Pegging the Swiss Franc to the Euro in a World with Different Types of Shocks: Simulations with a Macroeconometric Model

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1 Introduction

The Swiss economy has repeatedly been confronted with strong *upward pressures* on the *Swiss franc* due to its role as a "safe haven" in times of international uncertainties. Moreover, there was also a *trend appreciation* in the real exchange rate over the past three decades. On the other hand, Swiss interest rates – even when corrected for the appreciation – have been notably lower than in most other countries. This deviation from the interest rate parity condition can be viewed as an *interest rate bonus* in favor of Switzerland. These well-known facts have received renewed attention in the political discussion in Switzerland, in particular in connection with the situation of Switzerland as an outsider to the European Monetary Union (EMU). Considering that about 60% of Swiss exports go to the Euro area, it is sometimes argued that the benefits resulting from a stable Swiss franc/Euro exchange rate would outweigh the related loss of the interest rate bonus.

Of course, EMU accession is a feasible option only along with a full EU membership, which would differ from the status quo in many additional respects, both economically and politically. However, a route that could be taken by Swiss National Bank (SNB) unilaterally is *pegging the Swiss franc/Euro exchange rate*. If credible, such a policy would also result in a loss of the interest rate bonus. Moreover, it would prevent the Swiss National Bank from conducting an *autonomous monetary policy*. This paper tries to evaluate the pros and cons of such a Euro peg on basis of a quarterly econometric model for Switzerland.

The model has *Keynesian properties* in the short run but converges to a *classical growth path* in the long run. GDP, as determined from the demand side as the sum of the components of aggregate demand, is confronted in the supply part of the model with capacity output. The production function underlying the definition of capacity output also establishes a link from the goods to the labor market, where employment depends in a "Beveridge curve"-type approach on labor demand, labor supply and structural mismatch. Inflation is driven by the demand/supply-ratios in the goods and labor market and counteracted by monetary policy. Due to sluggish price and wage adjustments, aggregate demand and monetary variables play an important role in explaining short-term fluctuations of the real economy. In the long run, however, the development of GDP is determined by the supply side of the economy, i.e. any overhang in the growth of nominal demand over the potential is absorbed by inflation.

This model is regularly used at SNB along with other models in the process of inflation forecasting: In this paper, it forms the basis for various simulations aimed at assessing the pros and cons of a potential Euro peg.

(A) In a first step, the actual development of the Swiss economy since the start of EMU in 1999 is confronted with a counterfactual simulation in which the Swiss franc is pegged to the Euro at the exchange rate prevailing when EMU came into operation. The simulation thus suppresses on the one hand the actual appreciation of the Swiss franc of nearly 10% over the period 2000-2002. On the other hand, short and long-term interest rates jump to levels that are 1.5 percentage points higher than under the "status quo". The model analyzes the resulting adjustment process in the Swiss economy.

Whatever the outcome of this simulation, one should refrain from drawing far-reaching conclusions for the following reasons. First, the simulation refers to a specific time period characterized by a strong appreciation of the Swiss franc. In other periods, the Swiss economy was subject to various other types of shocks. In such circumstances, as the ECB's current "one size must fit all" problem illustrates, a fixed exchange rate and interest rates appropriate for the Euro area as a whole may turn out to be detrimental to a country whose cyclical position differs from the Euro area average. Second, the adjustment problems resulting from the sudden increase in interest rates may be severe, but this has little to say about the state of affairs once the adjustment process to a new monetary environment is completed. In order to reach a more balanced assessment, one should therefore distinguish between three quite different implications of an Euro peg, namely

(i) the interest rate shock associated with the introduction of the Euro peg,

(ii) the long-term consequences of a higher level of nominal interest rates, and

(iii) the loss of monetary independence vis-à-vis possibly asymmetric shocks.

Aspect (i) is dealt with in the aforementioned simulation (A). Aspect (ii) is not investigated because the model at hand is not suited to tackle questions related to long-term growth with sufficient rigor. Aspect (iii) is the topic of several additional simulations, addressing the following questions.

(B) How independently was Swiss monetary policy conducted in the past relative to the ECB (the German Bundesbank prior to 1999) and did the observed degree of independence contribute to more stability in terms of inflation rates and GDP growth? This question can be addressed by comparing the development of the Swiss economy under the actual course of Swiss short-term interest rates (baseline simulation) with an alternative in which the Swiss/Euro interest rate differential remains constant at the historical average of 1.5 percentage points. In other words, the alternative simulation assumes that the SNB had just duplicated the ECB's interest rate decisions (on a lower level, though), and the comparison with the baseline shows to what extent monetary independence was actually used and successful in terms of stabilizing the economy. The simulation period is 1981 to 2002 (quarterly data).

(C) The counterfactual simulation described in (B) is not a Euro peg scenario. It only assumes loss of control on short-term interest rates but leaves the exchange rate flexible. Flexibility on the one hand means that the exchange rate may move in response to fundamentals like interest rate and inflation differentials, which seems desirable with regard to economic stability. On the other hand, a flexible exchange rate is likely to be subject to destabilizing exogenous shocks. The potential advantage of a Euro peg over the status quo of monetary independence thus depends on

(i) the severity of exchange rate shocks relative to all other shocks,

(ii) the way in which Swiss monetary policy reacts to all types of shocks, and

(iii) the stabilizing role of fundamental exchange rate movements.

These are the issues that must be taken into consideration when comparing the regime of a Euro peg with the status quo of monetary independence. The Euro peg scenario is simulated by fixing the Swiss franc/Euro exchange rate at the historical average of the sample period while the assumption with respect to short-term interest rates is the same as in (B), i.e. the simulation does not address the short-run adjustment problems caused by a sudden increase in interest rates. Hence, there are two alternative simulations (A: loss of control on short-term interest rates, B: Euro peg), and the comparison with the baseline case of monetary independence shows whether the destabilizing effect of the loss of control on short-term interest rates is overcompensated by a potentially stabilizing effect of a fixed exchange rate. Again, the simulation period is 1981-2002 (quarterly data).

(D) In the comparison just mentioned, the regime of monetary independence is simulated on basis of the estimated equation for short-term interest rates (kind of a *Taylor rule*). This equation does not have the status of an "official" monetary reaction function. Moreover, although it has good statistical properties and may be assumed to reflect the average behavior of monetary policy in the past twenty years, it is certainly not cast in stone. Therefore, the question arises whether a more independent course of monetary policy, i.e. stronger reactions of short-term interest rates to Swiss-specific factors, would have done a better job in stabilizing the economy. The answer to this question is not obvious. As monetary policy affects GDP and - even more so - inflation with substantial lags, a more "activist" policy may in fact turn out to be *pro-cyclical*. For example, lowering interest rates aggressively in a trough involves the danger that the main stimulus on the economy falls in a phase where the cycle has already reversed. Hence, while it is usually fiscal policy that is criticized for having pro-cyclical effects, monetary policy may run into the same problems, although for different reasons. Whereas pro-cyclical effects of fiscal policy typically arise from decision and implementation lags, the same can happen to monetary policy due to delays in the response of GDP and inflation to policy changes. The question of whether a more activist course of monetary policy would have been stabilizing or destabilizing is addressed in the paper by running a series of alternative simulations in which the reaction function is made more responsive to some or all of its arguments.

The shocks to which monetary policy reacts (or is prevented from reacting by the peg) in the above simulations may be traced back in the model to two broad groups: Shocks that are transmitted to Switzerland through the *exogenous variables* of the model and shocks that are captured by the *error terms* of the stochastic equations. Accordingly, assuming a steady growth path for the world economy and setting all error terms of the model to zero, the Swiss economy also converges to a steady growth path. A somewhat different distinction is usually made in the literature on optimal currency areas, namely that between *symmetric* and *asymmetric* shocks.[1] In the context of this paper, symmetric shocks can be thought of as shocks that hit the Euro area and Switzerland in the same way. Further assuming that the ECB (formerly the Bundesbank) and the SNB share the same objectives, monetary reactions to such shocks would be identical anyway. So it is only in case of asymmetric (or Swiss-specific) shocks that monetary independence is potentially an advantage. The two distinctions (shocks transmitted to Switzerland through the exogenous variables vs. shocks captured by the residuals, symmetric vs. asymmetric shocks) are similar but do no fully coincide. On the one hand, the responses of the Swiss economy to world economy shocks may be partly Swiss-specific because of differences in the structure of the economy, the flexibility of prices and wages or different reactions of fiscal policy. Therefore, even if only world economy shocks were at work, monetary independence may be advantageous. On the other hand, shocks captured by the residuals are not necessarily entirely Swiss-specific because the may reflect disturbances that are relevant to the Euro area and Switzerland alike. The paper tries to shed some light on these questions as well.

The remainder of the paper is organized as follows. *Section 2* gives a short description of the model, focusing on the monetary reaction function and the monetary transmission mechanism because these parts of the model play a central role in the various simulations. This section also provides some information on the dynamic tracking performance of the model - as it seems crucial to base the analysis on a model that is able to reproduce the actual developments of the Swiss economy with reasonable accuracy, as opposed to overly stylized models that may look nice from a theoretical point of view but often lack empirical relevance.[2] *Section 3* presents the counterfactual simulation in which

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1 See, e.g., Mundell (1961) and Bayoumi and Eichengreen (1993).

2 On the other hand, it is probably true that models with a strong empirical orientation are more prone to the Lucas-critique, since it cannot be excluded that empirical regularities may change under a new policy rule. This reservation has certainly to be kept in mind when interpreting the simulation results.

the Swiss franc is pegged to the Euro at the start of EMU in 1999 and Swiss interest rates immediately jump to the higher Euro level. *Section 4* forms the core of the paper. It starts with the decomposition of shocks into different categories, examines to what extent monetary independence was actually utilized by SNB over the past twenty years relative to the ECB (the Bundesbank prior to EMU), discusses the Euro peg scenario and finally asks whether a more independent course of Swiss monetary policy would have mitigated the volatility of output and inflation. *Section 5* summarizes the main results and draws some conclusions.

2 The model

The model used in the following simulations is a quarterly structural model of the Swiss economy. In its present version, it contains 30 stochastic equations, which may be assigned to an *aggregate demand block*, a *supply block* (production function, labor market, wage-price dynamics) a *monetary block* (interest and exchange rates) and an auxiliary *income block* (derivation of disposable household income). The basic structure of the model is shown in *Figure 1*. Although the model is rather conventional in most respects, it involves some *distinguishing features* that should be pointed out.[3]

2.1 Specification

A rather non-standard approach is taken in the specification of the *supply block* of the model. The equations for firms' decisions on investment, production capacity and factor input ratios are based on a *putty-clay production function.* On this assumption, the problem of the firm is to choose on each investment vintage the cost-minimizing factor mix, to pursue an optimal policy of replacing old by new equipment and to adjust production capacities in response to changes in goods demand and factor costs. On the assumption of monopolistic competition in the goods market, firms set the *price* as a profit-maximizing markup over marginal costs. These can be defined either as total unit costs on new equipment or as unit labor costs on marginal (oldest) equipment. The two concepts are equivalent in equilibrium due to the scrapping rule, saying that existing vintages get replaced as soon as the associated unit labor costs exceed total unit costs on the most recent vintage.

At the micro level, the output level of an individual firm may be constrained in the *short run* either by demand or by available capacities. In case of a demand constraint, there is a negative spillover onto effective labor demand. At the aggregate level, however, one always observes a mix of the two regimes in the form of certain *proportions of demand and capacity-constrained firms*. This regime mix is endogenously determined in the model by the demand/supply ratio in the goods market and empirically measured by business survey data (assessment of capacities as "too big" or "too small").

The specification of the *labor market* is analogous. For instance, if aggregate labor demand increases, actual employment converges from below to aggregate labor supply and the proportion of labor-constrained firms tends - in the limit - to an upper bound of one, implying a relationship between unemployment and vacancies in the form of a Beveridge curve with a certain level of "structural"

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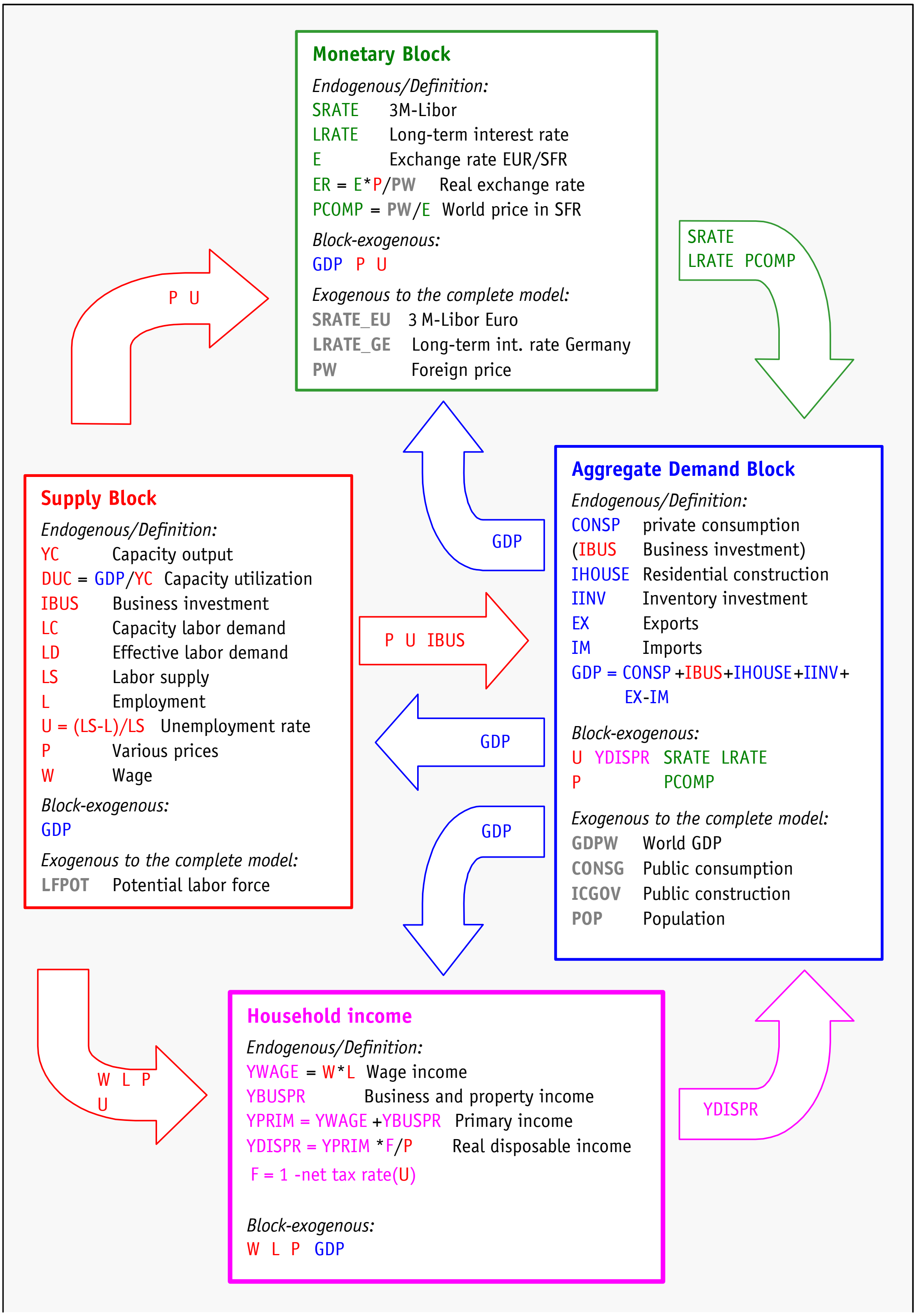
[3] A more detailed description of the model is given in Stalder (2001a, 2002).

Figure 1: Basic structure of the model



unemployment defined at the point where aggregate labor demand equals aggregate labor supply.[4] The proportion of labor-constrained firms is measured by business survey data on "labor bottlenecks".

Tension in the labor market (reflected in proportion of labor-constrained firms) and tension in the goods market (reflected in the proportion of capacity-constrained firms) feed into the *wage* and *price equations* of the model. If tension in the two markets gets too high, the formation of wages and prices is such that an inflationary spiral is set in motion. This process must go to the point where real activity is dampened enough to make the income claims or workers and firms compatible with stable inflation.[5]

The demand side of the goods market consists of several equations for the *components of aggregate demand*:

- *Private consumption* depends on real disposable household income, the real long-term interest rate and the unemployment rate.
- *Business investment* reacts on (and thus tends to close) the gap between available capacities and aggregate demand evaluated at the long-term normal mark-up price. In addition, relative factor cost influence business investment through the optimal factor input ratio.
- *Housing investment* responds to the level and the growth rate of GDP, a specific profitability measure (involving long-term interest rates, housing rents and construction prices) and population growth.
- *Inventory investment* is specified according to a *buffer-stock stock-adjustment* model. The impact of purely short-term demand shocks on GDP is thus buffered by inventory changes, whereas more persistent demand movements are reinforced by the stock-adjustment process.
- *Exports* depend on a weighted composite of GDP in Europe, the USA and Japan on the one hand and the Swiss supply price in relation to the price of competing producers in the world economy on the other hand.
- *Imports* react to all components of aggregate demand with component-specific elasticities on the one hand and import prices in relation to the GDP-deflator on the other hand.
- *Public construction* and *government consumption* are treated as exogenous or - as an alternative in long-term model simulations - linked in fixed proportions to GDP.

Together, these equations determine GDP from the demand side. In the long-run, however, GDP is constrained by capacity output. In a situation where GDP tends to this upper bound, the proportion of capacity constrained firms increases. This drives prices up, which in turn dampens aggregate demand, in particular via foreign trade (lower exports, higher imports), while investment and capacity growth are stimulated. Together, these mechanism work towards equilibrium in the long run.

The goods market and the labor market interact via the production function and wage-price dynamics, as described above. Another important link goes from income generated in the labor market to disposable household income and from there to private consumption on the demand side of the model.

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4 Theoretical foundations are set out in Stalder (1991). Similar approaches have been proposed by Lambert (1988), Sneessens (1987, 1990) and Drèze and Bean (1990).

5 This specification of wage-price dynamics is in the spirit of the specific NAIRU concept proposed by Layard, Nickel and Jackman (1991).

Labor income is the major component of *primary household income.* The other part, *business and property income*, is linked to *non-wage value-added*, defined as nominal GDP minus the total wage bill. Primary household income and the exogenous *net-tax rate* define *disposable household,* which enters the consumption equation of the model.

The central price equation of the model refers to the *GDP-deflator* (price of total value-added). In addition, the model determines various *sector prices*:

- *Consumer prices* are linked to the GDP-deflator and import prices.
- *Construction prices* depend on the GDP-deflator and the share of construction investment in total GDP as a rough indicator for tension in the construction sector.
- *Housing rents* are determined by construction prices and interest rates, reflecting Swiss legislation that allows house owners to pass changes in the mortgage rate in certain proportions to tenants.
- *Import prices* are linked to world market prices converted into Swiss francs by the trade-weighted external value of the Swiss franc.
- *Export prices* depend on the GDP-deflator and import prices as a proxy for the input prices of imported raw materials and intermediate products.

The *monetary block* determines *short-term interest rates* (three-month Libor for Swiss francs, the operational target of SNB), *long-term interest rates* (government bond rate) and the *exchange rate of the Swiss franc*. The specification of this part of the model, which will play a decisive role in the following simulations, is based on the following considerations:

- The orientation of *monetary policy* is reflected in the 3M-Libor, and it is assumed that this short-term interest rate is a "sufficient statistic" for the stance of monetary policy. Put differently, apart from supporting the desired short-term interest rate, there is no additional role for the quantity of money in the model.
- Swiss *long-term interest rates* depend on Swiss short-term interest rates and foreign long-term interest rates.
- The *exchange rate of the Swiss* reacts to interest rate differentials and the balance on the external account.

Taking into account the foreign trade relations of Switzerland, it is assumed that monetary policy pays special attention to the exchange rate of the Swiss franc vis-à-vis the Euro (the German Mark prior to EMU). Therefore, the model is focused on the determination of the Swiss franc/Euro exchange rate. The overall trade-weighted external value of the Swiss franc is then defined by the endogenous Swiss franc/Euro exchange rate and the exogenous exchange rates of the Euro against all other currencies.

Based on these considerations, monetary policy is assumed to be conducted in such a way that the 3M-Libor (*srate*) goes up if real GDP growth and inflation rise, whereas an appreciation of the Swiss franc and high unemployment are counteracted by lowering short-term interest rates. These reactions of *srate* take place in relation to the Euro (German) short-term interest rate (*srate**) in the following form:

$$\begin{aligned} \Delta srate_t = {} & S_s \Delta srate_t^* + S_e \log(e_t / e_{t-1}) + S_y \log(Y_t / Y_{t-1}) - S_u URATE_t \\ & - S_c \left(srate_{t-1} - S_0 - srate_{t-1}^* \right) \end{aligned} \tag{1}$$

The exchange rate e is defined as Euro per Swiss franc, so that an appreciation of the Swiss franc corresponds to an increase in e. Y is real GDP and $URATE$ is the unemployment rate. The equation is written in such a way that all reaction parameters (S_s, S_e, S_y, S_u) and the error correction parameter S_c are positive.

Attempts to include the current inflation rate in (1) were empirically unsuccessful. This result is neither surprising nor disturbing: On the one hand, in case of a cost-induced inflation, the appropriate policy response is rather to accommodate the price increase to some extent than to tighten monetary reins. On the other hand, in case of a demand-pull inflation, high GDP growth precedes inflation, so that monetary tightening is advisable already when GDP growth rises. Moreover, *URATE,* which can be regarded as a proxy for the output gap, is one of the driving forces in the wage-price block of the model. Thus, low values of *URATE* can be viewed as a leading indicator of rising inflation as well.

The dependence of *srate* on *srate** in (1) is of an *error correction* form. If *srate** changes, *srate* moves by the same amount in the long run, while the short-run adjustment is governed by parameters S_s and S_c. The dependence of *srate* on the change in the exchange rate, GDP growth and the unemployment rate is of a simple *partial adjustment* type. This can be made more apparent be rewriting (1) as:

$$\begin{aligned} srate_t = {} & S_0 S_c + (1 - S_c) srate_{t-1} + S_e \log(e_t / e_{t-1}) + S_y \log\left(Y_t / Y_{t-1}\right) + S_u URATE_t \\ & + S_s srate_t^* + (S_c - S_s) srate_{t-1}^* \end{aligned} \tag{1'}$$

For movements in *URATE*, e.g., the short-run impact on *srate* is given by S_u and the long-run impact by S_u / S_c.

The *long-term interest rate* depends on the foreign long-term interest rate and - in a specific form - on Swiss and foreign short-term interest rates:

$$\begin{aligned} \Delta lrate_t = {} & L_l \Delta lrate_t^* + L_s \left[\Delta srate_t - S_s \Delta srate_t^* + S_c \left(srate_{t-1} - S_0 - srate_{t-1}^*\right)\right] \\ & - L_c \left(lrate_{t-1} - L_0 - lrate_{t-1}^*\right) \end{aligned} \tag{2}$$

The dependence of *lrate* on *lrate** is of an *error correction* form as well, involving the assumption of a full pass-through in the long run, while the short-run adjustment is characterized by parameters L_l and L_c. The response of *lrate* to *srate* is of a *partial adjustment* type. Note that the term in brackets in (2) is derived from (1), excluding the terms in *e*, *Y* and *URATE*. This specification amounts to a distinction between changes in *srate* that result from changes in *e*, *Y* and *URATE* on the one hand and changes in *srate* that reflect changes in *srate** on the other hand. Only the former affect *lrate* in relation to *lrate**. Consider for instance a situation where *srate** increases while *lrate** remains unchanged. In this case, *srate* according to (1) adjusts to the higher *srate*,* but - as the term in brackets in (2) does not change - *lrate* remains unaffected. The spread of Swiss interest rates (*srate*-*lrate*) thus fully adjusts to the change in the foreign spread (*srate**-*lrate**), although with a certain lag. This can be seen as a *delayed tightening* of Swiss monetary policy in response to more restrictive course abroad. On the other hand, consider an increase in *srate* that is caused in (1) by an overheating of the Swiss economy. This will be reflected in (2) by a higher value of the term in brackets and hence transmit to *lrate*, but only partly, depending on the empirical estimates of L_s and L_c. Hence, a *relative tightening* of Swiss monetary is reflected in an increase of the Swiss spread (*srate-lrate*) in relation to the foreign spread (*srate*-lrate*).*

The equation for the *exchange rate of the Swiss Franc* vis-à-vis the Euro, defined as Euro/Swiss franc, is specified as

$$\log(e_t / e_{t-1}) = E_0 + E_\rho \log(e_{t-1} / e_{t-2}) + E_s\left((srate_t - lrate_t) - (srate_t^* - lrate_t^*)\right) \\ + E_b BAL_t - E_c \log(er_{t-1}) \qquad (3)$$

where *BAL* is the overall trade balance (including commodities, services and tourism) in relation to nominal GDP and *er* is the real Euro/Swiss franc exchange rate, defined as

$$er_t = e_t \left(\frac{p_t}{p_t^*}\right). \qquad (4)$$

According to this specification, the relative change in the exchange rate depends on the difference in interest rate spreads (indicating relative tightness of monetary policy) and the trade balance. In addition, there is an error correction feedback from the level of the real exchange rate *er* on the change in the nominal exchange rate *e.* This implies that persistent inflation differentials, giving rise to a trend in *p/p**, must be compensated in the long run by an opposite trend in *e*. Hence, if the other explanatory variables in (3) were stationary (which is not the case for *BAL,* though), *er* would be stationary as well (long-term tendency towards PPP). Moreover, one should note that although the monetary reaction function (1) does not include inflation directly, short-term interest rates will respond to inflation via the exchange rate: According to (4) and (3), higher inflation causes a depreciation of the Swiss franc, and the monetary reaction to this is to raise short-term interest rates.

Obviously, this specification of the monetary block has a rather strong *ad hoc* flavor. Theoretical arbitrage conditions like *UIP* or the *term structure condition* for interest rates are not taken into account explicitly. In terms of historical fit, parameter stability and out-of-sample forecasting performance, however, the specification works remarkably well. As an illustration of this claim, the following section will check the dynamic tracking performance of the monetary block in isolation as well as within the complete model.

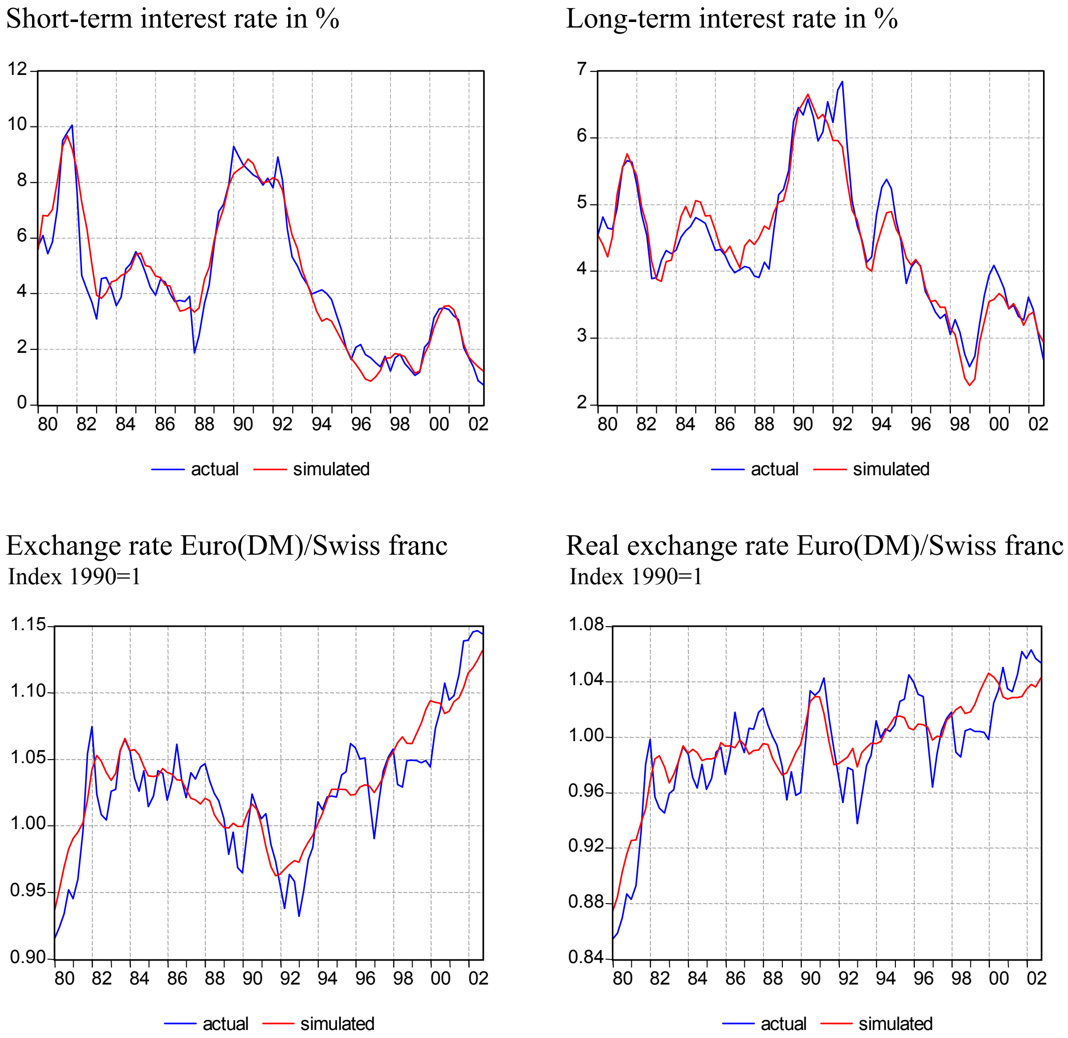
2.2 Dynamic tracking performance

The monetary block determines short and long-term interest rates and the exchange rate of the Swiss franc in dependence of exogenous foreign interest rates and foreign prices on the one hand and four block-exogenous Swiss variables, namely GDP, the unemployment rate, the trade balance and the price level (*LM* relationship). The block-exogenous variables are then endogenized in the (bigger) rest of the model (*IS* relationship and *Phillips curve*).

First, the dynamic tracking performance of the monetary block is checked separately. This amounts to a simulation of equations (1) to (4), conditional on the actual values of *srate**, *lrate**, *p** (exogenous) and *Y*, *URATE*, *BAL* and *p* (block-exogenous). As shown in *Figure 2*, short and long-term interest rates are tracked very well, whereas the course of the exchange rate is reproduced with somewhat less accuracy. In particular, the depreciation of the early 90's and the following strong appreciation from 1993 to 1995 are rather poorly explained by the fundamental factors taken into account by the model.

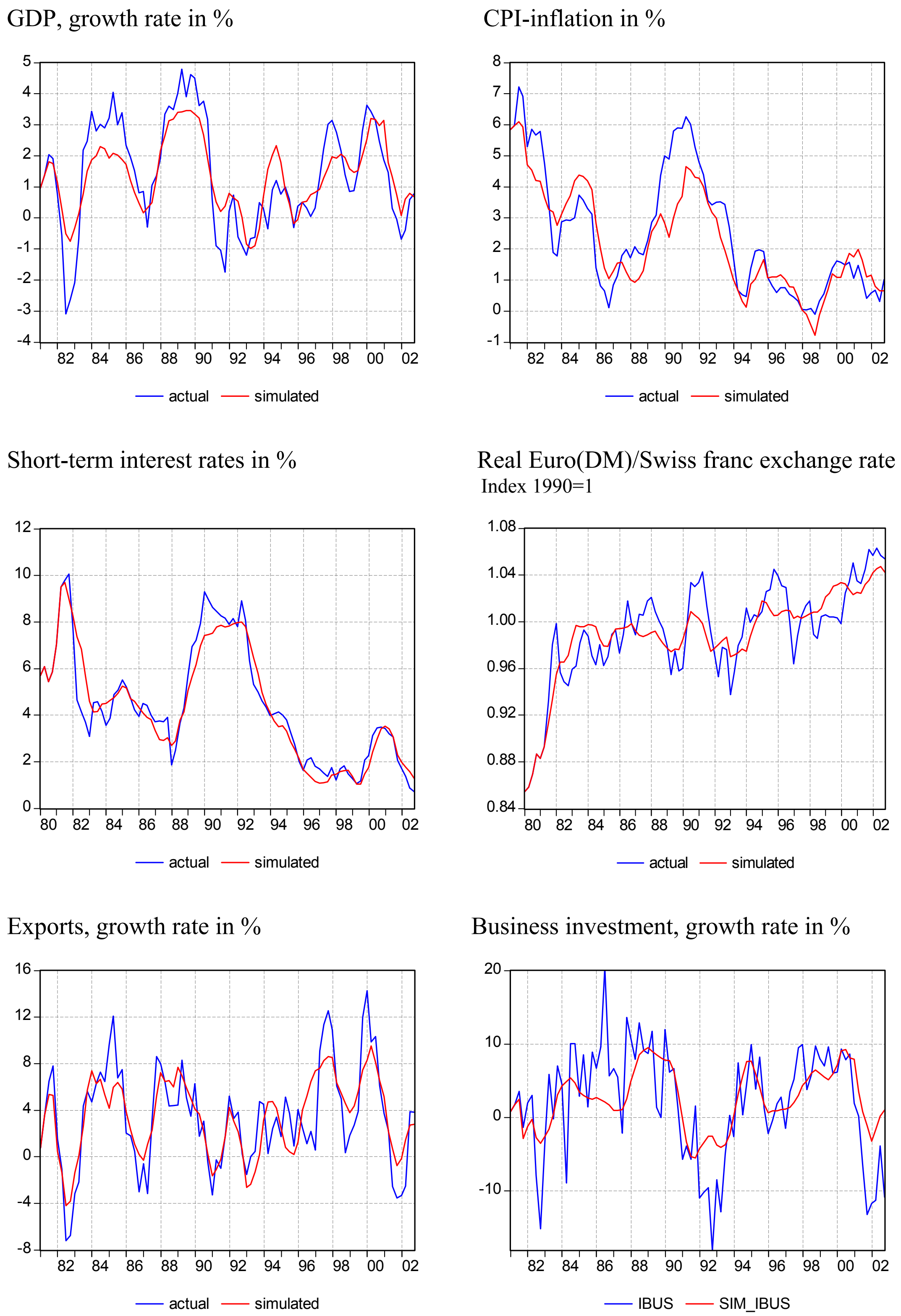
Figure 3 shows the results of *dynamic simulation of the complete model* conditional on the actual values of the exogenous variables (mostly international and demographic, see Figure 1). When interpreting such an exercise, one should keep in mind that it is quite normal for the errors of a dynamic simulation to become relatively large and autocorrelated even if the error terms of the estimated equations are small and white noise. In particular, equations determining first differences of variables will give rise to simulation errors in the levels that carry over from period to period. A similar accumulation of errors is likely to arise from stock-flow relationships (e.g. investment and the capital stock). Therefore, autocorrelated simulation errors do not indicate that the model is an inappropriate description of the data-generating process (Hendry and Richard, 1982). On the other hand, the presence of error correction mechanisms and other stabilizing feedbacks should prevent the simulated variables from deviating progressively from the actual values.

Figure 2: Dynamic tracking performance of the monetary block



Against this background, the simulation results shown in Figure 3 look quite satisfactory. Progressive deviations do not show up, and the model is able to reproduce the actual developments fairly well. In particular, the pronounced difference between high GDP growth in the second half of the 1980's and the long-lasting stagnation in the first half of the 1990's is captured by the model fairly well. However, actual GDP growth is underestimated to some extent in the years 1988-1990. This underestimation is reflected with a certain lag in an underestimation of consumer price inflation. Less convincing is the dynamic fit with respect to business investment, whereas exports are reproduced relatively well. For short-term interest rates and the exchange rate, the fit is slightly worse than in the simulation of the monetary block. This had to be expected, since that simulation was conditioned on the actual values of GDP, the unemployment rate and the trade balance. Overall, however, one may conclude that the model is a reasonable representation of the Swiss economy and thus an adequate basis for the following simulations.

Figure 3: Dynamic tracking performance of the complete model



2.3 Monetary transmission mechanism

What has the model to say about the transmission of changes in monetary policy to real output and inflation? The following simulation computes the effects of raising short-term interest rates by 1 percentage point as compared to a baseline simulation in which short-term rates are determined by the estimated reaction function (1). *Figure 4* shows deviations from the baseline simulation over seven years.[6] Higher short-term interest rates dampen economic activity via two main channels. First, according to (2), there is a partial pass-through to long-term interest rates, and this has a negative impact on aggregate demand, in particular housing investment and private consumption. Second, higher interest rates entail an appreciation of the Swiss Franc, and this dampens export growth. These initial effects set in motion a multiplier-accelerator process by which all income-dependent components of aggregate demand are negatively affected. GDP growth is reduced by a maximum of somewhat more than 0.5 percentage points eight quarters after monetary tightening. The reaction of export growth is quick and attains a maximum of 0.8 percentage points by the 5th quarter. The responses of business investment and housing investment are larger but somewhat delayed. Import growth is also reduced, which partly offsets the effect of lower aggregate demand on GDP. Business investment is stimulated later in the simulation period by lower prices of imported machinery and equipment. The effect on the growth rate of private consumption is relatively weak and slow.

CPI inflation is reduced two waves. In the first four quarters after monetary tightening, CPI inflation falls by 0.2 percentage points. This is due to the exchange rate channel, i.e. the dampening effect of the appreciation on import prices. In the second year of the simulation, there is a certain counter-effect coming from housing rents, which are pushed up by higher mortgage rates. This reflects Swiss legislation on tenancy rights, which allows house owners to pass higher mortgage rates in certain proportions to tenants.[7] Later in the simulation period, the dampening effects of lower economic activity begin to dominate so that inflation as measured by the GDP deflator declines. Consumer price inflation is reduced by a maximum of about 0.6 percentage points, although with a rather long lag of almost six years. Three (four) years after tightening, the reduction in CPI inflation is 0.45 (0.54) percentage points. The unemployment rate increases by a maximum of some 0.6 percentage points and the output gap falls by somewhat less (since production capacity is reduced through lower investment).

To summarize, by raising short-term interest rates by 1 percentage point, monetary policy may lower the inflation rate by about half a percentage point within three to four years. Such a restrictive move of monetary policy results in a temporary loss in GDP growth and an increase in the unemployment rate of about half a percentage point each.

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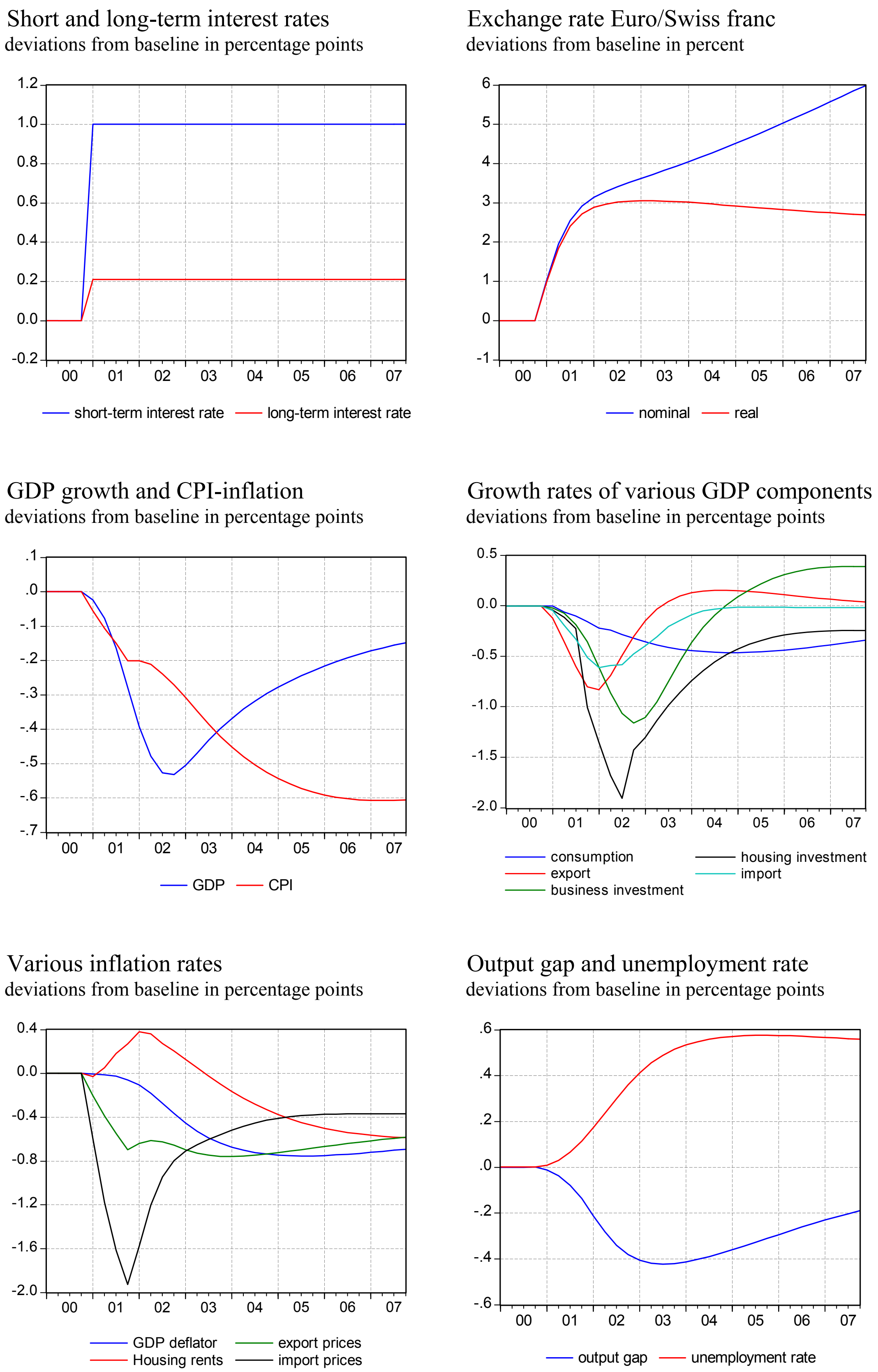
6 Due to a nonlinear Phillips curve, these effects to some extent depend on the original tension situation, being stronger for inflation and weaker for real output if capacity utilization is high and unemployment is low initially. The chosen baseline simulation represents a cyclically average situation.

7 As housing rents enter CPI with a weight of 20% and wages respond to CPI, this link is rather disturbing from the viewpoint of monetary policy. However, the pass-through of mortgage rates to housing rents has become weaker over time, presumably because an increasing proportion of apartments is nowadays rented at market prices and no longer at cost-determined rents below market prices. The simulation is based on a housing rent equation that takes the weaker pass-through into account.

Figure 4: Monetary transmission mechanism (monetary tightening)



3 Hypothetical performance of the Swiss economy under a Euro peg in 1999-2002

Since the start of EMU in 1999, the Swiss franc has strongly appreciated against the common currency. After an initial period of stability, the Swiss franc/Euro exchange rate fell from 1.60 in January 2000 to 1.47 in December 2001. Since then, the Swiss franc/Euro exchange rate has moved in a narrow band (standard deviation of 0.005) around this new level.[8] Some observers regard this as a persistent "overvaluation" of the Swiss franc, although is generally admitted that it is only one the factors responsible for the recent slowdown in the Swiss economy. Nevertheless, in the extreme it is sometimes argued that pegging the Swiss franc to the Euro at the start of EMU would have been advantageous or - realistically recognizing that such a peg would have lifted Swiss interest rates to the higher Euro level - at least the lesser evil for Switzerland.

A straightforward exercise to judge this claim is to run a counterfactual simulation in which the Swiss franc is pegged to the Euro at the exchange rate prevailing when EMU became effective in January 1999 (1.60 Swiss franc/Euro). The simulation thus suppresses on the one hand the actual appreciation of the Swiss franc. On the other hand, short and long-term interest rates rise by about 1.5 percentage points to the higher Euro levels. This alternative scenario is compared to a baseline simulation in which short and long-term interest rates as well as the Swiss franc/Euro exchange rate are inserted into the model with their actual values. The baseline simulation reproduces the actual development with reasonable accuracy. The correlation between simulated and realized values is 0.94 for GDP growth and 0.81 for CPI inflation. *Figure 5* compares the two scenarios.

During the first five quarters of the simulation (1999q1 to 2000q1), the actual exchange rate of the Swiss franc was nearly stable so that there is practically no difference between the scenarios in this respect.[9] Accordingly, *GDP growth* is initially reduced by higher interest rates under the Euro peg. The maximum loss in GDP growth is 0.7 percentage points in 2002q2. Thereafter, the progressive appreciation of the Swiss franc begins to dampen GDP growth in the baseline simulation. However, it is not before mid-2001 that GDP growth rates under the Euro peg begin to exceed baseline values. Moreover, the differences remain rather, so that the *level* of GDP stays below the baseline path until the end of the simulation period.

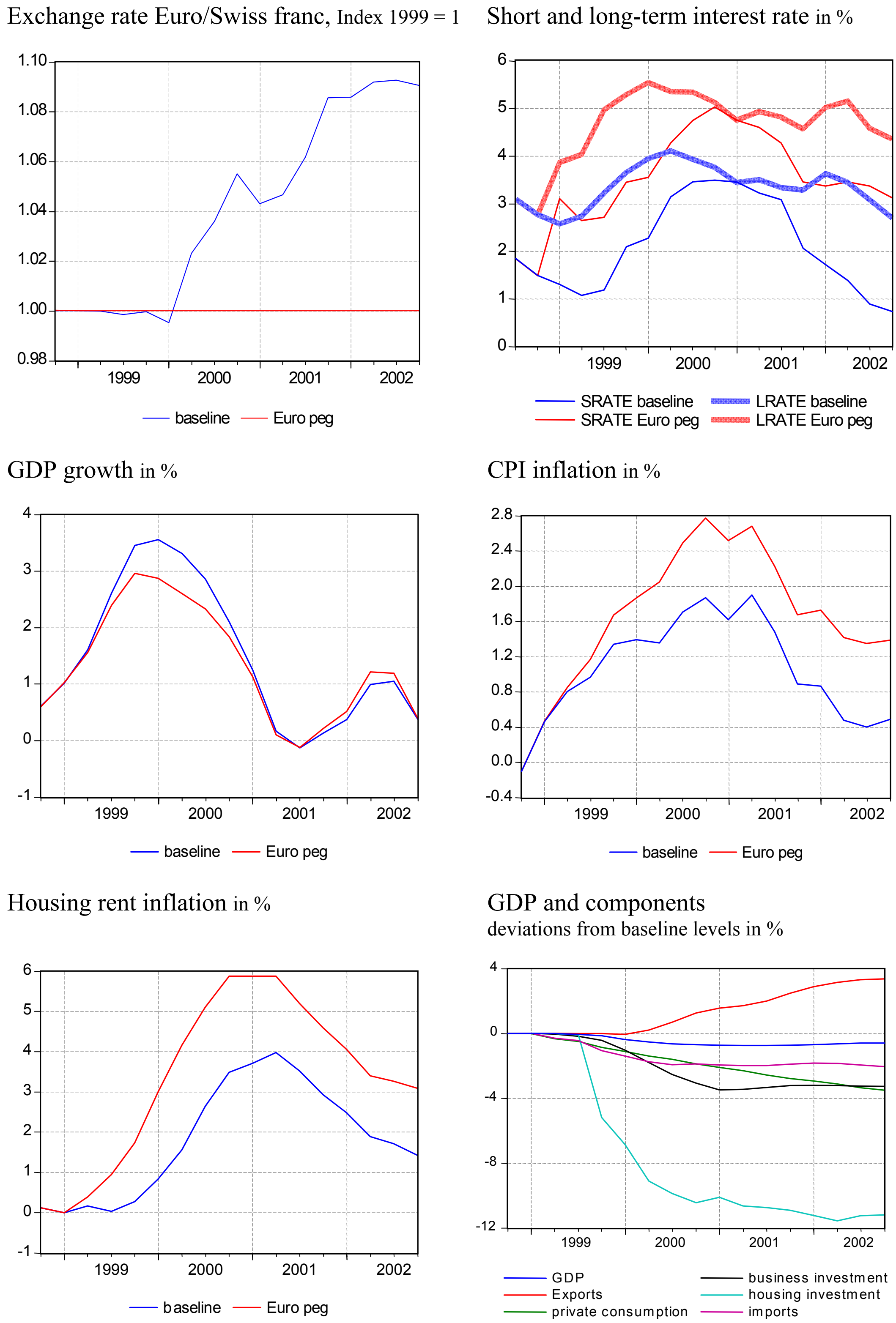
CPI inflation is pushed by about 0.9 percentage points above baseline values under the Euro peg. This is due to two main reasons, *first* to the pass-through of higher interest rates via mortgage rates to housing rents as established by Swiss legislation on tenancy rights, and *second* to the suppression of the actual appreciation of the Swiss franc. Housing rent inflation, entering the CPI with a weight of 20%, increases by a maximum of 2.6 percentage points. As the pass-through of higher mortgage rates to housing rents is only partial, the profitability of housing investment deteriorates, entailing a significant drop in this type of investment. In addition, higher housing rents translate into a real income loss for households. Together with direct impact of higher interest rates on consumer spending, this entails a substantial drop in private consumption as well. Hence, as can be seen from the last panel of figure 5, the composition of GDP changes substantially under the Euro peg. The only stimulus to GDP comes from foreign trade, with exports (imports) being positively (negatively)

8 From April to July 2003, however, the exchange rate moved back to about 1.54 Swiss franc/Euro.

9 Figure 5 depicts the exchange rate as Euro/Swiss franc so that an increase indicates an appreciation.

affected by the suppression of the appreciation. At the end of the simulation period, the following deviations from baseline levels are recorded: GDP -0.6%, private consumption -3.5%, business investment -3.3%, housing investment -11.2%, exports +3.4%, imports -2.1%.

Figure 5: Pegging the Swiss franc to the Euro at the start of EMU



The pass-through of higher mortgage rates to housing rents rights plays a rather disturbing role in the above simulation. One might thus argue that the legislation on housing rents could have been changed before the Euro peg was introduced, for instance by linking housing rents to overall CPI instead of mortgage rates.[10] Under such a *CPI rule* for housing rents, inflation is somewhat reduced in the first year of the simulation of the Euro peg due to the dampening effect of higher interest rates on aggregate activity. From 2000 on, however, the suppression of the actual appreciation of the Swiss franc results in inflation rates that lie about 0.5 percentage points above baseline values. This is about half of the effect obtained above under the *mortgage gate rule* for housing rents. With respect to GDP and its components, the Euro peg now has the following level effects at the end of the simulation period (2002q4): GDP -0.4%, private consumption -2.9%, business investment -2.9%, housing investment -12.2%, exports +3.5%, imports -1.7%. Compared to the previous simulation, housing investment is reduced by somewhat more because higher mortgage rates can no longer be passed to tenants, entailing an even stronger decline in the profitability of this type of investment. On the other hand, the smaller increase in inflation leads to a somewhat less pronounced fall in real household income and thus private consumption. Overall, however, the outcome of the Euro peg simulation under a CPI rule for housing rents differs only by little from the previous one.

To summarize, the simulation shows that fixing the Swiss franc/Euro exchange rate at the beginning of EMU would not have been advantageous for Switzerland. The positive effects resulting from the suppression of the appreciation turn out to be insufficient to outweigh the negative effects arising from higher interest rates. Moreover, the adjustment problems associated with the sudden increase in interest rates are probably understated by the model due to the adoption of an aggregate production function. In reality, firms and workers in the construction sector faced with a drop in housing demand would not find it so easy to switch their activities quickly to export production.

Judged from a more general perspective, one has to note that the simulation is not very conclusive with respect to the pros and cons of a Euro peg for the following reasons. On the one hand, the simulation refers to a specific period of time characterized by a strong appreciation of the Swiss franc. It thus tends to favor the alternative of a Euro peg. In periods dominated by other shocks, the monetary straightjacket of a Euro peg might prove more detrimental to the Swiss economy. On the other hand, the dampening effects of higher nominal interest rates on economic activity should primarily be seen as an short-run adjustment problem. In the longer run, it is difficult to argue that changes in nominal variables like nominal interest rates and nominal exchange rates would have real effects. For instance, if the upward trend in the real exchange rate of the Swiss franc is a structural phenomenon, it cannot be suppressed by a Euro peg. It would just show up under such a regime in the form of higher trend inflation.

The following simulations attempt to assess the pros and cons of a Euro peg from a more general perspective.

[10] Such a change in the legislation is on the political agenda right now and most likely to become effective in the near future.

4 Different shocks, monetary independence and the alternative of an Euro peg

4.1 Decomposition of shocks

The cyclical behavior of the Swiss economy can be traced back in the model to *two broad groups of shocks*, namely shocks resulting from the exogenous *world economy variables* and shocks captured by the *error terms* of the stochastic equations of the model. In a simulation that suppresses both types of shocks - by assuming a steady growth path for the world economy and setting all error terms to zero - the Swiss economy also converges to a steady growth path. The actual fluctuations of GDP and inflation around this path can thus be decomposed into two components: (i) fluctuations caused by deviations of the world economy from the steady growth path and (ii) fluctuations captured by the error terms of the model. At first glance, it may be tempting to label shocks of the first type as *symmetric* (because they entail parallel reactions in the Swiss economy) and shocks of the second type as *asymmetric* or *Swiss-specific* (because they are responsible for developments in Switzerland that differ from the world economy). Although such a labeling goes in the right direction, it is not fully appropriate.

- On the one hand, the responses of the Swiss economy to world economy shocks may be partly Swiss-specific because of structural differences like larger of smaller GDP shares of cyclically sensitive industries, higher or lower flexibility of prices, different situations and different reactions on the labor market, more of less efficient automatic stabilizers, etc. Therefore, even if only world economy shocks were at work, monetary independence could be an advantage.
- On the other hand, shocks reflected by the residuals of the equations are not necessarily entirely Swiss-specific. For example, worldwide political uncertainties may show up as negative residuals in the equations for private consumption and business investment, because these uncertainties are only partly captured by the exogenous variables on which the model is conditioned.

In order to make these considerations more concrete, the following sequence of auxiliary simulations is carried out:

- The model is simulated conditional on the actual course of the exogenous world economy variables with all residuals set to zero. This corresponds to the dynamic simulation of section 2.2 with one exception: Swiss short-term interest rates are assumed to move constantly 1.49 percentage points below Euro short-term rates ($srate = srate^* - 1.49$), corresponding to the historical average of the interest rate differential in the period 1981-2002. The purpose of this simulation is to figure out the reactions of the Swiss economy to world economy shocks in case that monetary policy does not react to the specific cyclical conditions in Switzerland but just takes over the European interest rate decisions, albeit on a lower level. This simulation is denoted as swiss(world).
- The model is simulated conditional on the historical values of the residuals while the world economy is assumed to move on a steady growth path. The shocks captured by the historical residuals are largely white noise, but the propagation mechanisms in the model translate them into more persistent movements of GDP and inflation around the steady growth path. To what extent this simulation can be taken to reflect fluctuations in Swiss GDP and inflation caused by Swiss-specific shocks will be discussed below. The simulation is denoted as swiss(res).
- The model is simulated conditional on the actual developments in the world economy and the historical values of the residuals. As all equations hold exactly on this assumption, the simulation

just reproduces the actual values of the endogenous variables. Hence, one may denote this simulation as swiss(world,res) or simply as swiss.

By this procedure, the actual fluctuations in GDP and inflation (swiss(world,res)) can be decomposed into the two components, swiss(world) and swiss(res).[11]

Results for GDP (Figure 6a)

Simulating the model conditional on the *actual course* of the exogenous *world economy variables* (swiss(world)) produces fluctuations in Swiss GDP that are similar in size to those in the Euro area and the world economy (Europe, USA, Japan). The standard deviations of GDP growth rates (in percentage points) are 1.22 for Switzerland, 1.26 for the Euro area and 1.21 for the world economy. However, the correlation between GDP growth rates in Switzerland and the Euro area is only 0.77, suggesting that an independent Swiss monetary policy may be advantageous even with respect to shocks that are rooted in the world economy.

Simulating the model on the assumption of a steady growth path of the world economy but with the *historical residuals* inserted for all error terms (swiss(res)) produces fluctuations in Swiss GDP growth rates with a standard deviation of 0.91, which is less than the standard deviation caused by the world economy variables (1.22). The fluctuations due to the residuals show a positive correlation of 0.36 with the fluctuations transmitted to Switzerland by the exogenous world economy variables, implying that the shocks captured by the residuals are largely but not fully Swiss-specific.

Simulating the model conditional on the actual course of the world economy *and* inserting the historical residuals for the error terms reproduces - by definition - the actual values of the endogenous variables (swiss(world,res) = swiss). The standard deviation of GDP growth rates is 1.76, compared to standard deviations of 1.22 in simulation swiss(world) and 0.91 in simulation swiss(res). The fact that $1.76 > \sqrt{(1.22^2+0.91^2)} = 1.52$ again shows that the two types of shocks are positively correlated. As can be seen from Figure 6a (right panel), this applies in particular to the periods 1984/85 and 1988/90, where favorable shocks from the world economy were enhanced by positive shocks from the residuals. In contrast, the period 1994/95 is characterized by positive shocks from the world economy but negative shocks from the residuals. With a standard deviation of 1.76, the actual Swiss GDP growth rates are clearly more volatile than GDP growth rates in the Euro area (1.26). Moreover, the correlation between the two series is only 0.73. Therefore, monetary independence is potentially advantageous.

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[11] To be precise, three minor complications must be noted:

Due to nonlinearities in the model, the fluctuations generated by swiss(world) and swiss(res) do not add up exactly to those generated by swiss(world,res). An exact decomposition can be obtained by computing the effects of the residuals in relation to a situation which already includes the world economy shocks. Obviously, one might also reverse the order of effects. The differences between these alternatives are fairly small though and can be neglected for practical purposes.

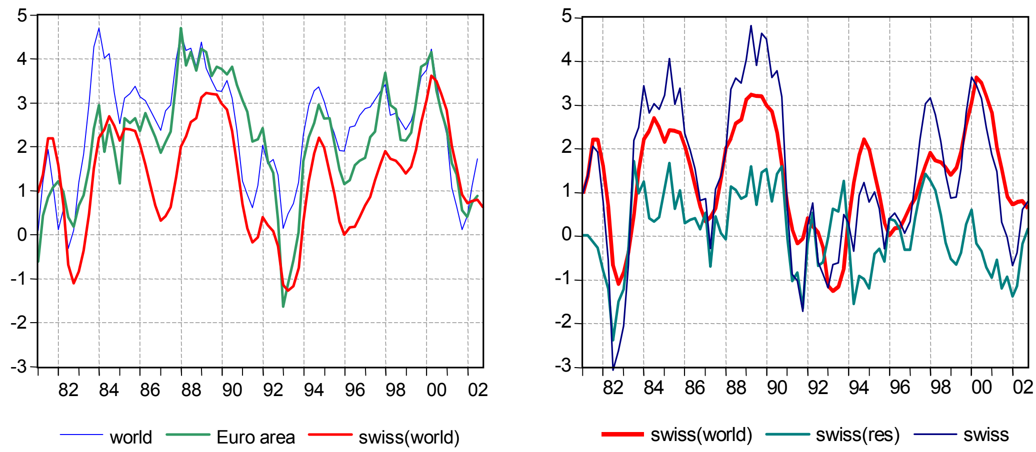
The model contains some exogenous variables for Switzerland (see Figure 1). However, these variables are unimportant in the context under investigation because they are either very smooth (like population) or quantitatively small in proportion to GDP (like public construction). The effects of these variables are technically included in simulation swiss(world).

To ensure that the simulation swiss(world,res) reproduces the actual developments of the endogenous variables exactly, the residuals of the equation for short-term interest rates must be replaced by the residuals with respect to the modified equation *srate* = *srate** - 1.49 + *residual*. In other words, the simulation is just conditioned on the actual values of *srate*.

Figure 6: GDP growth and CPI inflation in Switzerland - decomposition of fluctuations

- swiss(world):	simulation conditional on exogenous world economy variables, residuals = 0
- swiss(res):	simulation conditional on historical residuals, world economy on trend
- swiss(world,res) = swiss	simulation conditional on exogenous world economy variables and historical residuals (= actual developments)
- world:	a) GPD in the European Union (weight 0.7), USA (0.2) and Japan (0.1) b) CPI inflation in the OECD G7

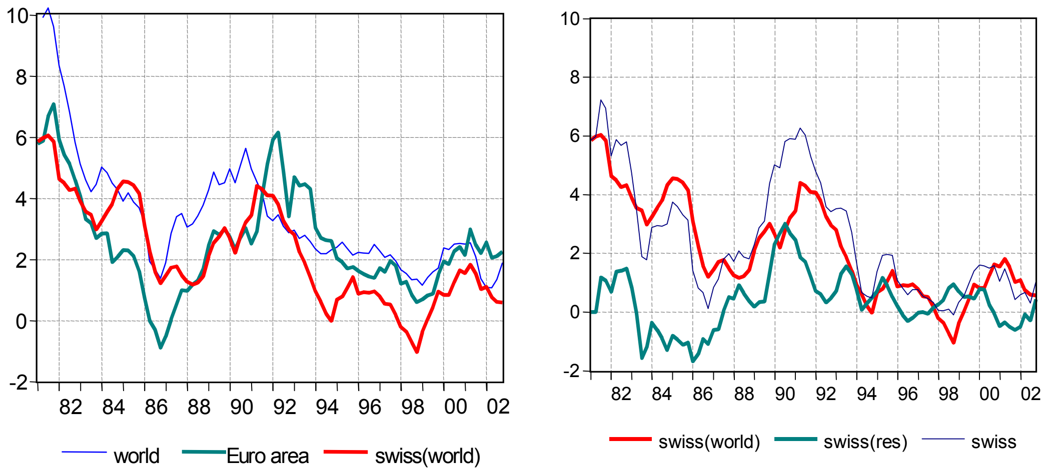
a) GDP growth in %



Standard deviations (main diagonal) and correlations

	world	euro area	swiss(world)	swiss(res)	swiss
world	1.21	0.79	0.71	0.56	0.78
euro area	0.79	1.26	0.77	0.39	0.73
swiss(world)	0.71	0.77	1.22	0.36	0.88
swiss(res)	0.56	0.39	0.36	0.91	0.76
swiss	0.78	0.73	0.88	0.76	1.76

b) CPI inflation in %



Standard deviations (main diagonal) and correlations

	world	euro area	swiss(world)	swiss(res)	swiss
world	1.80	0.66	0.82	0.32	0.84
euro area	0.66	1.60	0.65	0.41	0.74
swiss(world)	0.82	0.65	1.60	0.07	0.86
swiss(res)	0.32	0.41	0.07	0.98	0.56
swiss	0.84	0.74	0.86	0.56	1.93

Results for CPI inflation (Figure 6b)
Simulating the model conditional on the *actual course* of the exogenous *world economy variables* (swiss(world)) produces fluctuations in Swiss CPI inflation that are of the same size as those in the Euro area and somewhat smaller than those in the world economy (OECD G7). The respective standard deviations (in percentage points) are 1.60, 1.60 and 1.80. As was the case for GDP growth, the correlation between the fluctuations of CPI inflation in Switzerland caused by the world economy variables and CPI inflation in the Euro area is far from perfect (0.65), again implying that monetary independence may be useful even with respect to shocks that stem from the world economy.

Simulating the model conditional on a steady growth path of the world economy but with *historical residuals* inserted for the error terms (swiss(res)) produces fluctuations in Swiss CPI inflation with a standard deviation of 0.98, which is notably smaller than the standard deviation caused by the world economy variables (1.60). The fluctuations due to the residuals show practically no correlation with the fluctuations transmitted to Switzerland through the world economy variables (0.07), implying that the fluctuations in CPI inflation captured by the residuals are almost fully Swiss-specific. This outcome underlines the potential usefulness of an independent Swiss monetary policy.

Simulating the model conditional on the actual course of the world economy *and* the historical residuals reproduces the actual CPI inflation rates (swiss(world,res) = swiss). Their standard deviation is 1.93 and thus larger than the standard deviation of CPI inflation rates in the Euro area (1.60). In addition, the correlation between the two inflation series is only 0.74. Compared with the results for GDP growth, fluctuations in Swiss inflation seem to be linked somewhat more strongly to international factors. However, while this is true in general, the sharp increase in Swiss CPI inflation in 1989/90 is to a large extent due to the residuals.

In short, the following *conclusions* emerge from this auxiliary analysis. *First* and not surprisingly, cyclical developments in Switzerland are to a large part caused by world economy shocks. The shocks captured by the error terms of the model are also important, but smaller in size. Moreover, as they are correlated with the fluctuations generated by the world economy variables (at least with respect to GDP growth), they cannot be interpreted as entirely Swiss-specific but rather seem to include a component that is common with the world economy. *Second*, the volatilities of Swiss GDP growth and CPI inflation rates resulting from world economy shocks alone are comparable in magnitude to the volatilities of the corresponding Euro area variables. However, by including the shocks captured by the residuals, one obtains fluctuations in the Swiss variables clearly in excess of those in the Euro area. In addition, the correlation with the Euro area variables is far from perfect for both GDP growth and inflation. Therefore, monetary independence is potentially advantageous. To what extent it was actually used and successful in stabilizing the Swiss economy will be discussed in the following sections.

4.2 Did monetary independence contribute to economic stability?

Under a Euro peg, Switzerland would have to take over short-term interest rates from the Euro area. When discussing such a scenario, three quite different aspects must be distinguished, namely (i) the *transitory* problem of adjusting to a the upward jump in interest rates once the peg is introduced, (ii) the long-term consequences of a higher level of nominal interest rates (if any) and (iii) the *lasting* fact that Swiss National Bank would no longer be able to respond to the specific cyclical conditions in Switzerland. The focus of this section is on (iii), the loss of monetary independence. A straightforward way to *isolate* this aspect is to run a counterfactual simulation on the assumption that Swiss short-term interest rates had moved with a constant differential of 1.49 percentage points (the historical average in the period 1981-2002) below Euro short-term rates (German short-term rates prior to 1999). This counterfactual interest rate path is denoted by

$$srate^{\circ} = srate^{*} - 1.49\ . \tag{5}$$

In other words, monetary policy for Switzerland is taken over from ECB (the German Bundesbank) but the interest rate "bonus" is preserved. A comparison of this counterfactual scenario with actual developments shows to what extent monetary independence was actually used and successful in stabilizing the Swiss economy.

Figure 7a confronts the actual course of Swiss short-term interest rates (*srate*) with the alternative of $srate^{\circ} = srate^{*} - 1.49$. The two series move fairly closely together, implying that monetary independence was used rather discreetly in practice. Nevertheless, with a standard deviation of 1.04 percentage points, the "independent" moves of *srate* in relation to $srate^{\circ}$ are not negligible. The question then is whether the deviations of *srate* from $srate^{\circ}$ have contributed to more stability in terms of GDP growth and inflation. The baseline case is represented by simulation swiss(world,res) of section 4.1 above, which - due to the inclusion of the historical residuals - reproduces actual developments exactly. In the alternative, *srate* is replaced by $srate^{\circ}$ under otherwise identical assumptions. In particular, the same values of the residuals are inserted into the equations. Simulation swiss(world,res) is relabeled in this section as sim(*srate*) = *actual* and the alternative is denoted by sim($srate^{\circ}$). The degree of macroeconomic stability is judged on basis of three variables, namely GDP growth rates, deviations in GDP from an exponential trend and CPI inflation rates. The volatility of these variables is measured by their standard deviation (in percentage points).

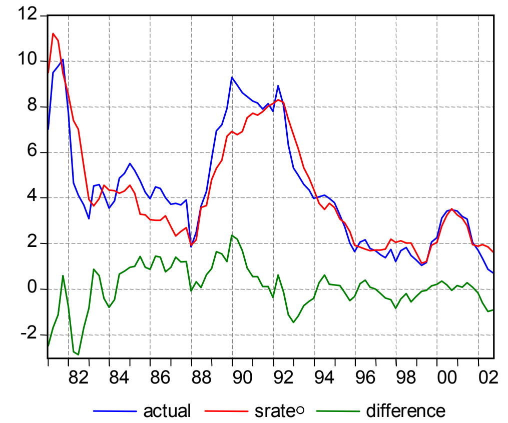
Figures 7 shows the results. As had to be expected in view of the rather close co-movement of *srate* and $srate^{\circ}$, the differences between the two scenarios are fairly small. But one may note that monetary policy as actually conducted was successful in the sense of slightly mitigating the volatility of all three variables. The standard deviation of GDP growth rates is 1.92 in sim($srate^{\circ}$) and 1.76 in sim(*srate*). For the trend deviations of GDP the corresponding numbers are 3.03 and 2.43 and for CPI inflation 2.02 and 1.93. In addition, by dampening the volatility of GDP, the actual policy has also somewhat reduced the average inflation rate. This outcome is mainly due to the convexity of Phillips curve relationship in the model.

The effects of the "independent" moves of Swiss monetary policy can be made clearer by computing the differences sim(*srate*)-sim($srate^{\circ}$). These are the green lines in Figure 7. An ideal countercyclical policy would have these lines always below (above) zero if GDP growth, the level of GDP and CPI inflation are relatively high (low). To some extent, this is actually the case: The correlation between sim($srate^{\circ}$) and the difference sim(*srate*)-sim($srate^{\circ}$) is -0.52 for GDP growth, -0.87 for the trend deviations of GDP and -0.41 for CPI inflation.

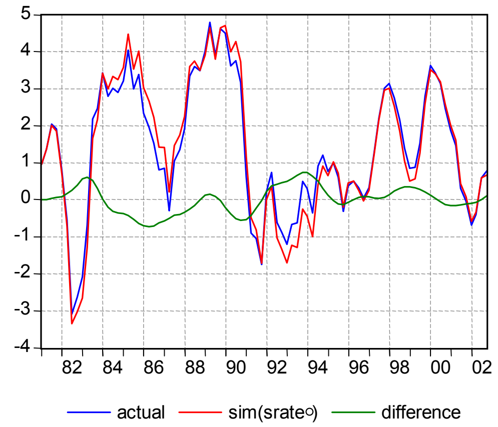
The simulation thus suggests that monetary policy was more successful in stabilizing GDP than inflation, a result that is somewhat at odds with the official focus of SNB on price stability as the central goal of monetary policy. In this connection, one may recall from the discussion of the *monetary transmission mechanism* that it takes about *four years* until interest rate changes unfold their full impact on inflation (as opposed to only one to two years for GDP growth). Given such a long policy lag and further considering the relatively short time spans between peaks and troughs in

Figure 7: Monetary independence and volatility of GDP growth and inflation
(Simulation period 1981q3 to 2002q4)

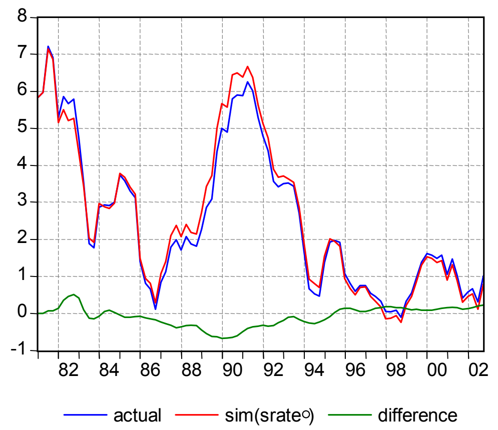
a) Short-term interest rates
actual = *srate*
srate°: *1.49* pp below Euro (German) rates
difference = *srate-srate°*



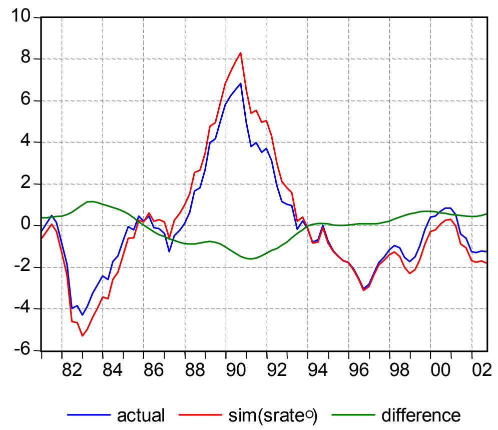
b) GDP growth in %
actual = sim(*srate*)
sim(*srate*°)
difference = actual-sim(*srate*°)



c) CPI inflation in %
actual = sim(*srate*)
sim(*srate*°)
difference = actual-sim(*srate*°)



d) GDP, deviation from exponent. trend in %
actual = sim(*srate*)
sim(*srate*°)
difference = actual-sim(*srate*°)



Summary statistics

	GDP growth in %		GDP trend deviation in %		CPI inflation in %	
	actual	sim(*srate*°)	actual	sim(*srate*°)	actual	sim(*srate*°)
mean	1.39	1.38	0.00	0.00	2.43	2.52
standard deviation	1.76	1.92	2.43	3.03	1.93	2.02
correlation with difference actual - sim(srate°)	-0.36	-0.52	-0.79	-0.87	-0.29	-0.41

the inflation series, it is clear that stabilizing the inflation rate is a rather difficult task. For instance basing policy decisions on the *current inflation rate* would be highly inapt because the effects of such a policy would often fall into phases where the cycle has already reversed. Considerations of this sort are actually taken into account in the new policy concept of SNB (and other central banks) in that policy decisions are based on an *inflation forecast*. Accordingly, the empirical evaluation of different versions of monetary reaction functions in the construction of the model has identified a *srate*-equation as "best" that does not include the current inflation rate. The included arguments are GDP growth, the unemployment rate and movements in the exchange rate, which all can be regarded as *leading indicators* of inflation.

The main conclusion to be drawn from this exercise is (i) that monetary independence was used rather retentively in the past but (ii) that the independent moves of monetary policy (i.e. the deviations of *srate* from *srate*°) went mostly in the right direction in the sense of stabilizing the economy. This result then raises the question of whether monetary independence should have been utilized more aggressively. Section 4.4 will address this issue on basis of several additional simulations in which the monetary reaction function is made more responsive to its arguments. Beforehand, however, the Euro peg scenario is discussed.

4.3 The Euro peg: Eliminating exchange rate shocks at the cost of loosing monetary independence

The potential advantage of a Euro peg resides in the fact that it eliminates - by definition - exchange rate shocks. On the other hand, it deprives Swiss monetary policy of the possibility to react to all other types of shocks. Moreover, it also suppresses exchange rate movements caused by fundamentals. Hence, to say that a Euro peg would eliminate exchange rate shocks is rather misleading because it eliminates exchange rate movements altogether. According to the model of this paper, the exchange rate is an important channel in the monetary transmission process. Ideally, the exchange rate would thus respond to fundamentals like the relative stance of monetary policy, inflation differentials and the current account position - but not be subject to exogenous shocks. Of course, such a shock-free world does not exist. Either one opts for monetary independence and a flexible but also temporarily shocked exchange rate - or one sacrifices monetary independence for a fixed exchange rate. The potential advantage of an Euro peg over the status quo of monetary independence thus depends on (i) the severity of exchange rate shocks relative to all other shocks, (ii) the way in which Swiss monetary policy reacts to all types of shocks and (iii) the stabilizing role of fundamental exchange rate movements.

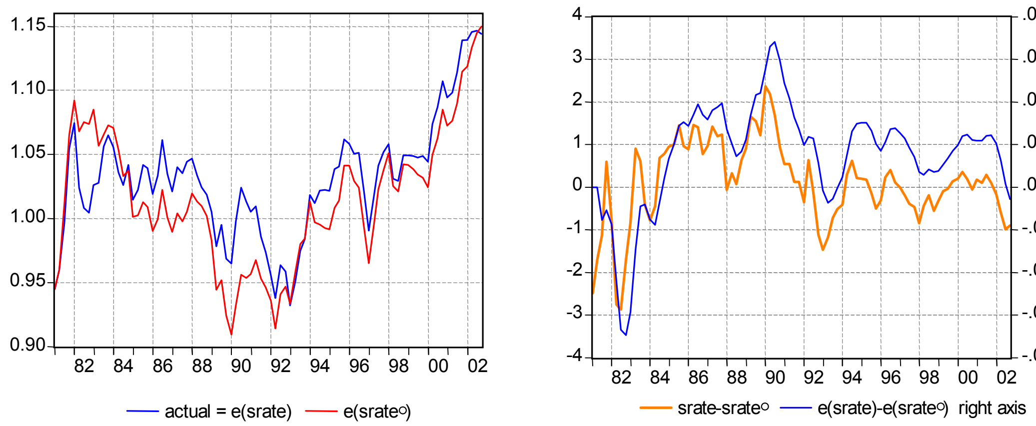
The purpose of simulation sim(*srate*°) in the previous section was to show how the Swiss economy would have developed under the interest rate decisions of the ECB (the German Bundesbank). This is not a Euro peg scenario, of course, since it shares with simulation sim(*srate*) the assumption of a flexible exchange rate. In the Euro peg simulation, the Euro/Swiss franc exchange rate is fixed at the mean value of the actual exchange rate in period 1981q3 to 2002q4. Assuming *srate*° = *srate**-1.49, the simulation again excludes the adjustment problems arising from a higher level of nominal interest rates, which was analyzed in section 3. The Euro peg simulation is denoted by sim(*srate*°,*efix*). It differs from the Euro peg simulation of section 3 in two respects. First, it refers to a much longer period of time in which the Swiss economy was subject to a large variety of shocks. Thus, the conclusions to be drawn with respect to the pros and cons of a Euro peg are better founded. Second, it concentrates on the effects arising from the loss of monetary independence - as opposed to those of a higher level of interest rates.

So there are three scenarios to be compared: sim(*srate*)=*actual*, sim(*srate*°) and sim(*srate°,efix*). The comparison of sim(*srate*) with sim(*srate*°) in the previous section has shown the destabilizing effects of taking over foreign interest rates. The comparison of sim(*srate*°) with sim(*srate°,efix*) in this section will show to what extent a fixed exchange rate is stabilizing the economy. Finally, by comparing sim(*srate*) with sim(*srate°,efix*) one obtains the overall effects of moving from the status quo of monetary independence to an Euro peg.

Beforehand, however, it is worthwhile to take a look at the respective exchange rate developments under the actual *srate*-policy and the alternative *srate*°-policy. *Figure 8a* displays the exchange rate as *e* = Euro/Swiss franc so that an increase in *e* corresponds to an appreciation of the Swiss franc. The two exchange rate paths are denoted in by *e*(*srate*) (= actual) and *e*(*srate*°). As can be seen from the figure, the deviations of *e*(*srate*) from *e*(*srate*°) are driven by the deviations of *srate* from *srate*° (i.e. the relative stance of Swiss monetary policy). This emerges very clearly from panel b, where the difference *e*(*srate*)-*e*(*srate*°) is plotted along with the difference *srate*-*srate*°. For example, by raising *srate* above *srate*°, Swiss monetary policy has counteracted the weakness of the Swiss franc in 1989-91. After a period of relative loosening, Swiss monetary policy was again tightened in 1994, this time reinforcing an appreciation of the Swiss franc. Over the whole period under consideration, the actual *srate*-policy has slightly reduced the volatility of the exchange rate as compared to the hypothetical *srate*°-policy. The respective standard deviations (relative to the mean of *e*) are 0.044 and 0.052. This outcome is not necessarily desirable *per se* because exchange rate movements caused by *fundamentals* tend to stabilize the economy. It may be interpreted, however, in the sense that monetary policy was often counteracting exchange rate *shocks*. When interpreting Figure 8b in detail, one should also keep in mind that *srate* affects other variables of the model as well, like the inflation rate and the trade balance, which in turn feed back on the exchange rate. These indirect effects alter the dynamic response of the exchange rate to changes in the interest rate differential to some extent. Moreover, as noted above, the actual *srate*-policy has not only reduced the standard deviation but also the mean of the inflation rate. Therefore, *e*(*srate*) increases slightly in relation to *e*(*srate*°) in the long run, keeping the real exchange rate relatively stable.

Figure 8: Exchange rate developments and the interest rate differential

a) Exchange rate Euro/Swiss franc (Index 1990=1) b) Exchange rate and interest rate differential

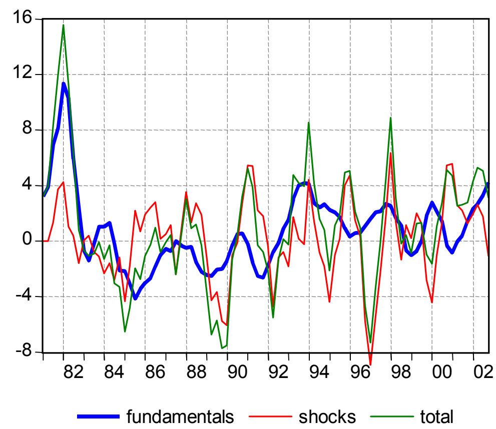


The relative importance of exchange rate shocks as opposed to fundamental exchange rate movements can be inferred from the estimated exchange rate equation. The *fundamentals* are represented by the *explanatory variables* while the *shocks* are captured by the *residuals*. A dynamic simulation in which the residuals are set to zero thus generates the fundamental exchange rate path and the inclusion of the residuals shows the contribution of the exchange rate shocks. In order to suppress reactions of monetary policy, this calculation is done on the assumption of a counterfactual *srate*°-policy. The outcome is shown in *Figure 9*. With respective standard deviations of 2.96 and 2.78, exchange rate changes caused by shocks and fundamentals are of similar magnitude. Hence, the desirable and undesirable consequences of a Euro peg (suppressing shocks vs. fundamentals) can be expected to be of similar importance.

The impact of the exchange rate shocks on the volatility of GDP can be assessed on basis of the complete model by comparing the simulation sim(*srate*°), which augments all equations by their historical residuals, with an additional simulation sim(*srate*°, *res_e* = 0) in which the residuals of the exchange rate equation are set to zero. Alternatively, one may also compare simulation sim(*srate*) with sim(*srate, res_e* = 0). In this case, *srate* is allowed to react to the exchange rate shocks. The results are shown in the table attached to Figure 9. The standard deviation of GDP growth rates is reduced by the elimination of exchange rate shocks from 1.92 to 1.80 under the *srate*°-policy and from 1.76 to 1.66 under the *srate*-policy. These numbers suggest that the volatility in GDP growth rates caused by exchange rate shocks is rather small.

Figure 9: Decomposition of exchange rate movements into fundamentals and shocks

Exchange rate *e* (Euro/Swiss franc)
change over previous year in %



Standard deviation of percentage change in *e*

due to fundamentals	due to shocks	total
2.78	2.96	4.26

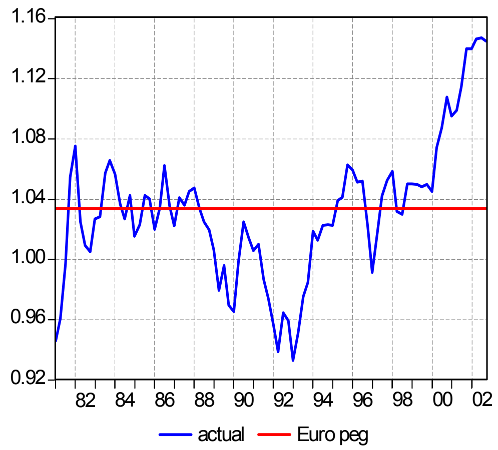
Standard deviation of GDP growth rates in %

	exchange rate shocks included	exchange rate shocks excluded
srate°-policy	1.92	1.80
srate-policy	1.76	1.66

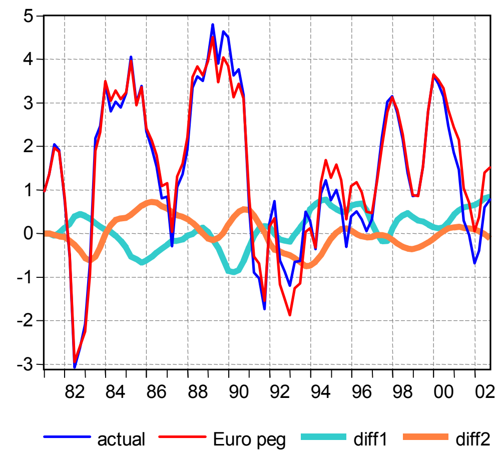
After these preliminary remarks about the exchange rate shocks and fundamental exchange rate movements, we now turn to the Euro peg simulation, in which the Euro/Swiss franc exchange rate is fixed at the sample mean. The degree of macroeconomic stability is again judged on basis of GDP growth rates, GDP trend deviations and CPI inflation rates, and the volatility of these variables is measured by their standard deviation. *Figure 10* confronts the Euro peg scenario sim(*srate°,efix*) with the baseline simulation sim(*srate*). As already mentioned, the baseline simulation augments all stochastic equations of the model by their historical residuals and therefore reproduces the endogenous variables exactly. As the same residuals are inserted into the Euro peg simulation, the deviations between the two scenarios reflect the different assumptions with respect to the short-term interest rate and the exchange rate. The deviations of the Euro peg scenario sim(*srate*°, *efix*) from the baseline sim(*srate*) can be split in two parts, namely diff1 = sim(*srate*°, *efix*) - sim(*srate*°) and diff2 = sim(*srate*°) -sim(*srate*).

Figure 10: Volatility of GDP growth and inflation under an Euro peg vs. status quo
(Simulation period 1981q3 to 2002q4)

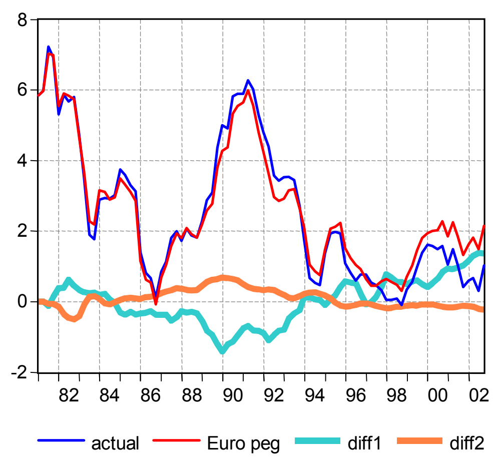
a) Euro/Swiss franc (Index 1990=1)
actual = sim(*srate*)
Euro peg = sim(*srate*°, *efix*)



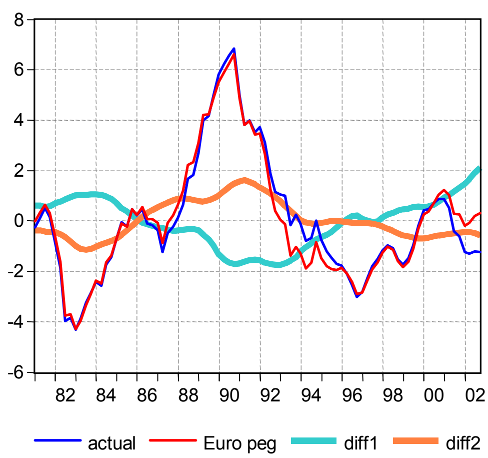
b) GDP growth in %
actual = sim(*srate*)
Euro peg = sim(*srate*°,*efix*)
diff1 = Euro peg-sim*(srate°)*
diff2 = sim(*srate*°)-actual



c) CPI inflation in %
actual = sim(*srate*)
Euro peg = sim(*srate*°, *efix*)
diff1 = *Euro peg*-sim*(srate°)*
diff2 = sim(*srate*°)-actual



d) GDP, deviations from trend in %
actual = sim(*srate*)
Euro peg = sim(*srate*°, *efix*)
diff1 = Euro peg-sim*(srate°)*
diff2 = sim(*srate*°)-actual



Summary statistics

	GDP growth in %			GDP trend deviation in %			CPI inflation in %		
	actual	sim(*srate*°)	Euro peg	actual	sim(*srate*°)	Euro peg	actual	sim(*srate*°)	Euro peg
mean	1.39	1.38	1.49	0.00	0.00	0.00	2.43	2.52	2.52
standard deviation	1.76	1.92	1.72	2.43	3.03	2.41	1.93	2.02	1.70

So diff1 shows the effects on GDP and CPI inflation arising from the fixed vs. the flexible (and shocked) exchange rate while diff2 does the same for the "fixed" vs. the flexible short-term interest rate ("fixed" in the sense of moving constantly 1.49 percentage points below the Euro rate). The figure is supplied with a summary table, which extends the table from Figure 7 by the inclusion of the Euro peg scenario.

Interestingly, the two diff-series move in opposite directions most of the time. In other words, the exchange rate effect and the interest rate effect, while being quite sizable individually (up to 2% in case of the trend deviation of GDP), tend to neutralize each other in most periods, resulting in an Euro peg scenario that almost coincides with the baseline, at least with respect to GDP. Responsible for this result is the behavior of monetary policy in the baseline case: Interest rates are quite systematically raised (*srate*>*srate*°) or lowered (*srate*<*srate*°), depending on whether the Swiss franc depreciates or appreciates. Hence, if the economy is stimulated in a certain period by a depreciation, it is at the same time dampened by higher interest rates, and vice versa. Put differently, the Euro peg eliminates two *opposing* forces and therefore differs only by little from the baseline. In the boom period at the end of the 1980's, for example, the Euro peg would have suppressed the actual depreciation of the Swiss franc. On the other hand, it would also have prevented Swiss short-term interest rates from moving in excess of *srate*°. While this is the general pattern, there are also some exceptions. In last three years of the simulation period, for example, the suppression of the actual appreciation of the Swiss franc under a Euro peg clearly dominates over the interest rate effect so that GDP and CPI inflation are higher. To be sure, *srate* was lowered in relation to *srate*°, but not before 2002. Therefore, the stimulating effect on GDP and CPI inflation comes too late to show up within the simulation range.

The neutralizing character of the two effects is also reflected in the standard deviations of the three key variables (see the summary statistics reported in Figure 10). The standard deviation of GDP growth rates increases from 1.76 in sim(*srate*) (baseline) to 1.92 in sim(*srate*°) (loss of control on interest rates) but falls back to 1.72 in sim(*srate*°, *efix*) (Euro peg). For the trend deviation of GDP, the corresponding numbers are 2.43, 3.03 and 2.41. Hence, the volatility of GDP under a Euro peg is practically the same as in the baseline scenario. In some contrast, the standard deviation of CPI inflation rates is slightly reduced by the Euro peg; it increases from 1.93 (baseline) to 2.02 (loss of control on interest rates) but falls fairly strongly to 1.70 under the Euro peg.

A further point that may seem to be in favor of a Euro peg is the fact that the average growth rate of GDP is slightly higher than in the baseline scenario (1.49 vs. 1.39). However, one should refrain from taking this result as a general one. It is largely due to a favorable coincidence of the stimulating or dampening effects of the peg with different states of the business cycle. In boom periods, GDP is constrained by the supply side of the economy so that changes in aggregate demand have strong effects on prices but small effects on output. In contrast, in situations with large excess capacities changes in aggregate demand go largely into GDP with relatively little effect on prices. Given this (realistic) asymmetry in the model, the suppression of the actual depreciation of the Swiss franc in the boom of the late 1980's dampens GDP only by little. On the other hand, the suppression of the actual appreciation of the Swiss franc at the end of the simulation period falls in a phase where the economy was going into a trough and therefore stimulates GDP quite strongly. In other (future) periods, the coincidence of exchange rate effects and the cyclical position of the economy may be different. Therefore, the result of higher average GDP growth under a Euro peg should not be generalized.

To summarize, the analysis so far suggests that a Euro peg would have left the volatility of GDP practically unchanged while slightly mitigating the volatility of CPI inflation as compared with the status quo of monetary independence. However, the differences between the two scenarios are small since the destabilizing effect of the loss of control over short-term interest rates is largely compensated by the stabilizing effect of a constant exchange rate. Of course, these results depend on the *reaction of short-term interest rates* in the regime of monetary independence. The corresponding equation in the model has convincing statistical properties and can be assumed to reflect the average behavior of Swiss monetary policy over the past twenty years quite accurately. Nevertheless, the estimated reaction parameters are not cast in stone. An obvious final step in this paper thus is to do some experimentation with the reaction parameters in order to see if values differing from the historical estimates would have done a better job in stabilizing the economy.

4.4 A further alternative: Utilizing monetary independence more decisively

The behavior of monetary policy is represented in the model by equation (1) for the short-term interest rate (3M-Libor, the operational target of SNB). This equation was introduced in section 2.1 and is restated here for convenience together with the estimated parameter values (1981q1 - 2002q4):

$$\begin{aligned} \Delta srate_t &= S_s \Delta srate_t^* + S_e \log(e_t/e_{t-1}) + S_y \log\left(Y_t/Y_{t-1}\right) - S_u URATE_t \\ &\quad - S_c\left(srate_{t-1} - S_0 - srate_{t-1}^*\right) \end{aligned} \tag{1}$$

$$S_s = 0.554, \quad S_e = \text{-}0.099, \quad S_y = 0.508, \quad S_u = \text{-}0.050, \quad S_c = 0.171$$

A notable feature of the equation is the fact that it does *not* include the *current inflation rate*. The included arguments - besides the foreign short-term rate - are the exchange rate, GDP growth and the unemployment rate, which all can be regarded as *leading indicators of inflation*. The equation should not be viewed as an official monetary reaction function. However, it describes the actual behavior of short-term interest rates quite well and is difficult to beat on empirical grounds.[12] In other words, the equation seems to reflect the economic analysis underlying the decisions process at SNB in a simplified but nevertheless accurate way. Moreover, one may note that the exchange rate, the unemployment rate and foreign short-term interest rates are variables that are directly observable and readily available. This is not the case for current GDP growth, but here one may assume that the decision makers can rely on a bundle of other indicators providing them with a fairly accurate assessment of current GDP growth.

According to the parameter estimates, Swiss short term interest rates follow Euro short-term rates (German short-term rates prior to 1999) quite closely in the short-run (S_s) and are cointegrated with them in the long run (S_c, the t-value of the error-correction parameter is 4.91.). The close relationship of *srate* and *srate** is also evident from Figure 7a, where *srate* is compared to *srate*° = *srate** - 1.49. The responses of *srate* to the Swiss-specific factors are captured by parameters S_e (changes in the Euro/Swiss franc exchange rate), S_y (GDP growth) and S_u (unemployment rate). These parameters are statistically significant but numerically rather small. For instance, an increase in the annualized quarterly GDP growth rate by one percentage point (0.25 percentage points in the equation) raises *srate* by only about 0.13 percentage points (0.508*0.25) on impact and 0.74 percentage points (0.13/S_c) in the long run. Accordingly, the deviations of *srate* from *srate*° = *srate** - 1.49 are rather small in general.

12 The R^2 of the equation is 0.608 with respect to Δ*srate* and 0.990 with respect to *srate*. The standard error of the equation is 0.506 if *srate* is measured in percent. The dynamic fit of the equation is shown in Figure 2.

This leads to the question of whether more pronounced reactions of *srate* to the Swiss-specific factors (i.e. utilizing monetary independence more decisively) would have done a better job in stabilizing the economy. As the reactions of *srate* captured by the empirical parameters S_e, S_y, and S_u are weak, they must be set to much larger values in order to produce sizeable deviations of *srate* from *srate*°. This is even more the case in a dynamic simulation of the complete model because the effects of stronger reactions of *srate* feed back on *srate* in a dampening way. For example, if *srate* is lowered more strongly in response to an appreciation of the Swiss franc, this will limit the appreciation and therefore weaken the reason for lowering *srate*.

Table 1 reports the outcomes of some experiments with different values of the reaction parameters. The degree of economic stability is again judged on basis of the volatility of GDP growth rates, GDP trend deviations and CPI inflation rates measured by standard deviations in percentage points. For comparison, the top and bottom rows of Table 1 restate the results for the actual policy (the historically estimated reaction parameters) and the Euro peg.

Table 1: Volatility of GDP and CPI inflation under different monetary reaction functions (Simulation period 1981q3 to 2002q4)

		Standard deviations in percentage points		
		GDP		CPI inflation
Reaction parameters:		growth rates	trend deviations	
- Historical estimates		1.762	2.425	1.930
- Stronger reactions to	factors			
A) exchange rate	5	1.666	2.263	1.902
	10	1.628	2.244	1.896
	15	1.622	2.275	1.901
B) GDP growth rate	5	1.522	1.554	1.811
	10	1.523	1.243	1.830
	15	1.754	1.250	**1.946**
C) unemployment rate	5	1.730	1.850	1.738
	10	**1.804**	1.552	1.616
	15	**1.968**	1.536	**1.570**
	e GDP u			
D) combination of all	5 5 5	1.433	1.360	1.744
	10 10 10	**1.304**	1.124	1.723
	5 10 10	1.364	**0.996**	1.733
	10 5 10	1.420	1.362	**1.691**
	10 10 5	1.305	1.220	1.763
- Euro peg		1.722	2.411	1.698

In a *panel A*, the reaction parameter pertaining to the exchange rate (S_e) is raised by factors of 5, 10 and 15 respectively. This reduces the volatility of all three variables under consideration. For GDP growth, the smallest standard deviation is obtained with factor 15 (indicated by blue), while factor 10 does the best job for GDP trend deviation and CPI inflation. The reductions as compared with the actual policy are rather small, though.

Panel B display the results for a monetary reaction function that gives more weight to GDP growth (S_y). The best outcome for GDP growth itself is obtained with factor 5. Interestingly, giving more weight to GDP growth does not entail a further reduction in the volatility of this variable but worsens the outcome. For GDP trend deviation and CPI inflation, the lowest standard deviations are obtained with factors 10 and 5 respectively. Hence, giving too much weight to GDP growth in the monetary reaction function also tends to increase the volatility of CPI inflation. Multiplyig S_y with a factor of 15 produces a standard deviation of CPI inflation that is larger than under the actual policy (indicated by red).

Panel C shows that stronger reactions to the unemployment rate (S_u) mitigate the volatility of CPI inflation and GDP trend deviations, but quickly (beyond factor 5) entail larger fluctuations in GDP growth. In other words, raising the weight of the unemployment rate in the reaction function produces a trade-off between more stable CPI inflation but less stable GDP growth, while at the same time reducing the trend deviations of GDP.

One way to respond to the result of this trade-off is to argue that judging economic stability on basis of GDP *growth rates* is not a good idea to begin with because low volatility of GDP growth rates is not desirable *per se*. For example, assume that a strong negative shock has created high unemployment and a large negative output gap. In such a situation, cutting short-term interest rates decisively makes sense. Such a policy moves GDP back to potential, i.e. stabilizes the trend deviation of GDP and unemployment, but results in a high variation of GDP growth rates. The question then is why the evaluation of different versions of equation (1) has identified GDP growth - and not the output gap - as a significant determinant of policy decisions. To answer this question, one should notice that GDP growth appears in (1) together with the unemployment rate, which can be regarded as a close, directly observable and readily available proxy for the output gap. So it is the combination of GDP growth and the degree of slack in the economy that matters. High GDP growth that would intensify a boom entails a pronounced tightening of monetary policy whereas high GDP growth starting from a trough does not. A similar argument applies to the exchange rate. For example, whether counteracting an appreciation by lowering interest rates makes sense depends on whether the economy is in a boom or a trough. Of course, the additive form of the three arguments (GDP growth, unemployment rate, change in the exchange rate) in equation (1) is a rather poor representation of these considerations. Nevertheless, the fact that the estimated equation involves all three arguments points out that monetary policy decisions were not just driven by one indicator but based on a broader view of the situation of the Swiss economy.

The simulation results suggest that such an approach is superior. According to the results reported in panels A to C of Table 1, it is rather difficult to enhance economic stability by raising the three reaction parameters individually. Better results are obtained if all three parameters are raised in parallel, as shown in *panel D*. The first row of this panel reports the results for a simulation in which the parameters S_e, S_y and S_u are multiplied by 5. This (5,5,5)-scheme reduces the standard deviations of GDP growth rates and GDP trend deviations quite substantially. The volatility of CPI inflation is also reduced in comparison with the actual (1,1,1)-policy, but remains higher than for the (1,1,15)-policy of panel C. A (10,10,10)-policy brings about a further decline in all three standard deviations, although the standard deviation of CPI inflation falls only by little. From all the cases considered, this is the policy that produces the lowest standard deviation of GDP growth rates. Taking this (10,10,10)-scheme as a new reference point, the last three lines of panel D evaluate the partial effects of the reaction parameters by setting them individually back to 5. Lowering the factor for the exchange rate to 5 makes GDP growth and CPI inflation somewhat more volatile but mitigates the deviations of GDP from trend. From all cases considered, this is the policy that keeps GDP closest to trend. Reducing the factor for GDP growth to 5 enhances the stability of CPI inflation but worsens the outcome with respect to GDP growth rates and trend deviations. Finally, setting the factor for the unemployment rate back to 5 leaves the standard deviation of GDP growth rates practically unaffected but slightly increases the volatility of GDP in relation to trend as well as CPI inflation.

All policies of panel D outperform the actual policy. The lowest standard deviation of GDP growth rates obtains for the (10,10,10)-policy, while the (5,10,10)-policy does the best job with respect to the trend deviations of GDP and the (10,5,10)-policy minimizes the volatility of CPI inflation. However, the (1,1,10) or (1,1,15)-policies of panel C, reacting more strongly to the unemployment rate only, reduce the standard deviation of CPI inflation rates by even more. On the other hand, such "one-sided" policies entail a substantially increase in the volatility in GDP, both in terms of growth rates and trend deviations. Nevertheless, as the foremost goal of SNB is to keep inflation under control, a policy that reacts strongly to the unemployment rate (or, equivalently, a measure for the output gap) seems advisable. A more balanced alternative that also pays attention to stability of GDP is maybe the (10,5,10)-policy. It would keep the standard deviation of CPI inflation close to the minimum and at the same time result in a fairly low volatility of GDP, in particular with respect to trend deviation. In relation to the actual policy, this policy reduces the standard deviations of the three variables by the following percentages: CPI inflation -12.4%, GDP growth rates -19.4%, GDP trend deviation -42.8%.

Figure 11 shows the results for the (10,5,10)-policy in some more detail in comparison with the actual (1,1,1)-policy. Short-term interest rates would have been raised more aggressively at the end of the 1980's and reduced more strongly in the mid-1990's.[13] With this policy, GDP growth and CPI inflation would have been dampened when they were high (at the end of the 1980's) and simulated when they were low (in the mid 1990's). The figure makes also clear that the stabilizing effects of such a policy would have been fairly small with respect to CPI inflation but substantial in that it GDP is kept much closer to trend. In the last six years of the simulation, however, GDP growth rates and CPI inflation almost coincide between the two policies. This period was characterized by short and not very pronounced cyclical developments (the recovery starting in 1997 was interrupted by the Asian crisis). In such circumstances, the potential of monetary policy is severely limited by the lags in the impact on GDP and inflation. It may be shown that raising the reaction parameters further would not have dampened but in fact magnified the fluctuations during this period because the effects would have fallen into phases where the cycle has already reversed for other reasons. This also suggests that decisive changes of monetary policy in case of large shocks to the economy make sense whereas moving short-term interest rates up and down by small amounts in short time intervals in response to minor disturbances does not.

The bottom row of Table 1 restates the volatility measures from the Euro peg simulation. As noted earlier, these do not differ much from those obtained for the regime of monetary independence under the actual behavior of monetary policy (top row). The only noticeable difference is a somewhat lower standard deviation of CPI inflation rates (1.698 instead of 1.930). By utilizing monetary independence more decisively like in the (10,5,10)-policy, this outcome for CPI inflation under the Euro peg can be improved only by a small margin (standard deviation of 1.691). However, this result comes along with a much lower volatility of GDP, both in terms of growth rates and trend deviations. In relation to the Euro peg, the standard deviation of GDP growth rates is reduced from 1.722 to 1.420 and the trend deviations are almost cut in half from 2.411 to 1.362. Similar reductions in the volatility are obtained for other variables like private consumption, investment, employment, etc. Hence, the analysis

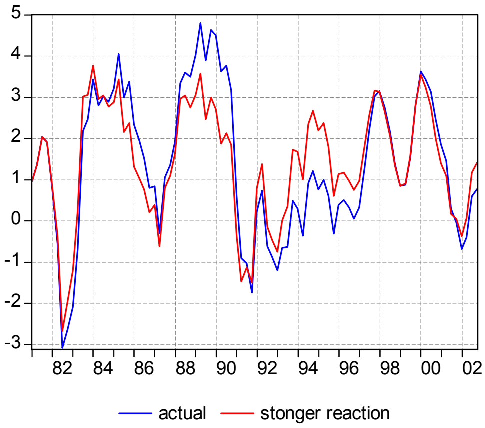
[13] In three short periods (1995q4-1996q1, 1998q1, 2002q1-2002q4) the zero lower bound constraint becomes binding.

suggests that main advantage of monetary independence lies in its stabilizing effect on GDP (and related macroeconomic variables like private consumption, investment, employment, etc.), provided that the control on short-term interest rates is used with sufficient determination, in excess of that observed in the past.

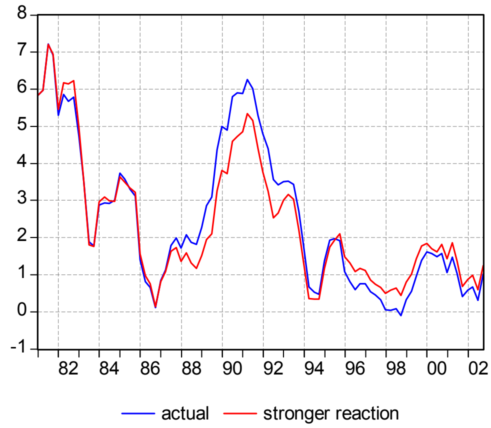
Figure 11: Volatility of GDP and CPI inflation under stronger monetary reactions
Raising the reactions of short-term interest rates to the exchange rate,
GDP growth and unemploment by factors 10, 5 and 10 respectively
(Simulation period 1981q3 to 2002q4)

a) Short-term interest rate in %

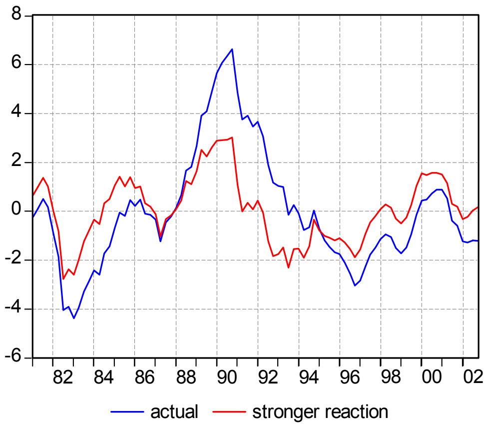
b) GDP growth rate in %



c) CPI inflation in %



d) GDP trend deviation in %



5 Conclusion

Pegging the Swiss franc to the Euro would change the monetary environment of the Swiss economy in several respects. First, the introduction of the peg would result in a significant upward jump in interest rates. Second, after the adjustment to this interest rate shock has taken place, the Swiss economy would have to operate under a higher level of nominal interest rates in the long run. Third, the Swiss National Bank would loose control on short-term interest rates and thus no longer be able to conduct a monetary policy that is adapted to the specific cyclical position of the country. Forth, the peg would eliminate exchange rate shocks but also prevent exchange rate movements in response to fundamentals. The paper analyses these issues - with the exception of the long-term consequences of higher nominal interest rates - on basis of simulations with an econometric macromodel for Switzerland.

There are several possible *objections* against the results reported in this paper. First, as any study that evaluates policy issues on basis of an econometric model, the paper has to be defended against the *Lucas critique*. A by-now standard line of defense it to say that the Lucas critique is certainly valid in principal but has limited relevance with respect to the particular investigation. Otherwise, investigations of this sort would obviously not have been undertaken in the first place. This is not much different here. So one has certainly to admit that replacing the current concept of Swiss monetary policy by a Euro peg amounts to a change in the policy rule. However, whether this alters the formation of expectations and thus the structure of the model in a significant way is unclear. Assuming that is does not is at least consistent insofar as - by adopting this assumption - the model produces a behavior of the economy that differs only gradually from the baseline simulation. Put differently, there is no contradiction between the assumption of unchanged expectations and the simulation results obtained under this assumption. In one respect, however, expectations would change fundamentally under a Euro peg: Agents must no longer worry about changes in the Swiss franc/Euro exchange rate and incur costs in order to hedge against such changes. In this context, a series of recent studies dealing with a potential EU membership of Switzerland have argued that a fixed exchange rate would produce notable efficiency gains and boost total factor productivity.[14] Whether true or not, this is in any case a claim that refers to long-term growth, which is not the issue here. Nevertheless, in a broader assessment of the pros and cons of a potential EU accession, the implications of a fixed exchange rate for long-term growth would have to be taken into consideration as well.

In the simulation experiments with different values of the reaction parameters, the reaction function itself remains unchanged. Hence, these simulations may seem to be immune to the Lucas critique. One should keep in mind, however, that the stabilizing effects of stronger monetary reactions come at the cost of substantially *more volatile short-term interest rates*. As the related information problems are neglected, the simulations may be suspected to overstate the advantages of stronger monetary reactions. On the other hand, one may also argue that such a policy would affect expectations with respect to GDP growth and inflation in a way that enhances its stabilizing effect on the economy.

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[14] These papers are collected in Baldwin and Brunetti (2001). They include - among others - Bärlocher (2001), Genberg and Kadareja (2001), Van Nieuwkoop and Müller (2001) and Stalder (2001b)

Another conceivable objection against the paper is that the analysis is not carried out in *real time*. First, the information set on which monetary policy decisions are based includes current GDP, a variable that is published with a lag and subject to revision. Second, the model is estimated over the full sample. With respect to the first point, the counter-argument is that other indicators may serve as a proxy for GDP growth, telling the decision-makers at least in a qualitative sense whether the economy is growing strongly or weakly in a certain period. Regarding the second point, professional observers of the Swiss economy may be assumed to have a good understanding of the basic functioning of the economy without recourse to a model that is estimated on a particular data set.[15]

These objections have certainly to be kept in mind when interpreting the results of the paper. However, they do not seem to be severe enough to overthrow the following conclusions.

A first simulation addresses the question of how the Swiss economy would have developed under a *hypothetical Euro peg as of the beginning of 1999* when EMU was started. The simulation thus suppresses on the one hand the actual appreciation of the Swiss franc vis-à-vis the Euro of almost 10% in the period 2000-2002. On the other hand, the Swiss economy is confronted with a sudden increase in interest rates of about 1.5 percentage points at the beginning of 1999. The simulation shows that the positive effects resulting from the suppression of the appreciation are insufficient to outweigh the adjustment problems resulting from the upward jump in interest rates. Over the whole simulation period (1999q1-2002q4), GDP growth would have been lower and CPI inflation higher, although GDP growth rates begin to exceed baseline values slightly from mid-2001 on.

The paper then takes a broader view on the *different types of shocks* that were hitting the Swiss economy over the past twenty years. It turns out that cyclical developments in Switzerland are mainly caused by world economy shocks. The shocks captured by the error terms of the model are also important but smaller in size. Moreover, they are moderately correlated with the fluctuations generated by the world economy variables and therefore cannot be interpreted as entirely Swiss-specific. The volatility of Swiss GDP growth and inflation resulting from world economy shocks alone is comparable in size to the corresponding Euro area variables. By including the shocks captured by the residuals, however, the model produces fluctuations in the Swiss variables in excess of those in the Euro area. In addition, the correlations of these fluctuations with those in the Euro area are far from perfect for both GDP growth and inflation. Therefore, monetary independence is potentially advantageous.

In a next step, the paper asks to what extent *monetary independence* was actually used and successful in *stabilizing the economy*. The counterfactual scenario is a simulation in which Swiss short-term interest rates move constantly by 1.5 percentage points below Euro short-term rates (while the exchange rate remains flexible). The scenario thus shows the hypothetical development of the Swiss economy in case that SNB, although formally independent, had just duplicated the ECB's interest rate decisions. The comparison of this scenario with the actual policy leads to the conclusion that monetary

[15] In the political discussion in Switzerland, monetary policy is sometimes criticized for having pursued a too restrictive or too expansionary stance in a certain period on basis of information that could not possibly be known at the time when the policy decisions were taken. Technically, this is like including future shocks in the monetary reaction function, with the obvious implication that the economy can be stabilized to any desired degree. Compared with such "benefit of the hindsight" statements, the investigation of this paper is very close to a real time analysis in that the monetary reaction function involves only current information (with the mentioned minor reservation regarding GDP growth).

independence was used rather retentively in the past twenty years but that the independent moves of short-term interest rates went in the right direction in the sense of stabilizing the economy.

In the *Euro peg simulation*, the Swiss franc/Euro exchange rate is fixed at the historical average of the period 1981 to 2002. The simulation differs from the first Euro peg scenario in two respects. On the one hand, the simulation comprises a much longer period of time in which the Swiss economy was subject to a large variety of shocks. On the other hand, it concentrates on the loss of monetary independence - as opposed to the adjustment problems resulting from higher interest rates - by keeping Swiss short-term interest rates again by a constant amount of 1.5 percentage points below Euro short-term rates. Comparing this scenario with the baseline of monetary independence shows that a Euro peg would have left the volatility of GDP practically unchanged while slightly reducing the volatility of CPI inflation. In other words, the stabilizing effects of a constant exchange rate by and large outweigh the destabilizing effects of the loss of control over short-term interest rates.

In view of this result of a near par between monetary independence and the regime of a Euro peg, the paper finally tries to improve the performance of an independent monetary policy by experimenting with reaction parameters in the equation for short-term interest rates that differ from their historical estimates. It turns out that *stronger monetary reactions* would have enhanced economic stability quite substantially. More precisely, by changing short-term interest rates more decisively in response to GDP growth, the exchange rate and the unemployment rate, the volatility of GDP could have been reduced strongly while the stabilizing effects on CPI inflation remain rather weak. Accordingly, in comparison with the Euro peg simulation, the volatility of CPI inflation is lowered by a negligible amount while the trend deviations of GDP are almost cut in half. The paper thus suggests that the main advantage of an independent Swiss monetary policy lies in its stabilizing effect on GDP and several related variables like private consumption, investment and employment. However, in order for these stabilizing effects to materialize, the instrument of short-term interest rates must be utilized with sufficient determination - in excess of that observed on average in the past twenty years. The resolute reduction of short-term interest rates in the recent downturn of the Swiss economy is a good example of such an independent move of Swiss monetary policy. Finally, one may note in favor of the actual conduct of monetary policy that more economic stability is attained in the experiments simply by raising the reaction parameters whereas the form of the reaction function remains unchanged.

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