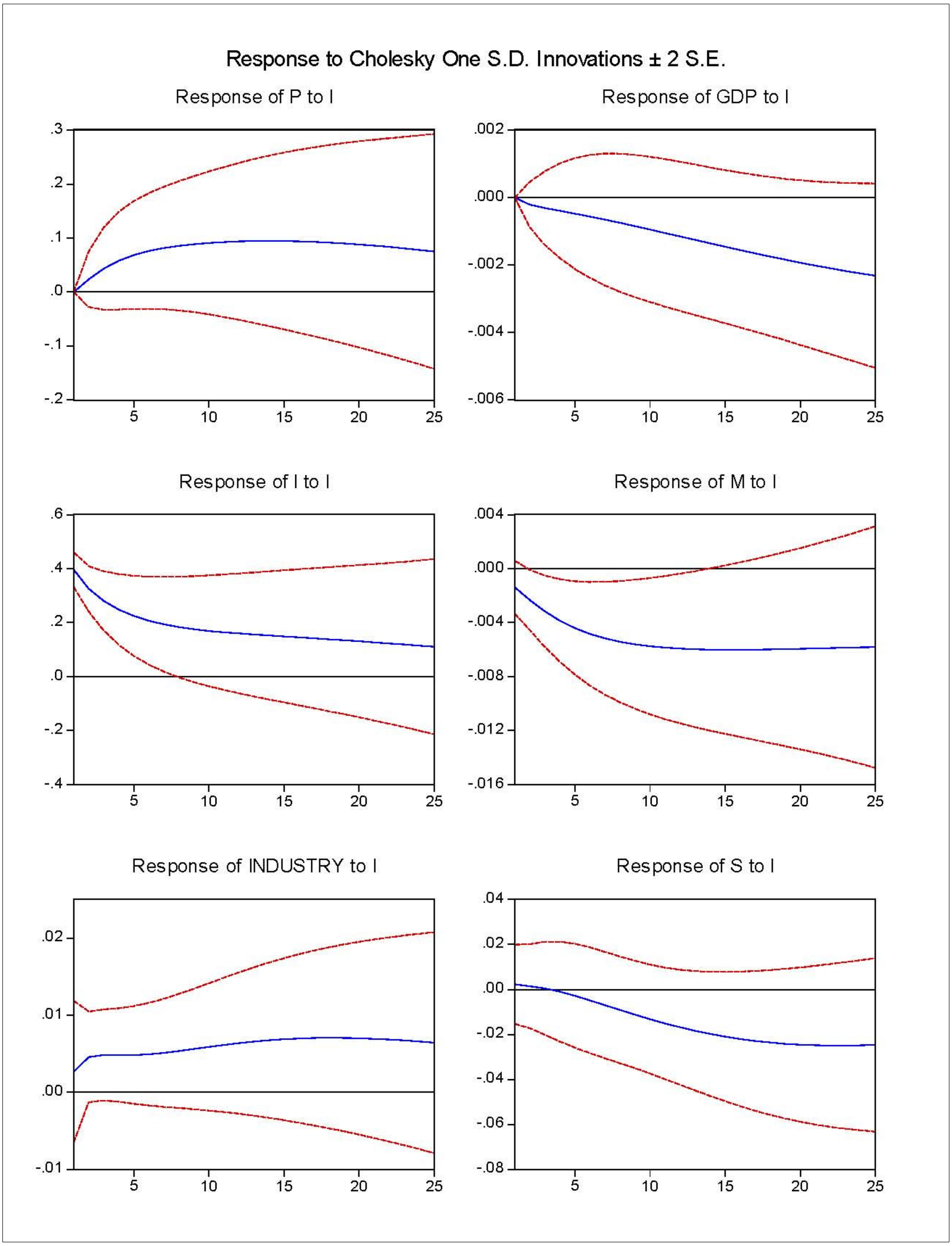


Figure A6: VAR including *Office.* Impulse Responses to the interest rate shock.

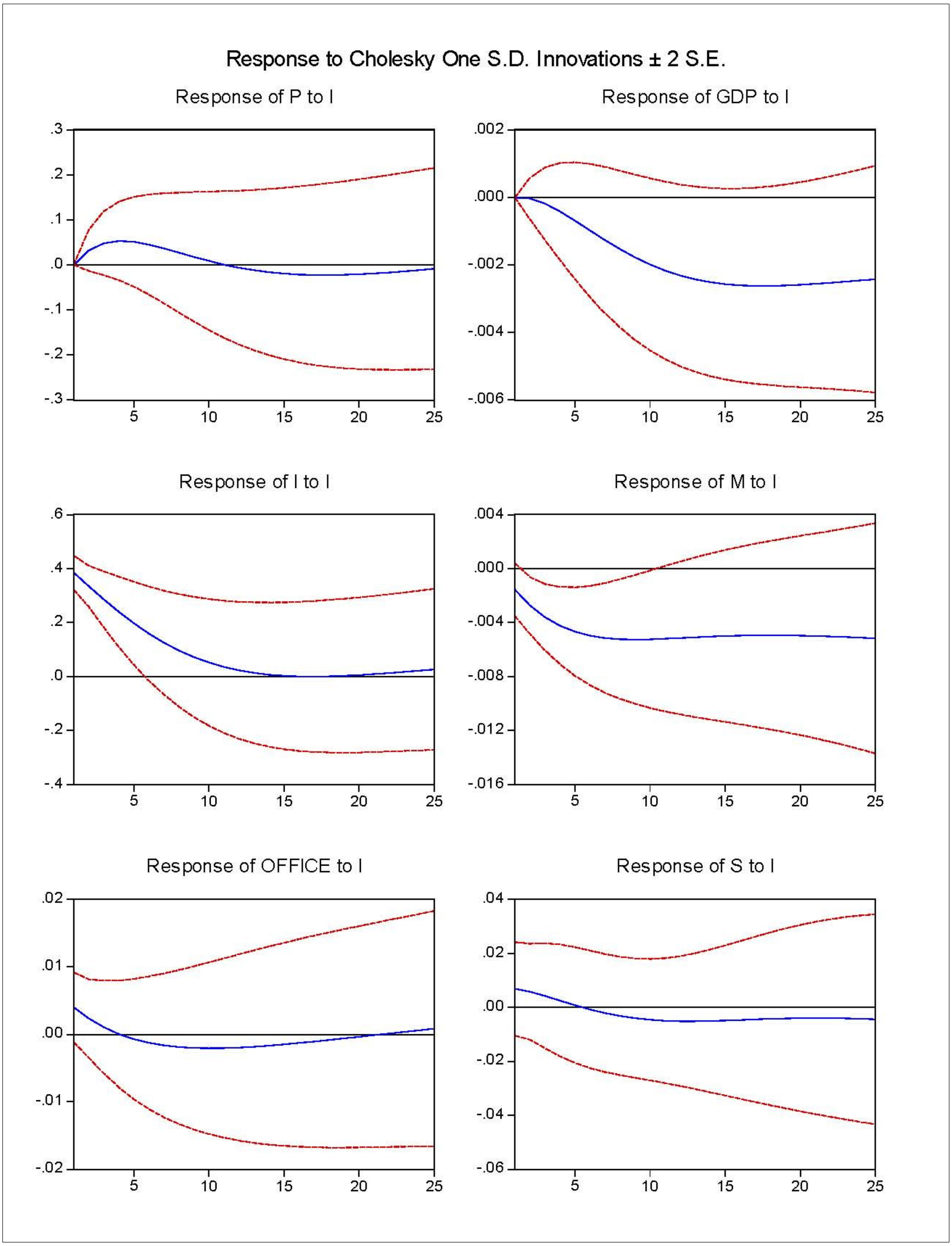
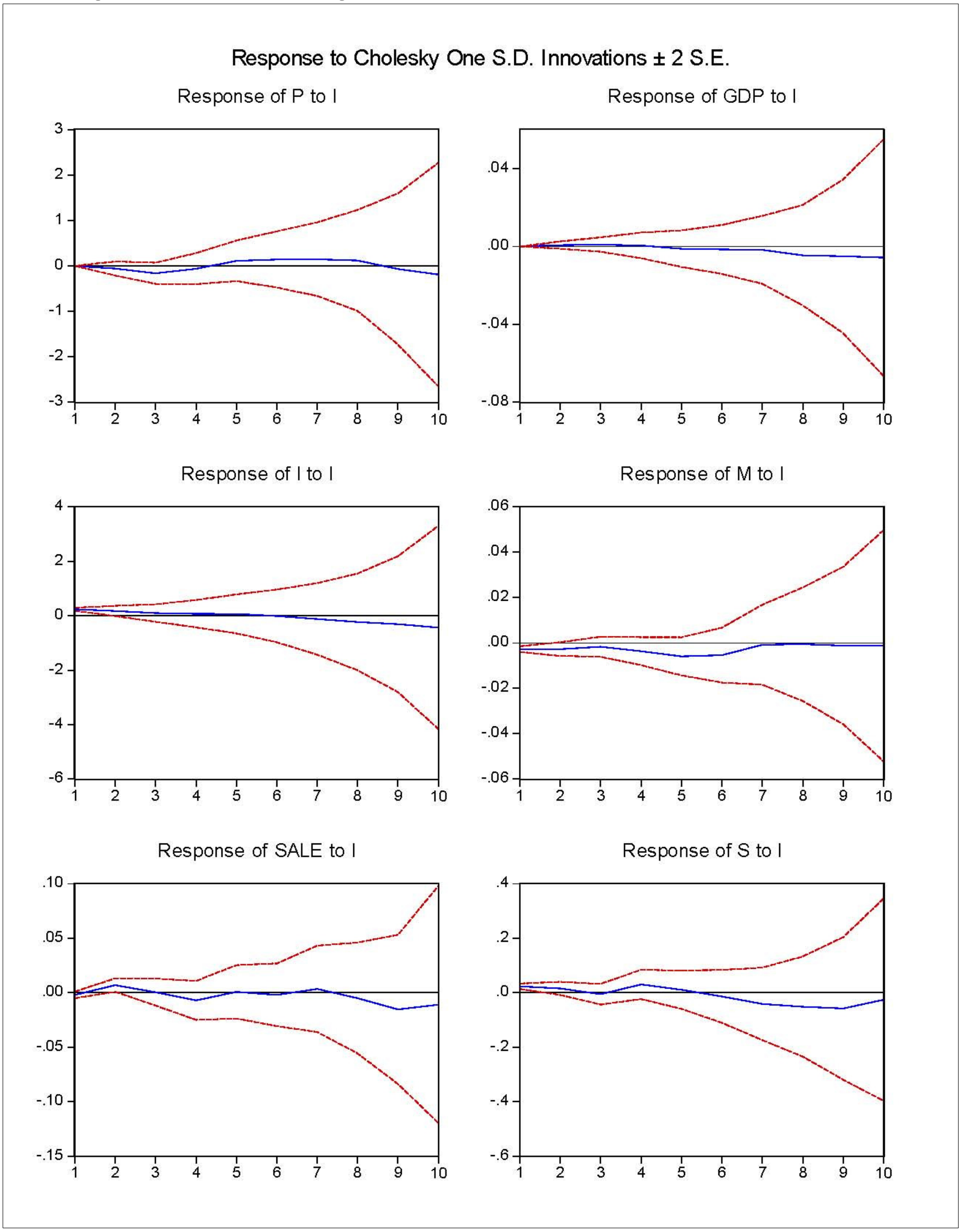


Figure A7: VAR including *Sale.* Impulse Responses to the interest rate shock.



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