Forecasting Swiss inflation with a structural macromodel: the role of technical progress and the "mortgage rate-housing rent" link

Peter Stalder

1. Introduction

At the beginning of the year 2000, the Swiss National Bank (SNB) adapted its monetary policy strategy. Instead of using a medium-term target path for the monetary base, an inflation forecast now serves as the main indicator for monetary policy decisions. At the operational level, the SNB has adopted three-month Libor (London interbank offered rate) as its new reference interest rate, and the intended stance of monetary policy is communicated to the public in terms of a target range for this interest rate with a width of 1 percentage point.

In view of this adapted concept, a sound foundation for monetary policy decisions requires deeper insights into the process generating future inflation in general and the transmission mechanism from short-term interest rates to long-term interest rates, exchange rates, real economic activity and inflation in particular. Ideally, an econometric model should be available that produces reliable conditional inflation forecasts, thus showing how three-month Libor has to be adjusted in order to keep inflation in conformity with the definition of price stability (CPI inflation below 2%).

The SNB inflation forecast is based on different models and indicators. Among the forecasting models, three approaches may be distinguished. A first approach follows the VAR methodology and identifies the variables that are most relevant for future inflation in Switzerland (Jordan (1999)). A second approach is a small structural model of the Swiss economy, centred on a Phillips curve and an IS relationship (Zurlinden and Lüscher (1999)). The third approach is a medium-size structural model of the Swiss economy with a relatively detailed representation of aggregate demand, a supply block (wage-price dynamics, capacity output, labour market) and a monetary block (interest rates and exchange rates). This latter model forms the basis for the analysis contained in this paper.

In the framework of the adapted concept, the appropriateness of monetary policy is connected in a straightforward manner to the reliability of the inflation forecast. Erroneous inflation forecasts give rise to wrong policy decisions, and wrong policy decisions can in principle be traced back to erroneous inflation forecasts, although performing this task may not be quite as easy in practice due to the overlapping character of updated inflation forecasts and monetary policy decisions. In this context, the paper investigates two issues that are related to (i) uncertainties in the process of forecasting inflation and (ii) institutional changes in the Swiss economy that may affect the monetary transmission mechanism.

Specifically, a first model simulation deals with the question of to what extent the inflation forecast is affected by alternative assumptions with respect to the rate of technical progress. This experiment is motivated by the recent discussion about potential, but so far insecure, productivity gains resulting from the "new economy" in connection with liberalised markets and intensified competition. A second simulation addresses the question of to what extent the link of housing rents to mortgage rates, as established by Swiss legislation on tenancy rights, hampers the monetary transmission mechanism. This is done by carrying out a counterfactual simulation in which the housing rent equation of the model, reflecting current legislation, is replaced by an alternative link of housing rents to the CPI. In fact, proposals going in this direction are currently being discussed in the Swiss parliament.

The second simulation is somewhat different in character from the productivity experiment since it addresses the implications of an institutional change that would be known to the monetary authorities some time in advance. In both cases, however, the change in the economic structure affects inflation and thus - if not taken into account properly in the forecasting model - will give rise to wrong signals for monetary policy. Alternatively, the second simulation can also be viewed as an exercise that sheds some light on the question of whether the current legislation should be changed or not.

All simulations and forecasts presented in this paper refer to a situation comparable to the one faced by the SNB in August 2000. It should be noted, however, that they are made for the purpose of this study only and do not necessarily coincide with the actual SNB forecast. Moreover, although the SNB does not actually pursue a policy of explicit inflation targeting, a strict inflation target of 1.7% is assumed for didactic reasons.

The remainder of the paper is organised as follows. Section 2 outlines the basic structure of the model, with emphasis on those parts that matter most in the following simulation experiments. The sequence of simulations starts - as in the actual monetary policy decision process - with an inflation forecast based on the assumption of an unchanged three-month Libor (Section 3). This baseline forecast is intentionally made somewhat more inflationary than the actual SNB forecast of August 2000 in order to bring it into clear contrast to price stability and to motivate - in Section 4 - the simulation of a more restrictive monetary policy. The role of productivity growth is analysed in Section 5. This simulation is implemented in such a way that, given higher productivity growth, the inflation target is attained without monetary tightening. On this basis, the consequences of two possible errors in the stance of monetary policy can be discussed: (i) tightening because actually higher productivity growth is not taken into account in the inflation forecast, (ii) not tightening because of expected higher productivity growth when in fact it remains unchanged. Section 6 deals with the role of the “mortgage rate-housing rent” link and analyses the extent to which this link affects the monetary transmission mechanism. Section 7 summarises the paper and draws some conclusions.

2. Structure of the model

The model used for the following simulations is a quarterly structural model of the Swiss economy recently developed at the SNB. In its present version, it contains 29 stochastic equations, which may be assigned to an aggregate demand block, a supply block (production function, labour market, wage-price dynamics) and a monetary block (interest and exchange rates).[1] Although the model is rather conventional in many respects, it involves some distinguishing features that should be pointed out. The emphasis in this section is on those aspects of the model that are particularly relevant for the simulations presented below.

2.1 Supply block

2.1.1 Capacity output, factor proportions, investment and scrapping

A rather non-standard approach is taken in the specification of the supply block of the model.[2] The equations for firms’ decisions on investment, production capacity and prices are based on a vintage production function, ie the assumption that “machines” can be designed to combine with an optimal input of labour prior to their installation but that the factor proportions remain fixed thereafter. Further assuming monopolistic competition in the product market, the problem of the firm is to choose on each investment vintage the cost-minimising factor mix, to pursue an optimal policy of replacing old investment vintages by new equipment and to adjust production capacities, output and prices in response to changes in goods demand and factor costs. In this framework, the evolution of capacity output YC_t and capacity labour demand LC_t (ie labour demand corresponding to full utilisation of available equipment) can be described by the following two equations:

$$YC_t = S_t\, YC_{t-1} + B_t I_t \tag{1}$$

$$LC_t = S_t\, LC_{t-1} + C_t I_t \tag{2}$$

[1] The developer of the model has previously been responsible for the development of the macroeconometric model at KOF/ETH. Several insights into the mechanism of the Swiss economy gained during this work at KOF/ETH are reflected in the model of this paper.

[2] A more detailed description is given in Stalder (1994).

In (1) and (2), S_t is the share of surviving equipment from the previous period (1-S_t is the scrapping rate). B_t is capital productivity and C_t is labour intensity of the new vintage, while I_t is gross investment for the period. Hence B_tI_t is capacity added by the vintage installed at time t and C_tI_t is the corresponding labour requirement. Assuming a Cobb-Douglas production function with labour-augmenting technical progress θ and labour share α, one obtains B_t and C_t as

$$B_t = B_0 q_t^{-\alpha} e^{\theta\alpha t} \qquad \text{and} \tag{3}$$

$$C_t = C_0 q_t^{-1} \qquad \text{where} \quad q_t = w_t / v_t \tag{4}$$

is the ratio of wages to capital cost at the time of investment.

The expected long-term growth rate of q_t theoretically also plays a role in (3) and (4) and at the same time affects the prospective lifetime of vintage t for the following reasons. The replacement of existing by new equipment is determined by a comparison of production costs. On existing vintages, the factor input proportions are fixed and capital costs are “sunk”. Existing vintages are thus replaced as soon as the associated unit labour costs exceed total unit costs on new equipment (scrapping rule). Hence, if wages are expected to increase strongly in relation to capital costs, the prospective lifetime of new equipment shortens and firms shift to a more capital-intensive expansion path, ie they choose lower B_t and C_t. Without such a shift, the prospective lifetime would obviously shorten more. In specifications (3) and (4), these considerations are neglected or, put differently, it is assumed that the expected long-term growth rate of q_t is constant. This can be justified by noting that the logarithm of q_t can be represented empirically as a random walk with drift, implying that the innovations of the process affect the actual growth rate of the factor price ratio but leave its expected long-term growth rate unchanged.

With respect to the scrapping decision of each period, it is, however, not the *expected* long-term growth rate but the known *actual* growth rate of q_t that matters (denoted by $\dot{q}_t$). Old equipment is typically more labour-intensive than new equipment and capital costs on old equipment are “sunk”. Therefore, if wages increase *strongly* in relation to capital costs in a certain period, a larger share of existing equipment will lose its competitiveness and be scrapped. Hence, the share of surviving equipment is a negative function of $\dot{q}_t$:

$$S_t = S(\dot{q}_t) \tag{5}$$

Investment behaviour can be specified on the basis of the same theoretical considerations. If S_t and B_t are low (because of high $\dot{q}_t$ and q_t respectively), a larger volume of new investment I_t will be needed to adjust production capacity from YC_{t-1} to YC_t. In fact, the investment equation can be derived from (1) by replacing YC_t by some concept of desired capacity, solving for I_t and allowing for adjustment lags (see below).

2.1.2 Price setting and regimes of the firm

On the assumption of monopolistic competition in the goods market, firms set the price as a profit-maximising mark-up over marginal costs *MC*. These can be defined either as total unit costs on new equipment or as unit labour costs on marginal (oldest) equipment. The two concepts are equivalent in equilibrium due to the scrapping rule (old vintages are replaced as soon as the associated unit labour costs exceed total unit costs on the most recent vintage). The normal mark-up price of a firm can thus be written as[3]

$$\bar{p}_t = \left(\frac{\eta}{\eta - 1}\right) MC_t \tag{6.1}$$

where η is the price elasticity of the firm’s demand curve and marginal costs are defined, on the basis of the Cobb-Douglas vintage production function, as

[3] The term “normal” is perhaps somewhat misleading. More precisely, $\bar{p}$ is the optimal price neglecting capacity constraints - or the long-term optimal price, since firms can always add new equipment, making the long-run "supply curve" horizontal. The effect of short-run capacity constraints will be introduced below.

$$MC_t = w_t^{\alpha} v_t^{1-\alpha} e^{-\theta\alpha t} \tag{6.2}$$

where α is the labour share and θ is the rate of labour-augmenting technical progress.

Desired production capacity is given by expected demand at $\bar{p}$, $YD(\bar{p})$. In the short run, however, the available set of vintages places an upper bound on output, giving rise to two possible regimes of the firm:[4]

1. If a firm faces a demand curve which, at the normal mark-up price $\bar{p}$, exceeds capacity output *YC*, it will produce at full capacity ($Y = YC < YD(\bar{p})$) and raise the price ($p > \bar{p}$) in order to choke off excess demand. Moreover, effective labour demand *LD* corresponds to capacity labour demand *LC*.
2. If demand at $\bar{p}$ falls short of capacity output *YC*, the firm's output level is constrained by demand ($Y = YD(\bar{p}) < YC$) and the optimal price p is equal to $\bar{p}$. In this case, effective labour demand *LD* falls short of capacity labour demand *LC*.

This theoretical framework, which is somewhat in the spirit of the "disequilibrium" approach of Malinvaud (1980), Benassy (1986) or Sneessens (1990), establishes a straightforward link to business survey data: a firm that reports capacities as being too small (too large) indicates it is in regime 1 (regime 2). Of course, individual firms will generally be in different regimes, and this creates an aggregation problem. Moreover, $YD(\bar{p})$ and YC are not directly observable.

2.1.3 Aggregation and the use of business survey data

A convenient way to deal with both problems at once has been proposed by Lambert (1988). Assuming that the ratio $YD(\bar{p})/YC$ is log-normally distributed in the population of firms and that the output level of each firm *i* is given by the minimum of the two possible constraints, ie $Y_i = \min(YC_i, YD(\bar{p}))_i$, the aggregate relationships can be approximated by

$$Y(1-\pi_G)^{-\kappa} = YD(\bar{p}) \tag{7.1}$$

$$Y\pi_G^{-\kappa} = YC \tag{7.2}$$

where π_G is the proportion of firms reporting capacities as being too small (capacity-constrained firms in regime 1). Equations (7.1) and (7.2) define a one-to-one mapping from the two latent variables $YD(\bar{p})$ and YC to the two observables Y and π_G. In order to see how this mapping works, it is instructive to divide (7.1) by (7.2), yielding a logit-type equation for π_G:

$$\left(\frac{\pi_G}{1-\pi_G}\right)^{\kappa} = \frac{YD(\bar{p})}{YC} \tag{7.3}$$

According to (7.3), the regime mix (π_G, 1-π_G) is endogenously determined in the model by the aggregate demand/capacity ratio, and the "curvature" of this relationship is shaped by parameter κ. If we let $YD(\bar{p})$ increase in relation to YC, π_G converges to its upper bound 1 ("all" firms are capacity-constrained). In such a limiting situation, Y according to (7.2) tends from below to YC, ie aggregate output corresponds to aggregate capacity. If we let $YD(\bar{p})$ decrease in relation to YC, then π_G converges to its lower bound 0 ("all" firms are demand-constrained) so that in the limit - according to (7.1) - Y is bounded from above by $YD(\bar{p})$. Aside from these limiting situations, actual output Y is smaller than YC and $YD(\bar{p})$, increasingly so for large values of κ. Parameter κ can be viewed as a measure of mismatch between the micro structures of aggregate demand and capacity. More precisely, it measures the dispersion of $YD(\bar{p})/YC$ in the population of firms.

4 In the following equations, the time subscripts are omitted.

Firms for which $Y = YC < YD(\overline{p})$ have an incentive to raise the price p above $\overline{p}$ in order to bring demand into line with available capacity. At the aggregate level, this can be formalised as follows:

$$p_t = \overline{p}_t \, (1 - \pi_{G_t})^{-\tau} \tag{8}$$

The aggregate price level p is an increasing function of π_G. The specification implies that p tends from above to its lower bound $\overline{p}$ if π_G converges to 0, which - according to (7.3) - happens if aggregate demand becomes sufficiently low in relation to capacity output ("all" firms demand-constrained). Provided that firms facing excess demand at $\overline{p}$ raise the price enough to eliminate excess demand, one may assume that $Y = YD(p)$. Note, however, that it is always $YD(\overline{p})$ - and not $YD(p)$ - that determines desired capacity and thus investment behaviour.

Substituting (6.1) and (6.2) into (8), one obtains the following aggregate price equation:

$$p_t = \left(\frac{\eta}{\eta - 1}\right) w_t^{\alpha} v_t^{1-\alpha} e^{-\theta \alpha t} \left(1 - \pi_{Gt}\right)^{-\tau} \tag{9}$$

In the empirical model, (9) is dynamically extended into an error correction equation and applied to the GDP deflator (excluding housing rents).

2.1.4 Investment behaviour

By investing in new equipment, firms tend to bring production capacities into line with the development of demand. Demand at the normal mark-up price determines desired production capacity, ie $YC_t^* = YD_t\,(\overline{p}_t)$. After substituting this into (1) one may solve for the desired investment rate:

$$IR_t^* \equiv I_t^* / YC_{t-1} = \left(\frac{YD_t\,(\overline{p}_t)}{YC_{t-1}} - S_t\right) / B_t \tag{10}$$

This equation defines the investment rate that would just close the gap between demand at $\overline{p}_t$ and the surviving capacity from the previous period. To allow for adjustment cost and other factors that may cause inertia in investment behaviour, a simple partial adjustment scheme is introduced:

$$IR_t = \lambda\, IR_t^* + (1 - \lambda) IR_{t-1} \quad \text{where } IR_t = I_t / YC_{t-1} \tag{11}$$

The role of capacity output in the model differs from the more commonly used concept of potential output in two respects. First, capacity output acts as a strict upper bound for actual output ($Y \leq YC$), ie the output gap is never positive, whereas potential output is usually defined as output at a normal utilisation rate so that actual output may exceed potential output in boom periods. Second - and also in contrast to the usual concept of potential output - capacity output refers to technical capacities only. The tension situation on the labour market is taken into account separately, as shown next.

2.1.5 Labour market and wage formation

On the labour market, the aggregate relationships can be formalised in a similar way. As outlined above, in capacity-constrained firms (regime 1, proportion π_G) we have $LD = LC$ while in demand-constrained firms (regime 2, proportion 1-π_G) we have $LD < LC$. At the aggregate level, this spillover from insufficient goods demand to effective labour demand can be represented by

$$LD = LC \pi_G{}^{\kappa} \tag{12}$$

where LC is given by (2). Apart from the limiting situation where π_G tends to 1 (ie as soon as some firms are demand-constrained in the goods market), effective labour demand LD falls short of capacity labour demand LC. To allow for labour hoarding, π_G is expanded into a lag structure in the empirical model. Employment L is determined in connection with aggregate labour supply LS as

$$L(1 - \pi_L)^{-\upsilon} = LD = LC \pi_G^{\kappa} \tag{13.1}$$

$$L \pi_L{}^{-\upsilon} = LS \tag{13.2}$$

where π_L, endogenously determined by *LD/LS*, is the proportion micro labour markets in excess demand (measured by the share of firms reporting labour shortages). The implied unemployment rate is

$$URATE = 1 - L/LS = 1 - \pi_L{}^{\upsilon} \quad (14)$$

If *LD* = *LS*, we have π_L = 0.5. This can be regarded as an aggregate equilibrium. The associated unemployment rate (structural rate of unemployment at equilibrium) is

$$SURE = 1 - 0.5^{\upsilon} \quad (15)$$

SURE is an increasing function of parameter υ, which can be viewed as a measure of demand/supply "mismatch" (dispersion of the demand/supply ratio across micro labour markets).[5]

In the empirical application, econometric equations are substituted on the right-hand side of (7) and (13), and the parameters of these equations are estimated jointly with the parameters υ and κ, which shape the transformation from the latent variables *YD*, *YC*, *LC* and *LS* to the observable variables *Y*, *L*, π_G and π_L.

The equation substituted for labour supply makes *LS* dependent on the exogenous potential labour force and involves a partial adjustment scheme with respect to actual employment. This can be seen as kind of a "discouraged worker" mechanism in the sense that low (high) employment entails a retreat from (re-entry into) the labour market. In addition, it may also reflect a cyclical buffer role of seasonal and frontier workers, who are not included in the potential labour force.

The proportion π_L enters the wage equation of the model in the following way:

$$w_t = p_t^{k_1} pc_t^{(1-k_1)} \left(\frac{Y_t}{L_t} \right)^{k_2} \left(\frac{\pi_{Lt}}{1 - \pi_{Lt}} \right)^{k3} \quad (16)$$

The development of the nominal wage thus depends on a weighted average of the GDP deflator *p* and consumer prices *pc*, labour productivity *Y/L* and π_L, reflecting tension in the labour market. In the empirical model, equation (16) is brought into an error correction form as well.

Equation (16) says that wages increase in relation to prices if the labour market becomes tight (high π_L). Equation (9) says that firms raise prices in relation to wages if capacity utilisation increases (high π_G). Hence, if both the goods and the labour market are tight, the formation of wages and prices may become incompatible in the sense that the income claims of workers and firms add up to more than what is actually available for distribution. The result is accelerating inflation that must continue to the point where real activity is dampened enough to make income claims compatible by lowering π_L and π_G.[6]

Consumer prices *pc,* which enter (16) with a weight of about 0.5, depend on the GDP deflator *p*, import prices *pim* (excluding oil), the price of imported oil *poil* and housing rents *phr*:

$$pc_t = pc(p_t, pim_t, poil_t, phr_t) \quad (17)$$

According to this equation, increasing import prices or housing rents may drive a wedge between the GDP deflator and consumer prices (or between the real producer wage and the real consumer wage) and thereby - since nominal wages are partly adjusted to consumer prices - also set in motion a wage-price spiral. This aspect of the model will become relevant in Section 6, where the impact of the formation of housing rents on the monetary transmission process is discussed.

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5 With regard to the *SURE* concept and some other aspects, the model of this paper is quite similar to the various country models presented in Drèze and Bean (1990).

6 This is in the spirit of the NAIRU model of Layard, Nickel and Jackman (1991).

2.1.6 Impact of higher productivity growth - theoretical considerations

Section 5 of this paper presents a model simulation addressing the question to what extent the inflation forecast is affected by higher technical progress. Given the above specifications, it is quite straightforward to carry out this exercise by raising the technical progress parameter θ in equations (3) and (9). In accordance with the adopted vintage framework, this amounts to the assumption that higher technical progress falls exclusively on new equipment:

- In equation (3), a higher θ entails a stronger increase of capital productivity *B* and thus labour productivity on new equipment, which is given as[7]

  $$A_t = B_t / C_t = (B_0 / C_0) q_t^{1-\alpha} e^{\theta \alpha t} \tag{18}$$

- In equation (9), a higher θ lowers the output price in relation to factor prices.

Of course, these are just initial effects. Eventually, all variables of the supply block are affected by higher productivity growth in a rather complex way. The responses also depend on various reaction parameters in the aggregate demand block and the monetary block of the model. A crucial issue is the extent to which the higher growth potential of the economy is actually absorbed by a steeper increase in aggregate demand. If the positive effect of lower prices on aggregate demand is weak, investment and employment will decline as a result of higher capital productivity and labour productivity, respectively. The corresponding underutilisation of resources enhances the direct price dampening effect of productivity growth. If aggregate demand is stimulated strongly by lower prices, negative reactions of investment and employment may be prevented. But then, the price-dampening effect of higher productivity growth will also be smaller.

More technically, consider an increase of θ by an amount of $\Delta\theta$. Initially, this raises the growth rate of both capital productivity and labour productivity by $\Delta\theta\alpha$ but leaves the labour intensity of new equipment unaffected, as can be seen from equations (3), (4) and (18). In the sequel, however, since higher technical progress pushes prices down in relation to wages, there will be an increase in the factor price ratio *q* = *w/v*, shifting the factor input ratio in favour of capital (lower *C*). This process of capital deepening on the one hand raises the growth rate of labour productivity still further. On the other hand, it dampens the growth rate of capital productivity. An illustrative benchmark case obtains if we assume that the growth rate of *q* just rises by $\Delta\theta$ (wages increase in relation to capital costs exactly by the amount of additional labour-augmenting technical progress, thus keeping the factor price ratio in terms of efficiency units constant). In this case, the growth rate of labour productivity *A* rises by $\Delta\theta$ (instead of $\Delta\theta\alpha$), while capital productivity *B* remains constant (instead of rising by $\Delta\theta\alpha$). Empirically, it turns out that the growth rate of *q* increases, but by less than $\Delta\theta$. Nevertheless, the induced process of capital deepening reduces the negative impact of faster technical progress on investment while the negative impact on employment is enhanced. Both negative effects are mitigated or even reversed if aggregate demand shows a large positive reaction to lower prices (which can be expected in the longer run).

The model distinguishes between three concepts *of* labour productivity, namely technical labour productivity on new equipment (*A* = *B/C*), technical labour productivity on the entire production apparatus (*YC/LC*) and measured labour productivity (*Y/L*). The increase in *YC/LC* resulting from a higher value of θ hinges on the speed with which old equipment is replaced by new equipment, ie scrapping and investment. Measured labour productivity *Y/L* additionally depends on cyclical factors like capacity utilisation *Y/YC* and labour hoarding.

Empirically, all three productivity measures show a positive reaction to a higher value of θ. The effect on output *Y* is positive as well, but smaller than the increase in labour productivity. As a result, employment *L* declines and unemployment rises, lowering the tension measure π_L. In the wage equation (16), one thus has two opposing effects, a positive productivity effect and a negative tension effect. Empirically, the productivity effect dominates so that wages decline by less than the GDP deflator and consumer prices. Accordingly, both the real producer wage (*w/p*) and the real consumer wage (*w/pc*) increase. The price of new capital goods, *v*, also declines substantially in relation to the nominal wage so that the factor price ratio *q* = *w/v* increases. The fall in *v* is partly due to the

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7 *B* is output per unit of new capital, *C* is labour per unit of new capital, hence *B/C* is output/labour, ie labour productivity.

functioning of the monetary block, where lower domestic prices lead to an appreciation of the Swiss franc, which in turn has a dampening effect on the prices of imported investment goods.

Investment behaviour is influenced by higher technical progress in different ways. First, the stronger increase in the factor price ratio $q = w/v$ lowers S, ie speeds up scrapping and thus stimulates investment. Second, the stronger growth of capital productivity B exerts an opposing negative effect on investment since less investment is needed to attain a certain production capacity. Third, the response of investment depends on the extent to which aggregate demand is stimulated by lower prices. Empirically, it turns out that the response of investment to a higher rate of technical progress is negative in the short run (the effect of higher capital productivity dominates) but positive in the longer run (as the aggregate demand effect gains strength).

In the following, we describe the specification of the aggregate demand part of the model, which is rather conventional.

2.2 Aggregate demand, income determination and sector prices

On the demand side of the goods market, we have the equations for the various components of aggregate demand:

- *Private consumption* depends on real disposable household income, the real long-term interest rate, the share of the non-active population and the unemployment rate.
- *Investment in machinery and equipment* is determined in close connection with the specification of capacity output as a function of tension in the goods market and the level and growth rate of relative factor costs, as described in Section 2.1 above.
- *Business construction* reacts with some delay on investment in machinery and equipment and relative construction prices.
- *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 United States and Japan on the one hand and the Swiss supply price in relation to the prices of competing producers in the world economy (converted into Swiss francs by the trade-weighted external value of the Swiss franc) on the other.
- *Imports* react to all components of aggregate demand with component-specific elasticities (reflecting different import intensities) on the one hand and import prices (excluding oil) in relation to the GDP-deflator on the other.
- *Public construction* and *government consumption* are treated as exogenous or - as an alternative in model simulations - linked in fixed proportions to GDP.

Together, these components define GDP (Y) from the demand side. However, Y is constrained in the supply block of the model by capacity output YC. In a situation where Y tends to its upper bound YC, prices increase, which dampens aggregate demand, in particular via foreign trade (lower exports, higher imports), while investment and capacity growth are stimulated. This mechanism works towards equilibrium in the goods market in the long run.

The goods market and the labour market interact via the production function and wage-price dynamics, as described above. In addition, income generated in the labour market is the most important component of *primary household income* and thus the central determinant of private consumption. The other component of primary household income, business and property income, is linked to non-wage value added, defined as nominal GDP minus total labour costs. The net tax *rate* that enters in the definition of *disposable household income* is treated as exogenous.

The aggregate demand part of the model also collects the equations for those sector prices that are not part of the supply block:

- *Construction prices* depend on the GDP deflator and the share of construction investment in total GDP as a rough indicator of the relative position of the construction sector in the overall business cycle.
- *Housing rents* are determined by construction prices and interest rates, reflecting Swiss legislation that allows house owners to pass changes in the mortgage rate on to tenants. An increase in interest rates by 1 percentage point pushes housing rents up by 4.5% (with a lag), which is less than what is legally allowed but nevertheless hampers the efficiency of monetary policy to a significant degree, as shown in Section 6.
- *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.

Finally, one should note that equation (9), the central price equation of the model, refers to the GDP deflator excluding housing rents, *p*. The overall GDP deflator is then obtained by a definition equation involving *p* and housing rents *phr*. This distinction is motivated by the following consideration. As noted above, the speed with which tighter monetary policy dampens CPI inflation is hampered by the fact that higher interest rates are passed on to housing rents. However, increasing housing rents not only raise consumer prices and thus depress real wages but also raise non-wage incomes, which mitigates the negative effect on overall real household incomes. This is taken into account by the explicit appearance of housing rents in the equation for the GDP deflator, since it is the difference between nominal GDP and labour costs that determines non-wage household incomes. When simulating a more restrictive monetary policy (Section 4) or when suppressing the impact of interest rates on housing rents (Section 6), taking these income effects properly into account is important.

2.3 Monetary block

The monetary block determines short-term interest rates (three-month Libor), long-term interest rates (government bond rate) and the exchange rate of the Swiss franc, defined as its trade-weighted external value. The specification of this part of the model is based on the following assumptions:

- The orientation of *monetary policy* is reflected in the development of the *short-term interest rate* (three-month Libor), and it is assumed that this interest rate is a "sufficient statistic" for the stance of monetary policy. Put differently, monetary policy affects the economy only through short-term interest rates and 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 franc* reacts to interest rate differentials and the balance on the external account.

Furthermore, taking into account the orientation of Swiss exports as well as the origin of Swiss imports, it seems likely that monetary policy pays special attention to the exchange rate of the Swiss franc against the euro (historically the Deutsche mark or the currencies of the "DM-block"). Therefore, the model is focused on the Swiss franc/euro (Deutsche mark) exchange rate and the corresponding interest rate and inflation differentials. The overall trade-weighted external value of the Swiss franc is then determined by the endogenous Swiss franc/euro (Deutsche mark) exchange rate and the exogenous external value of the euro (Deutsche mark) against other currencies.

Based on these considerations, monetary policy is assumed to be conducted in such a way that Swiss short-term interest rates (*srate*) go up if real GDP growth ($\dot{y}$) and inflation ($\dot{p}$) rise, whereas an appreciation of the Swiss franc ($\dot{e}$) and increasing unemployment (*URATE*) 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**) as a point of reference in the following form:

$$\begin{aligned}\Delta srate_t = {} & S_s \Delta srate_t^* + S_e \log(e_t/e_{t-4}) + S_y \log(Y_t/Y_{t-1}) + S_u URATE_t \\ & - S_\gamma \left(srate_{t-1} - S_0 - srate_{t-1}^* \right)\end{aligned} \qquad (19)$$

In the actual process of inflation forecasting, equation (19) is typically removed from the model and three-month Libor is treated as an exogenous instrument. Equation (19) should also not be viewed as the "official SNB policy rule". For certain simulation exercises it is necessary, however, to endogenise three-month Libor. Historically, the behaviour of three-month Libor is captured quite well by (19). Attempts to include the current inflation rate were empirically unsuccessful. This result is not really surprising: on the one hand, in the case of cost-induced inflation, the appropriate policy response is rather to accommodate higher money demand to some extent than to tighten monetary reins. On the other hand, in the case of demand-pull inflation, high GDP growth precedes inflation, so that monetary tightening is already advisable when GDP growth rises. Moreover, *URATE* is the driving force in the wage-price block of the model. Hence, low values of *URATE* can be viewed as a leading indicator of rising inflation as well.

The dependence of *srate* on *srate** in (19) is of an error correction form and involves the assumption that *srate* is cointegrated with *srate**. If *srate** changes, *srate* moves by the same amount in the long run, while the short-term adjustment of *srate* is governed by parameters S_γ and S_s. The dependence of *srate* on the relative change in the external value of the Swiss franc, GDP growth and the unemployment rate is of a simple partial adjustment type. This can be made more apparent by rewriting (19) as:

$$\begin{aligned} srate_t &= S_0 S_\gamma + (1 - S_\gamma) srate_{t-1} + S_e \log(e_t / e_{t-4}) + S_y \log\left(Y_t / Y_{t-1}\right) + S_u URATE_t \\ &\quad + S_s srate_t^* + (S_\gamma - S_s) srate_{t-1}^* \end{aligned} \qquad (19)$$

In the case of *URATE*, for example, the short-run impact on *srate* is given by parameter S_u (< 0) and the long-run impact by S_u / S_γ. The exchange rate *e* is defined as euro (Deutsche mark) per Swiss franc (external value), so that an increase in *e* reflects an appreciation.

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

$$\begin{aligned} \Delta lrate_t &= L_l \Delta lrate_t^* + L_s \left[\Delta srate_t - S_s \Delta srate_t^* + S_\gamma \left(srate_{t-1} - S_0 - srate_{t-1}^*\right)\right] \\ &\quad - L_\gamma \left(lrate_{t-1} - L_0 - lrate_{t-1}^*\right) \end{aligned} \qquad (20)$$

The dependence of *lrate* on *lrate** is of an error correction form, involving the assumption of a full pass-through in the long run, while the short-run adjustment of *lrate* to *lrate** is characterised by parameters L_γ and L_s. The response of *lrate* to *srate* is of a partial adjustment type. Note that the term in brackets in (20) is derived from (19). 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 have an impact on *lrate* (in relation to *lrate**). Consider, for instance, a situation where *srate** increases while *lrate** remains unchanged. In this case, *srate* according to (19) adjusts to the higher *srate*,* but - as the term in brackets in (20) 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 a more restrictive course abroad. On the other hand, consider an increase in *srate* that is induced in (19) by an overheating of the Swiss economy. This will be reflected in (20) by a higher value of the term in brackets and hence transmit to *lrate*, but only partly (as $L_s + L_\gamma < 1$ empirically). Such a relative tightening of Swiss monetary policy entails an increase of the spread (*srate-lrate*) in relation to the foreign spread (*srate*-lrate*).*

The equation for the external value of the Swiss franc vis-à-vis the euro (Deutsche mark) is specified as

$$\begin{aligned} \log(e_t / e_{t-1}) &= E_0 + E_\rho \log(e_{t-1} / e_{t-2}) + E_s \left((srate_t - lrate_t) - (srate_t^* - lrate_t^*)\right) \\ &\quad + E_b BAL_t + E_\gamma \log(er_{t-1}) \end{aligned} \qquad (21)$$

where *BAL* is the balance on the external account including commodities, services and tourism in relation to nominal GDP and *er* is the real external value, defined as

$$er_t = e \left(\frac{p_t}{p_t^*}\right) \qquad (22)$$

According to this specification, the relative change in the external value of the Swiss franc depends on the difference in interest rate spreads (indicating relative tightness of monetary policy) and the external account. In addition, there is a kind of error correction "feedback" from the real external value *er* on the change in *e* ($E_{\gamma} < 0$), ensuring that persistent inflation differentials, giving rise to a trendlike behaviour of *p/p**, must be accompanied by a compensating trend in *e*. Hence, if the other explanatory variables in (22) were stationary (which is not the case for *BAL,* however), *er* would be stationary as well.

Obviously, this specification of the monetary block has a strong ad hoc flavour. Theoretical considerations like the uncovered interest rate parity condition and the term structure of interest rates are not taken into account explicitly, although the equations involve some rough approximations to these concepts. Empirically, however, the specification works quite well in terms of historical fit, parameter stability and accuracy of ex post forecasts (Stalder (2000)).

3. Baseline forecast (unchanged three-month Libor)

In the baseline forecast, the Swiss short-term interest rate (three-month Libor) is held constant at 3.5% (level prevailing in August 2000). Together with the assumptions for the world economy, the model predicts a strong expansion of the Swiss economy in the year 2000 and a moderate slowdown in the following years. After an increase of 3.3% in 2000, GDP growth falls to 2.2% in 2001. The growth rate is further reduced to 1.8% in 2002-03 and picks up slightly to 1.9% in 2004. Despite this slowdown, the expansion of GDP exceeds productivity growth throughout the forecast period. Accordingly, employment increases - on average by somewhat more than labour supply - so that the unemployment rate falls from 2% in 2000 to 1.7% in 2004.

CPI inflation increases from 0.8% in 1999 to 1.7% in 2000 and reaches 2.5% in the next two years. In 2003-04 the inflation rate falls somewhat, but remains above 2% until the end of the forecast period.[8]

The rise in CPI inflation is caused by:

(i) a sizeable increase in housing rents, due to the delayed adjustment to higher interest rates,

(ii) increasing import prices, caused by the weakness of the Swiss franc against the dollar and higher oil prices,

(iii) higher wage growth and a stronger increase in the GDP deflator resulting from tighter conditions in the labour and product markets (lower unemployment, narrowed output gap).

Factor (i) becomes weaker towards the end of the forecasting horizon. Factor (ii) dies out quickly in 2001 and is even reversed later on. In contrast, factor (iii) remains relevant during the whole forecast period. In other words, the external factors responsible for the current rise in inflation are replaced in the course of the forecast period by higher internal market tension.

The baseline forecast is presented in some more detail in Table 1 (Appendix).

4. The effects of tighter monetary policy (Alternative 1)

The SNB defines price stability as a CPI inflation rate below 2%. This definition is violated in the baseline forecast, implying that monetary policy should become more restrictive. However, one should note in this respect that SNB officials have indicated on several occasions that inflation rates in excess of 2% may temporarily be tolerated, in particular if caused by factors beyond the reach of monetary policy. Moreover, one should also recognise that a sizeable amount of inflationary pressure is already in the pipeline for the year 2001 and could be counteracted only by a radical monetary tightening at excessive cost in terms of real output loss. What monetary policy may reasonably try to control is

[8] What is referred to here as the baseline forecast has been designed for the purpose of this paper and does not fully correspond to the actual assessment of the SNB. In particular, the baseline forecast is intentionally made somewhat more expansionary and inflationary than the official SNB forecast of August 2000.

inflation at longer forecasting horizons. Although the SNB does not pursue a policy of explicit inflation targeting, it is assumed in this paper that the baseline forecast is considered too inflationary and that monetary policy is tightened such as to bring CPI inflation down to a target value of 1.7% in 2004 (instead of 2.2% as in the baseline forecast).

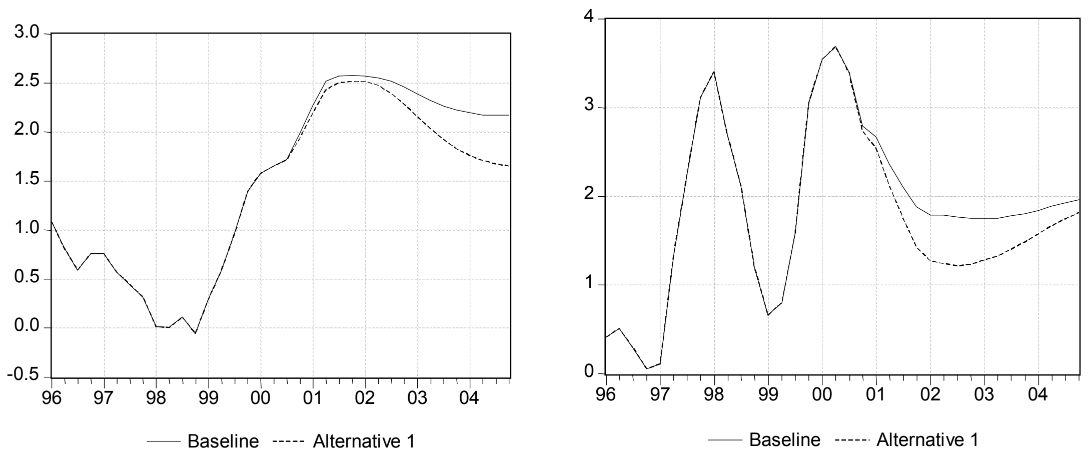
According to the model, this target can be attained by raising three-month Libor from 3.5% to 4.5% at the start of the simulation period (2000 Q3). Of course, other paths of three-month Libor that would produce the same inflation outcome in 2004 are conceivable as well. However, as GDP growth is stronger now than later in the forecast period, an immediate tightening of monetary policy seems preferable with regard to a smooth development of aggregate output.

The forecast with higher short-term interest rates (three-month Libor = 4.5%), referred to as Alternative 1, is documented in Table 2a. Table 2b shows the effects of monetary tightening in the form of differences between Alternative 1 (Table 2a) and the baseline forecast (Table 1). The effects are expressed as differences in growth rates except for the long-term interest rate and the unemployment rate where differences in levels are displayed. Figures 1 and 2 show the dynamic responses of some important endogenous variables of the model on a quarterly basis. Figure 1 compares the two scenarios with respect to CPI inflation and GDP growth in the form of percentage rates of change over the same quarter in the previous year. Figure 2 shows the deviations of Alternative 1 from the baseline path as level effects for interest rates and the unemployment rate and as differences in annualised quarterly growth rates for all other variables.

Figure 1

Effects of tighter monetary policy (baseline and Alternative 1)

(a) CPI inflation (b) GDP growth

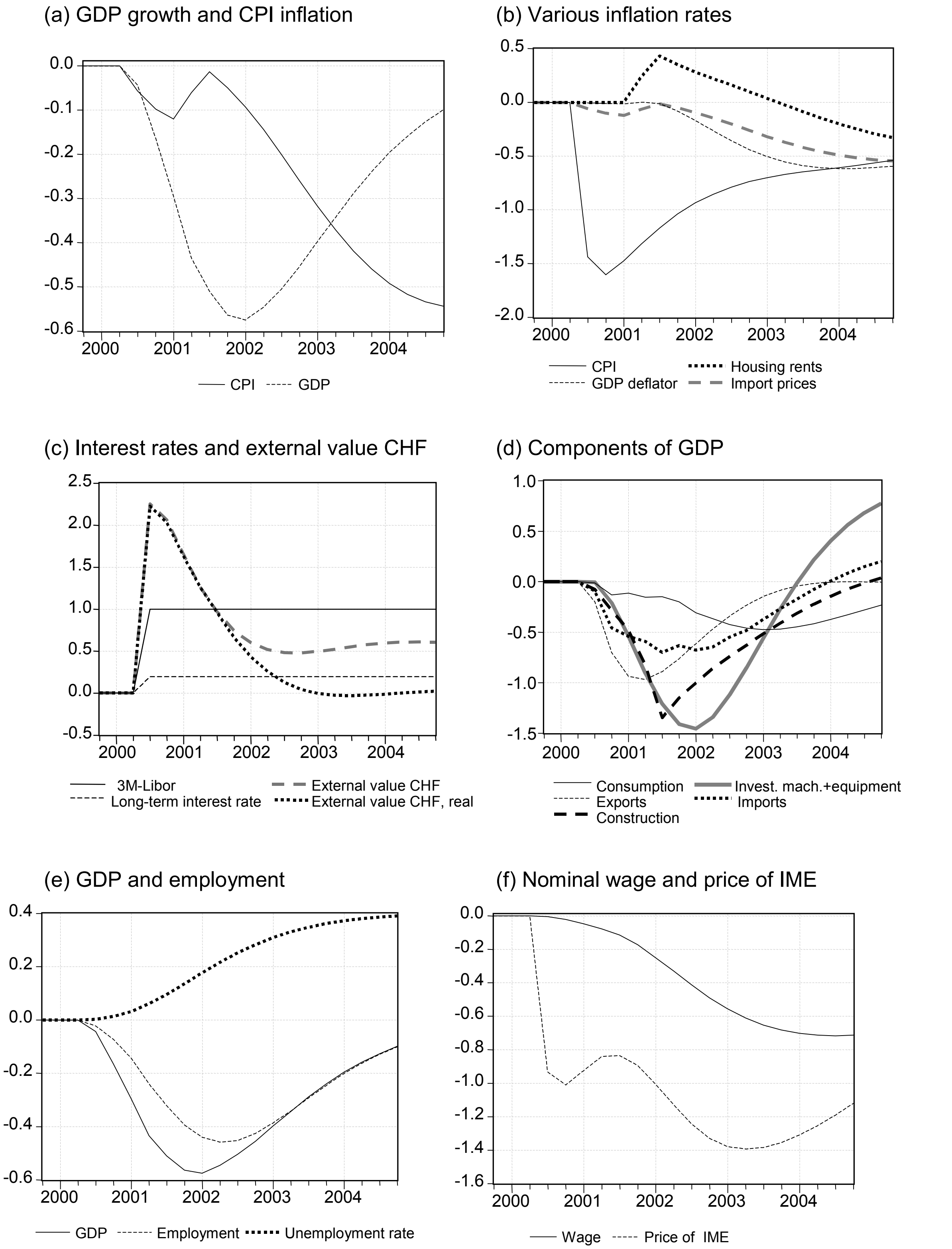


The mechanisms in the model by which monetary tightening dampens CPI-inflation can be assigned to an exchange rate channel and an aggregate demand channel. A temporary countereffect originates from the response of housing rents to higher interest rates. The rise in three-month Libor entails a quick appreciation of the Swiss franc (Figure 2c). This has a dampening impact on CPI inflation via declining import prices (Figure 2b) and reduces aggregate demand via lower export growth. Second, there is a partial pass-through of short-term to long-term interest rates, and this reduces aggregate demand via investment and private consumption (Figure 2d). Both initial effects set in motion a multiplier-accelerator process, by which all income-dependent components of aggregate demand are further reduced. Of course, import growth also declines, which partly offsets the negative impact of lower aggregate demand on GDP. GDP growth falls by a maximum of about 0.6 percentage points six quarters after the rise in three-month Libor. The response of export growth is relatively quick with a maximum loss of about 1 percentage point. The reaction of construction and investment in machinery and equipment is stronger but somewhat delayed. In the case of investment in machinery and equipment, there is a positive response later in the simulation period. This is caused by the dampening effect of the appreciation on (imported) investment goods. As shown in Figure 2f, the price of investment goods (machinery and equipment) falls markedly in relation to wage costs, changing the factor price ratio in favour of capital. The response of private consumption turns out to be relatively weak and slow.

Figure 2

Effects of tighter monetary policy

Alternative 1, deviations from baseline growth rates or levels (interest rates and unemployment rate)



CPI inflation is reduced in two waves (Figures 2a and b). There is a quick downward move already in the first few quarters of the forecast period. This is mainly brought about by the exchange rate channel. In the second year of the simulation, there is a sizeable countereffect coming from increasing housing rents. Due to this mechanism, the inflation dampening record of tighter monetary policy looks quite disappointing one year after action has been taken. CPI inflation is almost back to the baseline path whereas there is a considerable loss in GDP growth of about 0.6 percentage points. Thereafter, however, the dampening effects of lower aggregate demand and higher unemployment (Figure 2e) begin to work, reducing CPI inflation by slightly more than ½ percentage point by the end of the forecast period, while GDP growth rates tend back to the baseline values.

5. The role of productivity growth

5.1 The effects of higher productivity growth (Alternative 2)

Productivity growth is captured in the supply block of the model by the rate of labour-augmenting technical progress on new equipment, θ (see Section 2.1). The historical estimate of θ is 0.003 or 1.2% on an annual basis. The forecasts described in the preceding sections are based on this estimate. Motivated by the outstanding recent development of the US economy (high growth and low unemployment without much indication of rising inflation), many observers have argued that the fast diffusion of new technologies has given rise to productivity growth which is much faster than that suggested by historical estimates. In this paper, we do not try to make an assessment as to the relevance and magnitude of such a "new economy" effect.[9] The purpose of the following simulation is merely to show the sensitivity of the inflation forecast with respect to alternative assumptions about productivity growth.

In the baseline forecast, on the assumption of a continuing historical productivity trend and an unchanged three-month Libor of 3.5%, the CPI inflation rate is 2.2% in 2004. In Section 4, it was shown that a 1 percentage point increase in three-month Libor to 4.5% is required to bring inflation down to 1.7% in 2004. In the following scenario, the technical progress parameter θ is raised to such an extent that the inflation target of 1.7% is attained without any monetary tightening (three-month Libor = 3.5%). According to the model, θ has to be raised from 0.003 to 0.0045, lifting the annual rate of labour-augmenting technical progress from 1.2% to 1.8%. This scenario, denoted as Alternative 2, is documented in Table 3a (Appendix). Table 3b shows the effects of higher productivity growth in the form of deviations of Alternative 2 from the baseline forecast.

The implications of faster technical progress in the adopted vintage framework have already been discussed from a theoretical perspective in Section 2.1.6. The initial effect of a higher θ is a stronger increase in capital productivity and labour productivity on new equipment and a decline in the output price in relation to factor prices. What happens in the sequel is the result of an interaction of various responses in the labour market, on the demand side of the goods market and in the foreign exchange market. The extent to which the higher growth potential of the economy is actually absorbed by a stronger increase of aggregate demand is decisive for the outcome. The larger the stimulation of aggregate demand by lower output prices, the smaller the inflation dampening effect of higher productivity growth becomes.

As shown in Figures 3 and 4a, higher productivity growth has a sizeable negative effect on the inflation rate of about ½ percentage point towards the end of the forecast period while GDP growth is stimulated only weakly. Accordingly, employment growth decreases in relation to the baseline path and unemployment rises (Figure 4c). In wage formation, we thus have two opposing forces, namely a stimulating effect of stronger productivity growth and a dampening effect of higher unemployment. The productivity effect dominates. To be sure, the growth rate of nominal wages declines, but by less than both CPI inflation and inflation measured by the GDP deflator (Figure 4d). Hence, real wage growth is

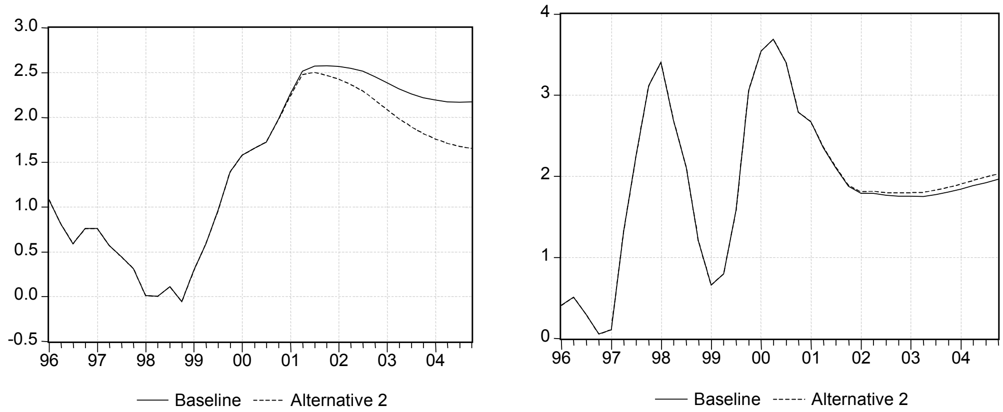
9 A rather sceptical view is advocated for instance by Gordon (2000).

higher than in the baseline forecast. The price of investment goods (machinery and equipment, largely imported) is dampened strongly. This is due to the functioning of the monetary block, where lower inflation reduces the real external value of the Swiss franc but leads to a nominal appreciation in the longer run (Figure 4e).

Figure 3

Effects of higher productivity growth (baseline and Alternative 2)

(a) CPI inflation (b) GDP growth



The decline of investment prices in relation to wages induces a change in the factor price ratio in favour of capital. The resulting process of capital deepening raises the growth rate of labour productivity above the initial effect of higher technical progress (Figure 4b). The initial effect is 0.42 percentage points, corresponding to the increase in θ of 0.6 percentage points (annualised) times $\alpha = 0.7$ (output elasticity with respect to labour). Together with the effect of capital deepening, the growth rate of labour productivity on new equipment is raised by the end of the forecast period by somewhat more than 0.7 percentage points. The effect on technical labour productivity on the whole production apparatus is of course smaller because the higher rate of technical progress is exclusively embodied in new equipment and thus materialises only to the extent that old equipment is replaced by new equipment. In fact, due to the faster increase of relative wage costs, replacement speeds up, but the share of new equipment in the whole production apparatus nevertheless remains small within a time horizon of four years. The growth rate of overall technical labour productivity is raised by about 0.2 percentage points by the end of the simulation period. The effect on measured labour productivity is even somewhat smaller (0.16 percentage points) since employment is reduced by slightly less than what would be technically feasible. The 0.16 percentage point productivity gain is split in roughly equal parts between higher GDP growth and lower employment growth (Figure 4c).

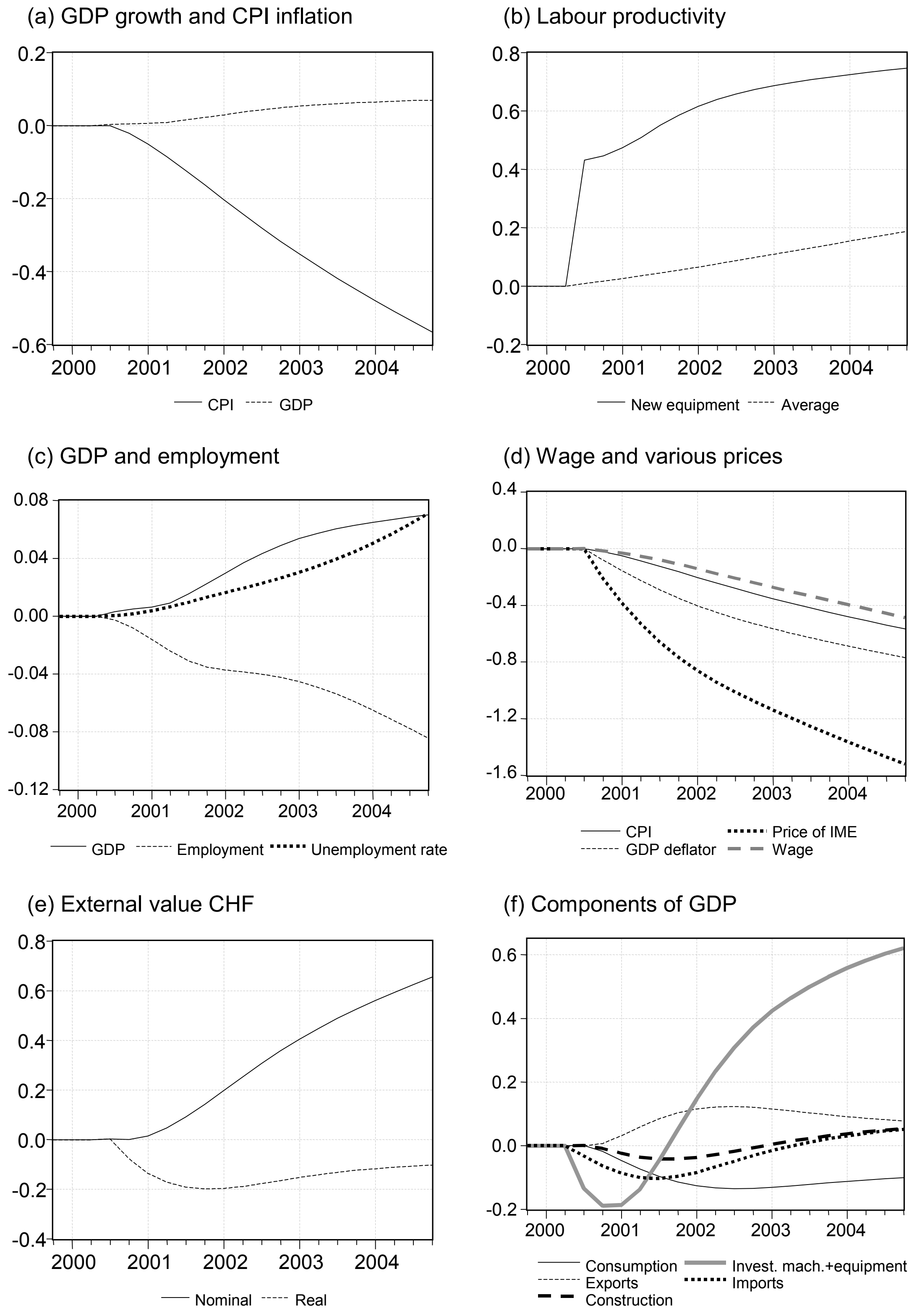
The reactions of the various components of GDP are shown in Figure 4f. Investment in machinery and equipment is first negatively affected by the stronger growth of capital productivity (less investment is needed for a given expansion of production capacity). In the second year of the simulation, the response turns positive as GDP growth increases and the factor price ratio shifts in favour of capital. At the end of the forecast period, the growth rate of investment in machinery and equipment exceeds the baseline values by 0.6 percentage points. Private consumption shows a delayed and weak but long-lasting negative response. The increase in the real consumer wage is smaller than the decrease in employment, so that real household income is negatively affected. In addition, there is a negative impact of higher unemployment on consumption. Construction investment remains practically unaffected. Lower Swiss inflation improves international competitiveness and thus stimulates export growth. However, this effect weakens in the course of the forecast period as the Swiss franc appreciates (Figure 4e). The reaction of import growth is negative in the first half of the simulation period but becomes positive in the second half. This reflects the changes in the various components of aggregate demand on the one hand and improved competitiveness of domestic producers on the other.

To summarise, one can say that the assumption of a higher rate of technical progress dampens future inflation significantly while it stimulates GDP growth only weakly. The two results are connected to each other. The fact that the higher growth potential of the economy is only partly matched by higher growth of actual GDP reinforces the price dampening effect of stronger productivity growth through increased slack in the goods and labour market. The stronger growth of capital productivity temporarily reduces investment in machinery and equipment, and the stronger increase of labour productivity has a long-lasting negative effect on employment.

Figure 4

Effects of higher productivity growth

Alternative 2, deviations from baseline growth rates or levels
(interest rates and unemployment rate)

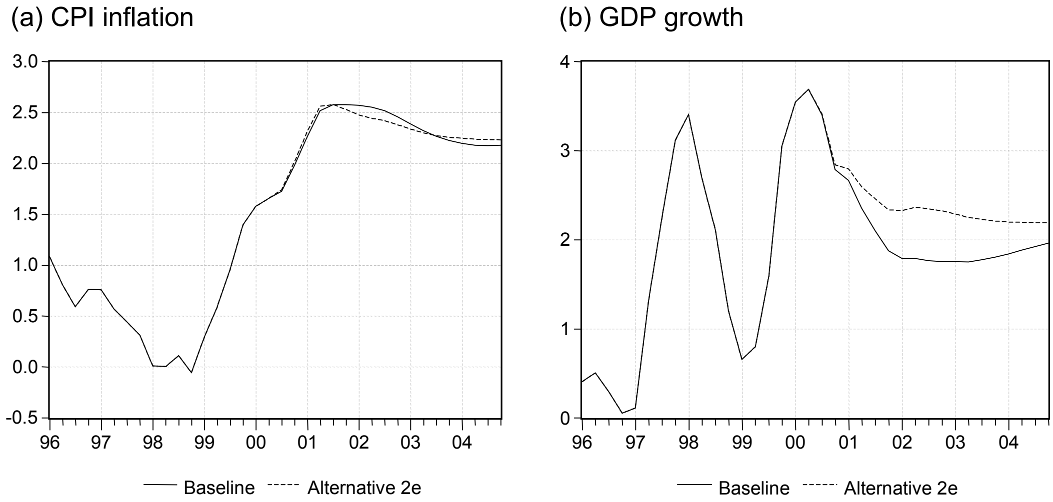


Of course, the split of the productivity effect on lower inflation and higher GDP growth can be influenced by monetary policy. For instance, by cutting three-month Libor from 3.5% to 2.5%, monetary policy would stimulate aggregate demand and thus give more room for actual output to increase. On this assumption, as shown in Figure 5 (to be compared with Figure 3), one obtains an inflation forecast that practically coincides with the baseline forecast whereas GDP growth is notably higher. In other words, given a certain inflation target, the appropriate level of short-term interest rates is lower the more productivity rises. The recent development in the United States can be taken as an illustration of this relationship. Counting on faster technical progress, the Federal Reserve has tightened monetary conditions only gradually although the US economy was expanding for several years at a pace that would have had to be judged as highly inflationary on the basis of historical estimates of productivity growth.

Figure 5

Effects of higher productivity growth

Baseline and Alternative 2e (monetary policy relaxed: three-month Libor = 2.5%)



In other respects, the recent US experience shows that the above simulation exercise captures potential "new economy" effects only in a very limited sense. In particular, in the US economy higher productivity growth was not accompanied by a decline in investment activity and employment. To some extent, this may be due to a lucky coincidence with other factors that *independently* stimulated the economy from the demand side. However, it is probably more appropriate to think of the "new economy" as a phenomenon that simultaneously boosts productivity *and* spurs aggregate demand through the creation of new market opportunities. A related point is made by Gordon (2000). He finds that the productivity effect of the "new economy" is confined to durables manufacturing. The other sectors of the economy invest in new technologies as well, but without much impact on productivity. For instance, firms may be forced by competition to engage in internet activities, to maintain websites and to offer e-commerce services. In many cases, such investments are only duplicating traditional sales promotion activities rather than replacing them by something more productive.

Obviously, such direct demand effects are not taken into account in the scenario of Alternative 2. To be sure, higher productivity growth influences aggregate demand, but only through the adjustment of relative prices like an increase in the real wage, a relative decline in capital costs and a fall in the real exchange rate. Eventually, these adjustments bring about an increase in aggregate demand. The process is slow, however, and is moreover delayed by the initial decline in investment and employment. Against this background, labelling Alternative 2 as a "new economy" scenario would seem rather problematic.

5.2 Implications for monetary policy (Alternative 3)

In this section, we want to illustrate how monetary policy may be led astray by incorrect assessments of future productivity growth. In order to establish a clear basis of comparison, monetary authorities are again assumed to aim at an inflation target of 1.7% in 2004. Accordingly, Alternative 1 (historical productivity growth, three-month Libor = 4.5%) portrays an appropriate stance of monetary policy. This is also the case for Alternative 2 (higher productivity growth, three-month Libor = 3.5%). In both scenarios, three-month Libor is set on the basis of correct assumptions with respect to productivity growth and the inflation target is therefore attained (Figure 6a). Of course, as shown in Figure 6b, GDP growth is higher in Alternative 2 since the reduction in the inflation rate is brought about by stronger productivity growth instead of monetary tightening. In contrast, two other scenarios are conceivable in which monetary authorities either underestimate or overestimate future productivity growth:

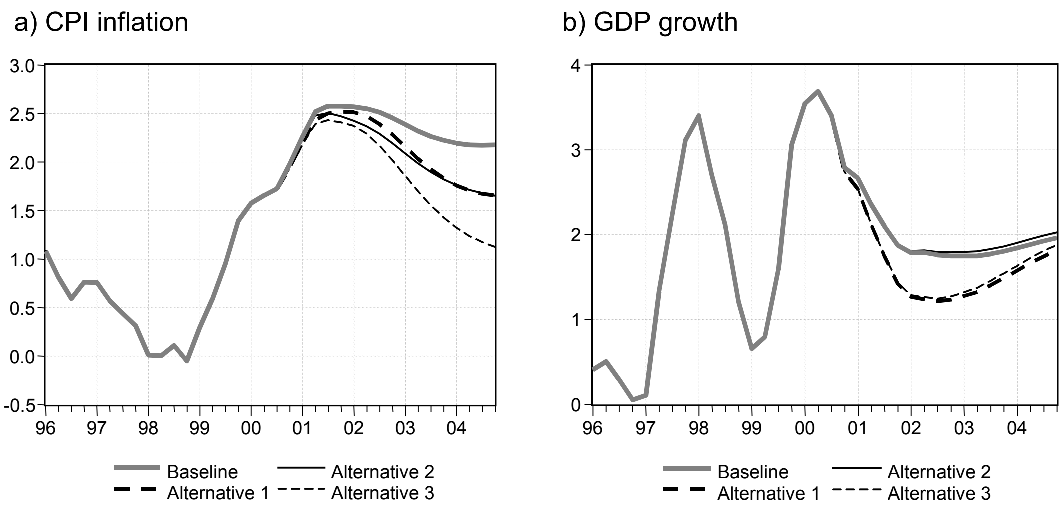
- The inflation forecast is based on the assumption of an unchanged productivity trend (θ = 1.2%) and three-month Libor is therefore raised to 4.5%. In fact, however, productivity growth accelerates (θ = 1.8%). In this scenario, referred to as Alternative 3 (Table 4, Appendix), monetary policy turns out to be too restrictive. The inflation rate falls to 1.2% (0.5 percentage points below the target), at the cost of an unnecessary depression of GDP growth as compared to Alternative 2, where the acceleration of productivity growth is correctly anticipated and three-month Libor is therefore left unchanged at 3.5% (Figure 6). The cumulative loss in GDP growth associated with the excessive tightness of monetary policy is 1.5 percentage points.
- Monetary authorities may expect an increase in productivity growth but in fact productivity proceeds on the historical trend. Simulating such a scenario is not really necessary since the baseline forecast (Table 1) can be interpreted this way. It combines unchanged productivity growth (θ = 1.2%) with a three-month Libor of 3.5%, which would be appropriate with regard to the inflation target in case of increased productivity growth (θ = 1.8%). However, as productivity growth actually remains unchanged, monetary policy turns out to be too lax. The inflation rate in 2004 is 2.2% (0.5 percentage points above the target), as shown in Figure 6.

In this latter case, there is a cumulative gain in GDP growth of 1.7 percentage points as compared to Alternative 1, where the three-month Libor is raised to 4.5%. However, one should refrain from weighing this GDP gain against the deviation from the inflation target because, by doing so, one would call the target itself into question. Moreover, as can be seen from Figure 6, the loss in GDP growth associated with monetary tightening in Alternative 1 is largely temporary, whereas not tightening in case of unchanged productivity growth has inflationary consequences of a longer-term nature.

Figure 6

Baseline (three-month Libor = 3.5%), Alternative 1 (three-month Libor = 4.5%)

Alternative 2 (higher productivity growth, three-month Libor = 3.5%)
Alternative 3 (higher productivity growth, three-month Libor = 4.5%)



6. The role of the "mortgage rate-housing rent" link

As already noted in Section 4, monetary tightening reduces inflation via the exchange rate channel and the aggregate demand channel, but there is a sizeable temporary countereffect resulting from the dependence of housing rents on mortgage rates. In this section, we want to quantify the importance of this countereffect by means of a model simulation in which housing rents are alternatively linked to the overall CPI.

6.1 The effects of linking housing rents to CPI (Alternative 4)

The equation for housing rents in the model does not explicitly include the mortgage rate as an argument but takes the long-term interest rate as a proxy. Using the mortgage rate would require an additional equation in the model, linking mortgage rates with a certain lag to market interest rates. However, a simple error correction equation for housing rents (*phr*) with a three-quarter lag on the long-term interest rate (*lrate*) and construction prices (*picnstr*) actually works better than the alternative approach. The equation reads as

$$\Delta \log(phr_t) = b_0 + b_1 \Delta lrate_{t-3} + b_2 \Delta \log(picnstr_{t-3}) - \gamma\left[\log(phr_{t-1}) - \beta_1 lrate_{t-4} - \beta_2 picnstr_{t-4}\right] \quad (21a)$$

Estimation of (21a) shows that the pass-through of interest rates to housing rents is significant. However, as an analysis of parameter stability reveals, the pass-through has become somewhat weaker over time (decreasing values of b_1 and β_1). Taking this into account, the equation used in the above simulations implies that a 1 percentage point increase in long-term interest rates pushes housing rents up by about 4.5% (β_1), although with a substantial degree of inertia (γ = 0.15). This is less than what would be allowed according to Swiss legislation on tenant protection, permitting a 3% rise of housing rents per ¼ percentage point rise in mortgage rates. A plausible explanation of the reduced impact is that an increasing share of apartments are nowadays rented at market prices and no longer at cost-determined rents below market prices. Nevertheless, the impact of interest rates on housing rents is still strong enough to hamper the efficacy of monetary policy to a considerable degree.

In the following simulation, (21a) is replaced by an alternative "rule" that links housing rents (*phr*) to the overall CPI (*pci*). Proposals for such a change in the legislation are currently being discussed in the Swiss parliament. From an economic point of view, linking housing rents to the CPI is rather problematical since it amounts to fixing the relative price of a sector that probably differs from the rest of the economy with respect to the development of production costs and demand. In fact, in the period 1980-99 housing rents increased more than the CPI, on average by 0.23 percentage points per quarter. Accordingly, when a CPI rule for housing rents is fitted to the data, one needs to include a constant term, which assumes a significant positive value of 0.0023:

$$\Delta \log(phr) = 0.0023 + \Delta \log(pci) \quad (21b)$$

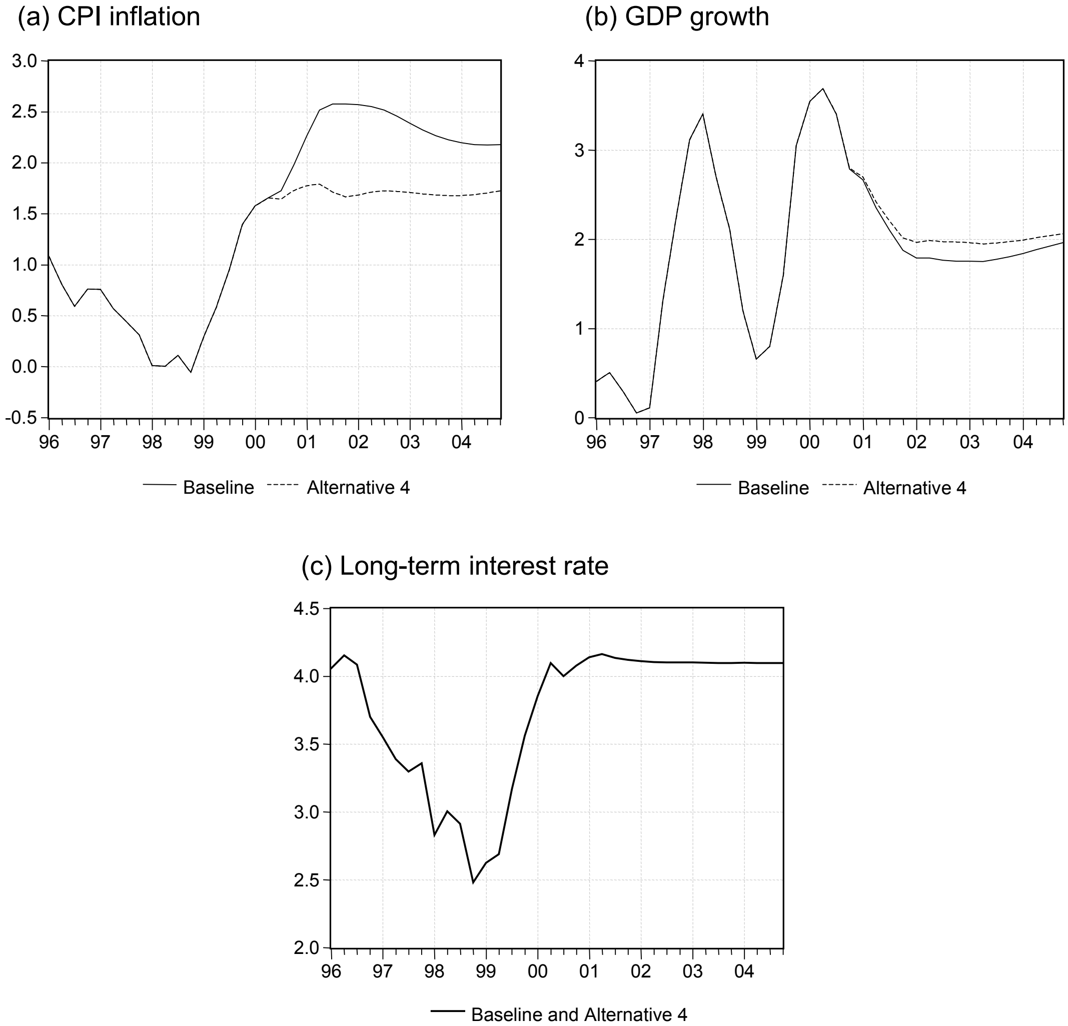
Longer-run simulations without such a constant term would entail a continuous decline of housing investment. This outcome is due to the fact that the equation for housing investment involves a measure of profitability, and this measure deteriorates if *phr* is prevented from increasing in relation to *pci*. In the following simulation, the interest rate rule for housing rents, (21a), is therefore replaced by a CPI rule in the form of (21b). The constant term in (21b) ensures that the long-term development of housing rents is the same on average as for (21a). In periods of increasing interest rates, (21b) will, however, produce smaller increases in housing rents than (21a).

This forecast scenario, referred to as Alternative 4, is presented in Table 5a. Table 5b displays the differences in comparison to the baseline forecast, where everything is identical except that housing rents are determined by (21a). Figures 7 and 8 show the extent to which the forecasts for important endogenous variables of the model are affected by the change in the housing rent equation. Figure 7 compares the two scenarios with respect to CPI inflation and GDP growth. Figure 8 shows the deviations of Alternative 4 from the baseline path as level effects for interest rates, the output gap and the unemployment rate, and as differences in annualised quarterly growth rates for all other variables of the model.

Figure 7

Effects of linking housing rents to CPI

(baseline and Alternative 4)



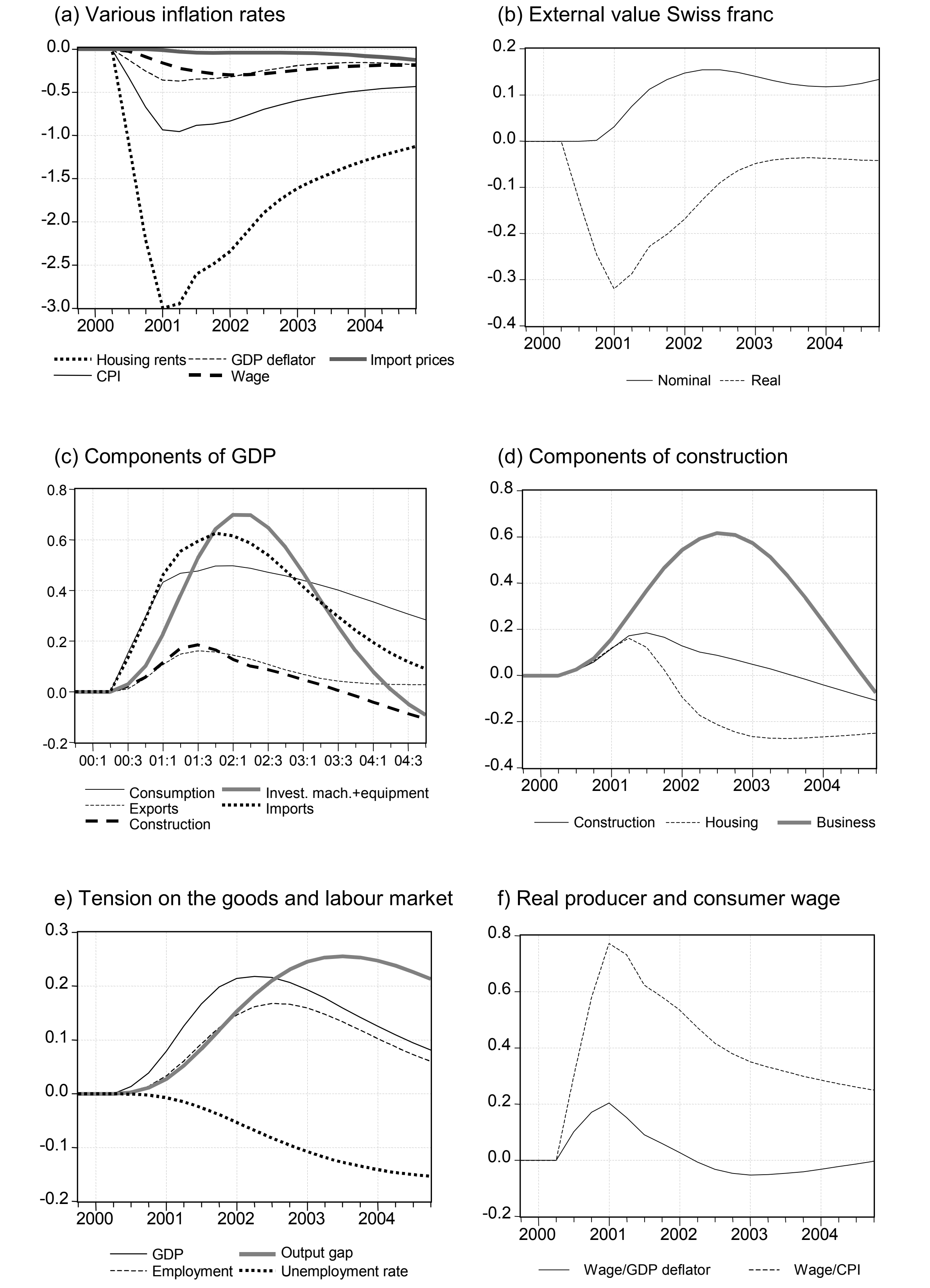
Suppressing the impact of interest rates on housing rents by linking them to the CPI has a considerable effect on the inflation forecast. Whereas CPI inflation is temporarily pushed as high as 2.5% in the baseline forecast, it hovers close to 1.7% throughout the forecast period in Alternative 4 (Figures 7a and c). At the same time, there is a small positive effect on GDP growth (Figure 7b). In terms of differences in annualised quarterly growth rates, housing rent inflation is reduced by a maximum of 3 percentage points in 2001 Q1 (Figure 8a). This is reflected in a reduction of overall CPI inflation of almost 1 percentage point. Due to second-round effects, the reaction of CPI inflation exceeds the direct impact of housing rents to some extent. Inflation measured by the GDP deflator is dampened by about 0.4 percentage points. Nominal wage growth is also reduced, but by less than CPI inflation, so that real wages, in particular real consumer wages, are positively affected by the CPI rule (Figure 8f).

The second-round effects on inflation have to be seen in the context of the wage equation of the model that links wages to a weighted average of the CPI and the GDP deflator, and the "wedge" driven between the CPI and the GDP deflator by increasing housing rents. This wedge, reflecting the income claims of house owners, is reduced in Alternative 4 as compared to the baseline forecast. Hence, the inflationary pressure resulting from conflicting income claims becomes smaller, and this lets the economy move towards a new equilibrium with lower unemployment, increased capacity utilisation and higher income shares of workers and firms. For a more detailed explanation of these mechanisms on the basis of a stylised version of the model's wage-price dynamics, see the Box on page 249.

Figure 8

Effects of linking housing rents to CPI

Alternative 2, deviations from baseline growth rates or levels (interest rates and unemployment rate)



Lower inflation raises real disposable household incomes, although non-wage incomes are depressed somewhat by the smaller increase in housing rents. As a result, the growth rate of private consumption shows a positive reaction (Figure 8c). Lower inflation also leads to a real depreciation of the Swiss franc (always in relation to the baseline forecast), which stimulates export growth. This effect is, however, mitigated in the course of the forecast period by a nominal appreciation (Figure 8b). The higher growth of consumption and exports sets in motion a multiplier-accelerator process by which employment, capacity utilisation, investment in machinery and equipment and construction investment are all positively affected (Figure 8c). The stronger growth of aggregate demand is, however, partly absorbed by higher imports, so that the GDP effect turns out to be rather small. Nevertheless, the output gap narrows (higher capacity utilisation) and unemployment decreases (Figure 8e). Towards the end of the forecast period, the growth rate of construction shows a negative reaction. This is due to the fact that the smaller increase of housing rents depresses the profitability of housing investment. Accordingly, as can be seen from Figure 8d, the growth rate of housing investment is negatively affected, whereas business construction shows a positive response, in close connection to the behaviour of investment in machinery and equipment.

Box: The role of housing rents in a stylised version of the wage-price block[1]

Wages *w* react to a weighted average of the GDP deflator *p* and consumer prices *pci* and in addition depend on labour market tension (π_L):

$w = w(p, pci, \pi_L)$ (This equation represents the income claims of workers.)

The GDP deflator (to be viewed as the aggregate price of domestic production) depends in a flexible mark-up equation on wages *w* and tension in the goods market (π_G):

$p = p(w, \pi_G)$ (This equation represents the income claims of firms.)

Consumer prices depend on the GDP deflator *p*, housing rents *phr* and import prices *pimp*:

$pci = pci(p, phr, pimp)$

Now, a rise in *phr* entails an increase of *pci* in relation to *p* and - since *w* partly depends on *pci* - also an increase of *w* in relation to *p* (for given labour market tension). Thus, a rise in *phr* produces a lower real consumer wage *w/pci* (since *w* is only partly adjusted to *pci*) but a higher real producer wage *w/p* (since *w* is partly adjusted to *pci*). However, the higher real producer wage *w/p* is in conflict with the *p*-equation, which - for given tension in the goods market - implies a fixed mark-up of *p* over *w*. In other words, for given market tension, the income claims of workers and firms become incompatible as a result of the higher income claims of house owners, exceeding what is actually available for distribution. This conflict sets in motion an inflationary process, which must continue to the point where reduced market tension re-establishes compatibility of the income claims. In the *w*-equation, a lower value of π_L (higher unemployment) dampens *w* in relation to *p*. In the *p*-equation, a lower value of π_G (lower capacity utilisation) reduces the mark-up of *p* over *w*.

A conceivable new equilibrium (taking the increase in *phr* as exogenous) has π_G and thus the mark-up of *p* over *w* back to the starting point, whereas π_L and *w/pci* are lower. So firms are eventually unaffected by the higher *phr*, while workers carry the full burden in the form of a reduced real consumer wage. This is brought about in the *w*-equation by lower π_L (higher unemployment), which completely counteracts the response of *w* to the higher *pci* (weaker bargaining position of workers). Of course, alternative equilibrium positions in which firms also carry part of the burden in the form of a lower π_G and thus a lower mark-up of *p* over *w* are conceivable as well. But what happens in the model is closer to the first solution for the following reason. Investment and thus production capacity react fairly quickly to reduced capacity utilisation so that π_G has a rather strong tendency to return to the initial equilibrium. In contrast, the supply side of the labour market is much more rigid. Accordingly, compatibility of the income claims is re-established primarily through higher unemployment and a lower real consumer wage *w/pci* - and not through reduced capacity utilisation and a higher real producer wage *w/p* (smaller mark-up of *p* over *w*).

Exactly the same "wedge" mechanism comes into play if import prices (*pimp*) increase. In both cases, the inflationary pressure and the increase in unemployment depend crucially on the weights of *p* and *pci* in the *w*-equation. If *w* depended only on *p*, then workers would "voluntarily" accept a lower real consumer wage *w/pci*. In this case, an increase in *phr* or *pimp* would not set in motion an inflationary spiral of wages and prices. The stronger the impact of *pci* in the *w*-equation, the more workers have to be forced to accept a lower real consumer wage *w/pci* by higher unemployment. Until this point is reached, the incompatibility of income claims gives rise to an inflationary process with wages pushing up prices and prices pushing up wages.

[1] The specification is in the spirit of Layard et al (1991); see also Section 2.1.

6.2 Implications for monetary policy

In the simulations of Section 5, it was shown that the inflation forecast depends quite strongly on alternative assumptions as to future productivity growth, even if these assumptions remain within the bounds of possibility. This was an illustration of one of the various types of uncertainty surrounding monetary policy (parameter uncertainty, model uncertainty, uncertainty with respect to the exogenous variables in the forecast period, future shocks). The simulation in this section with a changed equation for housing rents is different in character. The current legislation on rent control is known and a potential new rule would be introduced only after a lengthy political process. The simulation is therefore rather to be viewed as a counterfactual experiment, shedding light on the question of whether the current legislation should be changed.

Due to the constant term in the CPI rule (21b), the development of housing rents is the same on average as for the interest rate rule (21a) in a long-term simulation. In the concrete forecasting situation under consideration, however, using the CPI rule instead of the interest rate rule makes quite some difference because it prevents higher interest rates from being passed on to housing rents. Supposing again an inflation target of 1.7% for the year 2004, the forecast of Alternative 4 implies that monetary policy may remain unchanged (three-month Libor = 3.5%) since the inflation target is just met.[10] In contrast, the baseline forecast has inflation at 2.2% in 2004 and therefore signals that monetary conditions must be tightened, as in Alternative 1 (three-month Libor = 4.5%). In other words, it is the interest rate rule for housing rents that necessitates a move to a more restrictive stance of monetary policy - and at the same time hampers the effectiveness of monetary tightening in reducing inflation.

Considering the entire forecasting horizon and also taking GDP growth into account, the advantage of the CPI rule becomes even more evident (Figure 9). Alternative 1 (interest rate rule, three-month Libor = 4.5%) and Alternative 4 (CPI rule, three-month Libor = 3.5%) both produce an inflation rate of 1.7% in 2004. However, whereas the inflation dampening effect of tighter monetary policy is subject to a long lag, the replacement of the interest rate rule by the CPI rule reduces inflation to 1.7% right from the beginning of the forecast period. Moreover, there is a sizeable real side effect of monetary tightening that reduces GDP growth temporarily to 1.2%, while GDP growth remains at about 2% throughout the forecast period in the scenario with the CPI rule.

The beneficial impact of a switch to the CPI rule should, however, be interpreted with care. In particular, it must be recognised that it is not a general result but applies to the concrete forecasting situation with rising interest rates. To be sure, interest rates do not rise much *during* the forecast period, but they rise by 1.5 percentage points in the seven quarters *preceding* the forecast period. This increase, given the delay in the adjustment of housing rents to interest rates, is thus in the pipeline under the interest rate rule. The switch to the CPI rule then simply blocks up this pipeline at a time when it matters a great deal. Hence, the strong inflation dampening effect of the switch to the CPI rule is conditional on the concrete forecasting situation.

A way to assess the difference between the two rules for housing rents from a more general perspective is to analyse the monetary transmission mechanism under the two regimes. This requires a further simulation in which three-month Libor is raised to 4.5% under the CPI rule as well - as was done under the interest rate rule in Alternative 1. This forecast, referred to as Alternative 5, is documented in Table 6a and compared to Alternative 4 (three-month Libor = 3.5%) in Table 6b. Table 6b thus shows the effects of raising three-month Libor by 1 percentage point under the CPI rule. Table 2b, comparing Alternative 1 with the baseline forecast, does the same for the model with the interest rate rule. These effects are not conditional on the concrete forecasting situation since the past interest rate increases that are in the pipeline under the interest rate rule are cancelled out by the comparison of the scenarios. Thus, Tables 6b and 2b show only the effect of the *additional* increase in interest rates that takes place *within* the forecast period.

[10] To be precise, one should mention that the constant term in (21b) has been set to a slightly larger value of 0.00247 in order to obtain this result. With the estimated value of 0.0023, inflation would even fall somewhat below 1.7% in 2004.

Figure 9

Housing rents linked to CPI (Alternative 4) versus tighter monetary policy under the "mortgage rate-housing rent" link (Alternative 1)

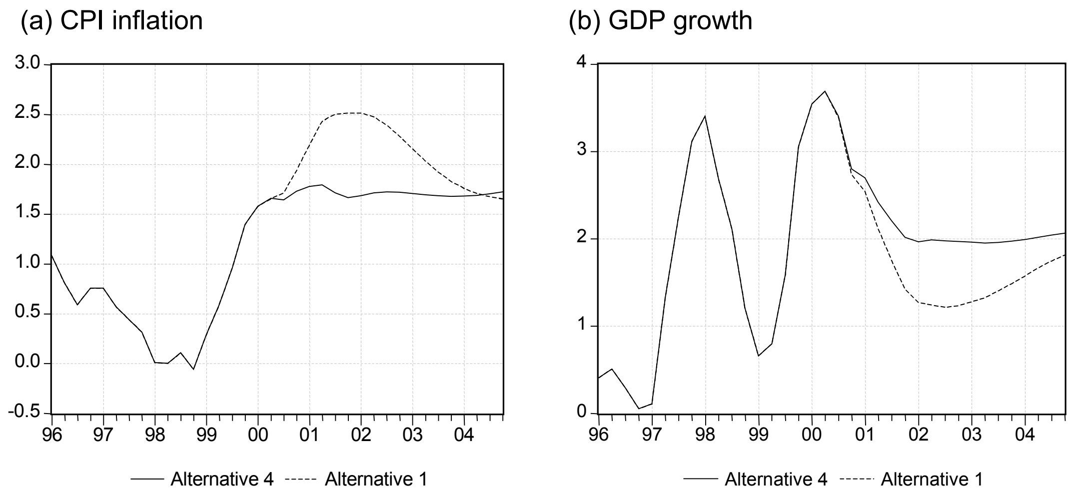
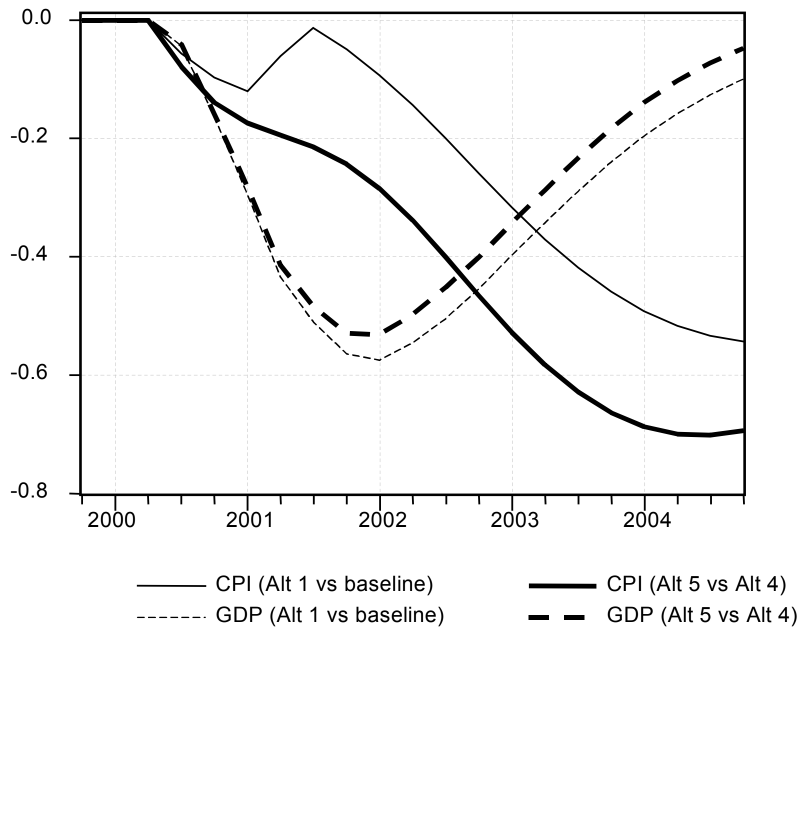


Figure 10 shows the effects of monetary tightening on inflation and GDP growth under the two regimes. The thin (bold) lines refer to the model with the interest rate rule (CPI rule). The solid (dashed) lines show the reaction of CPI inflation (GDP growth rates). The CPI rule makes the monetary transmission mechanism more efficient in two respects. First, while the interest rate rule pushes CPI inflation almost back to the baseline path by the fifth quarter of the simulation, monetary tightening under the CPI rule entails a smoother and overall stronger reduction in CPI inflation. At the end of the forecasting horizon, the reduction is 0.54 percentage points in case of the interest rate rule and 0.69 percentage points in case of the CPI rule. Second, the negative side effect of monetary tightening on GDP growth is somewhat less pronounced under the CPI rule.

Figure 10

Effects of tighter monetary policy (three-month Libor raised from 3.5% to 4.5%)

Housing rents linked to interest rates:	Alternative 1 vs baseline
Housing rents linked to CPI:	Alternative 5 vs alternative 4



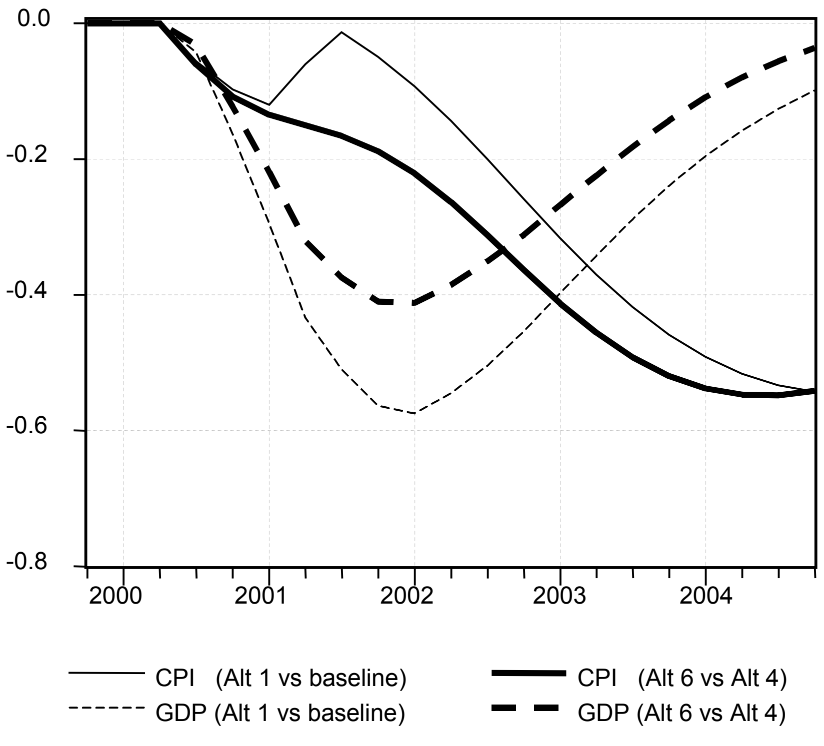
A more detailed account of the differences between the two regimes is given by a comparison of Table 6b with Table 2b. Monetary tightening reduces the growth rate of private consumption to a lesser extent under the CPI rule. The mirror image is a somewhat stronger negative effect on housing investment. The more favourable development of private consumption under the CPI rule is partly absorbed by higher import growth. Moreover, lower inflation initially results in a somewhat smaller real appreciation of the Swiss franc. This is, however, compensated later in the forecast period by a stronger nominal appreciation. The growth rate of exports thus differs only very little between the two regimes. Taken together, the reactions of the various demand components amount to a somewhat smaller reduction of overall GDP growth under the CPI rule.

Of course, one should not expect big differences in overall GDP growth between the two regimes in the first place. The only way for monetary policy to bring down inflation is through a depressing impact on the real economy. What differs to some extent between the two regimes is the distribution of the effects on the different sectors of the economy. However, the main difference between the two regimes pertains to inflation. Given a certain degree of monetary tightening (three-month Libor = 4.5% instead of 3.5%), the inflation dampening effect is more pronounced under the CPI rule. Of course, turning the argument around, one may also say that, for a certain reduction in the inflation rate, a less resolute monetary tightening is required under the CPI rule. This point can be made more concrete by solving the model for the three-month Libor that produces the same inflation dampening effect as the increase in the three-month Libor from 3.5% to 4.5% under the interest rate rule. It turns out that three-month Libor must be raised to 4.27% only, and this is associated with a smaller adverse GDP effect. As shown in Figure 11, the maximum loss in GDP growth is only about 0.4 percentage points instead of nearly 0.6 percentage points in case of the interest rate rule.

Figure 11

Effects of tighter monetary policy

Housing rents linked to interest rates: Alternative 1 (three-month Libor = 4.5%) vs baseline
Housing rents linked to CPI: Alternative 6 (three-month Libor = 4.27%) vs Alternative 4



Overall, the simulations of this section show that the link of housing rents to interest rates, as established by Swiss legislation on tenancy rights, hampers the efficacy of monetary policy in two dimensions. First, the inflation dampening effect of monetary tightening is reduced. Second, the adverse side effects on the real economy are larger. Under an alternative CPI rule, the same reduction in the inflation rate is attained with a less restrictive course of monetary policy and thus a smaller loss in real GDP. In other words, Swiss legislation on tenant protection forces monetary policy to become more restrictive if a certain reduction in the inflation rate is to be achieved, since the countereffect of increasing housing rents has to be compensated for.

7. Summary and conclusions

At the beginning of the year 2000, the Swiss National Bank (SNB) replaced its traditional monetary targeting approach by a concept that focuses on inflation forecasts. The key elements of this concept are: (i) an explicit definition of price stability (CPI inflation below 2%), (ii) regularly updated conditional inflation forecasts with a horizon of three years and (iii) the announcement of a target range for short-term interest rates (three-month Libor). For instance, an inflation forecast - obtained on the provisional assumption of an unchanged three-month Libor - exceeding 2% gives a signal for monetary tightening. The simulations presented in this paper have to be seen in the context of this adapted concept of monetary policy.

It is a commonplace to say that monetary policy, irrespective of the concrete concept, has always been a difficult area. One of the advantages of the modified concept is that it makes these difficulties more transparent and therefore offers a better chance to learn from past errors. From a methodological point of view, things are in fact quite simple: the appropriateness of monetary policy hinges directly on the reliability of the inflation forecast. If the stance of monetary policy in a certain period turns out to be inappropriate, the error can be traced back to an erroneous inflation forecast for that period, although the overlapping character of updated inflation forecasts and monetary reactions would complicate this task in practice.

Forecasting errors may arise for several reasons. First, the economy may be affected by shocks in the forecast period, as was the case in the past. However, while past shocks are captured by the stochastic error terms of the model, these error terms are set to zero in the forecast period since future shocks are - by definition - unpredictable. Second, the parameters of the model are estimated on the basis of a limited sample and are therefore subject to sampling error. Third, the forecast may be led astray by incorrect assumptions with respect to the exogenous variables of the model. It should be recognised that all these types of errors will occur even if the model gives an adequate description of the data generating process. However, assuming one can obtain such an ideal, correctly specified model is unwarranted, as documented by the simple fact that different researchers typically advocate different types of models. Hence, forecast errors of a fourth type must be expected in practice, arising from the uncertainty with respect to the adequate specification of the model.

Against this background, this paper presents two specific examples of structural/institutional changes that affect the inflation forecast and thus - if not taken into account properly in the forecasting model - would give wrong signals for monetary policy. The first simulation experiment deals with the impact of productivity growth on inflation. This experiment may be regarded as an example of model uncertainty. Can the historical estimate of technical progress be carried over to the forecast period, or is it more realistic to assume a faster rate of technical progress in the era of the “new economy”, liberalised and globalised markets and tougher competition? If such considerations seem relevant, to what extent do they affect technical progress in the forecast period? The second simulation deals with a potential change in the Swiss legislation on tenancy rights, replacing the traditional link of housing rents to mortgage rates by an alternative link to the CPI. This simulation is somewhat different in character since it addresses the implications of an institutional change that, in principle, would be known to the monetary authorities some time in advance, although the practical working of the new rule might be less obvious.

These simulation experiments are carried out with a medium-size structural macromodel and are imbedded in a forecasting situation similar to the one faced by the SNB in August 2000. As in the actual monetary policy decision process, the first step is thus to compute a baseline forecast conditional on the assumption of an unchanged three-month Libor. The baseline forecast is intentionally made somewhat more inflationary than the actual SNB forecast of August 2000. The inflation rate increases from 1.7% in the current year to 2.5% in 2001-02 and falls back slightly to 2.3% and 2.2% in 2003-04. Hypothetically assuming an inflation target of 1.7%, the baseline forecast thus gives a signal for monetary tightening. According to the model, as shown in a second simulation

(Alternative 1), three-month Libor has to be raised from the current 3.5% to 4.5% in order to attain the inflation target.

In the model used so far, productivity growth proceeds on its historical trend. A further simulation (Alternative 2) then addresses the implications of higher productivity growth. The simulation is implemented by raising the technical progress parameter of the model by 50%, implying an annual rate of labour-augmenting technical progress of 1.8% instead of 1.2% as in the baseline forecast. Since the production function of the model is of a vintage type, faster technical progress falls exclusively on new equipment. The productivity gain on the whole production apparatus is endogenous, depending on the replacement of old equipment by new equipment (scrapping and investment). Although this process is sped up by a higher rate of technical progress on new equipment (old equipment loses its competitiveness more quickly), the share of new equipment in the production apparatus remains relatively small in the time horizon under consideration. Hence, overall productivity increases by less than productivity on new equipment. Nevertheless, the productivity gain in Alternative 2 is sufficient to bring inflation down to 1.7% in 2004. As this is just the assumed target value, no monetary tightening is indicated - in contrast to the baseline forecast, where the inflation target is missed by 0.5 percentage points.

Evidence for a sustained boost to productivity growth in Switzerland is, at least for the time being, far from being conclusive. Monetary policy can thus be misled in two directions. First, future productivity growth may be overestimated. In this case, monetary policy is based on an overly optimistic inflation forecast and thus turns out to be too lax. The cost of the forecast error shows up in the form of an inflation rate that exceeds the target value. Second, productivity growth may be underestimated. In this case, monetary policy is based on an overly pessimistic inflation forecast and thus turns out to be too restrictive: the inflation rate falls below the target value at the cost of an unnecessary depression of real GDP growth. This is an illustration of the many uncertainties surrounding monetary policy. Changes in parameter values, even if they remain within the bounds of possibility, can have sizeable effects on the inflation forecast and hence on monetary policy decisions.

As a second issue, the paper tries to assess the implications of a potential change in the formation of housing rents. The equation for housing rents reflects current legislation on tenant protection, which permits house owners to pass higher mortgage rates in certain proportions on to housing rents.[11] If monetary policy is tightened, mortgage rates and thus housing rents increase. Housing rents being an important component of the CPI, one may suspect that this mechanism hampers the efficiency of monetary policy. In order to see to what extent, the housing rent equation of the model is replaced by an alternative rule that links housing rents to the CPI. On the basis of this model, two further simulations are performed. The first refers to the concrete forecasting situation of August 2000. The second compares the monetary transmission mechanism between the two regimes from a more general perspective.

In the forecasting situation of August 2000, the alternative CPI rule lowers the inflation forecast significantly (Alternative 4). Supposing again an inflation target of 1.7%, the forecast implies that monetary policy may remain unchanged. In contrast, the baseline forecast has inflation at 2.2% in 2004 and therefore signals that monetary policy should be tightened. Moreover, while monetary tightening lowers inflation only slowly and in company with a substantial negative GDP effect under the interest rate rule, the switch to the CPI rule reduces inflation to 1.7% right from the beginning of the forecast period and has a small positive impact on GDP growth.

These beneficial effects may be traced back to the formation of wages, which depend on a weighted average of the CPI and the GDP deflator, and the “wedge” driven by increasing housing rents between the CPI and the GDP deflator. The existence of this wedge, reflecting the income claims of house owners, requires higher unemployment and lower capacity utilisation in order to confine the income claims of workers and firms. The switch to the CPI rule lowers the wedge, so that the economy moves towards a new equilibrium with lower inflation, higher employment and higher GDP.

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[11] The term *tenant protection* and the right of house owners to pass higher mortgage rates on to tenants may seem somewhat contradictory at first sight. However, one should recognise that rents of older apartments are often below potential market prices. Therefore, the principle of cost-determined housing rents “protects” tenants from market-determined rent increases. Moreover, the mechanism should also go in the other direction, ie lower mortgage rates should be passed to tenants as well. To what extent this actually happens in reality is, however, less clear.

It should be stressed, however, that these results are not general but apply to the specific forecasting situation, which was preceded by a considerable increase in interest rates. Due to adjustment lags, a strong increase in housing rents is therefore already in the pipeline under the interest rate rule. The switch to the CPI rule then cuts this pipeline at a time when it matters a great deal. Hence, the rather strong inflation dampening effect is conditional on the concrete forecasting situation.

In order to assess the differences in the monetary transmission mechanism between the two regimes from a more general perspective, a final simulation is carried out that tightens monetary policy under the CPI rule as well (although this is not necessary with regard to the inflation target). It turns out that the CPI rule makes the monetary transmission mechanism more efficient in two respects. First, the inflation dampening effect is quicker and stronger, since the adverse countereffect of rising housing rents is suppressed. Second, the negative side effects on GDP growth are less pronounced. Put differently, Swiss legislation on tenant protection forces monetary policy to become more restrictive if a certain reduction in the inflation rate is to be achieved, and this additional tightening is reflected in a higher loss of real GDP growth.

Appendix: Tables for the various scenarios

Table 1

Baseline forecast

		1998	1999	2000	2001	2002	2003	2004	
Exogenous:									
GDP EU 15	GDPEUR	2.64	2.34	3.32	3.37	3.03	2.98	3.05	(a)
GDP USA	GDPUSA	4.31	4.15	5.07	3.28	2.74	2.88	3.19	(a)
GDP Japan	GDPJAP	– 2.55	0.27	1.41	1.89	2.59	2.93	2.83	(a)
Consumer price Germany	PCONS_GE	0.93	0.59	1.53	1.83	2.00	1.66	1.49	(a)
Short-term interest rate euro	SRATE_GE	3.55	2.96	4.30	4.95	5.00	5.00	5.00	(b)
Short-term interest rate US dollar	SRATE-US	4.78	4.64	5.89	5.83	4.94	4.72	4.72	(b)
Long-term interest rate Germany	LRATE_GE	4.62	4.53	5.46	5.64	5.56	5.55	5.55	(b)
Price of oil in USD	POILUSD	12.7	17.8	28.2	30.0	30.0	30.0	30.0	(c)
Exchange rate USD/Euro	EDOEURO	1.11	1.07	0.93	0.89	0.91	0.93	0.94	(c)
Swiss monetary policy:									
Short-term interest rate	SRATE	1.55	1.40	3.10	3.50	3.50	3.50	3.50	(b)
Endogenous:									
Private consumption	CONSP	2.24	2.21	2.04	1.81	1.71	1.61	1.72	(a)
Real disp household income	YDISPBR	3.80	1.98	2.07	1.99	1.72	1.63	1.79	(a)
Construction investment	ICNSTR	0.92	– 6.24	2.28	– 0.58	1.51	2.45	2.48	(a)
Investm in mach and equipment	IME	8.89	8.82	2.42	3.66	2.77	2.98	3.90	(a)
Exports (incl services & tourism)	EXTOT	5.03	5.82	9.56	4.77	4.19	4.29	4.64	(a)
Imports (incl services & tourism)	IMTOT	9.60	5.50	7.37	2.41	3.29	4.22	4.96	(a)
Inventory investment	IINVWB	1.61	– 0.09	0.63	– 0.40	– 0.35	– 0.14	– 0.04	(d)
Gross domestic product	GDP	2.35	1.53	3.35	2.25	1.77	1.77	1.90	(a)
Employment (labour input in hours)	LVOLUS	1.32	0.34	1.53	0.94	0.36	0.23	0.29	(a)
Labour productivity	LPROD	1.01	1.18	1.80	1.30	1.40	1.54	1.61	(a)
Labour producitiviy, technical	LTPROD	1.05	0.94	1.32	1.42	1.45	1.48	1.52	(a)
Labour productivity, new equipment	LCPROD	1.55	1.67	2.16	2.25	1.84	2.05	2.10	(a)
Consumer price (CPI)	PCI	0.02	0.81	1.74	2.48	2.52	2.30	2.18	(a)
Construction price (NaAcc deflator)	PICNSTR	– 0.25	2.90	2.12	1.21	1.08	1.15	1.32	(a)
Housing rents	PHR	0.05	0.69	1.83	5.07	5.02	4.35	4.01	(a)
Price of IME (NaAcc deflator)	PIME	– 0.05	– 2.00	– 2.32	– 0.49	0.19	– 0.54	– 0.43	(a)
Export price (NaAcc deflator)	PEXTOT	– 0.94	1.17	2.00	1.98	1.74	1.38	1.47	(a)
Import price (NaAcc deflator)	PIMTOT	– 3.88	– 1.24	3.97	1.22	0.36	– 0.19	– 0.06	(a)
GDP deflator	PGDP	0.24	0.55	0.91	1.76	2.36	2.24	2.21	(a)
Nominal wage (BfS index)	WAGE	0.70	1.21	1.44	2.26	2.80	2.78	2.72	(a)
Nominal wage (NaAcc concept)	WINCI	1.12	1.69	2.63	3.39	3.71	3.69	3.66	(a)
Real consumer wage	WRINC	1.10	0.87	0.87	0.88	1.16	1.36	1.45	(a)
External value of CHF	EVN	1.71	– 0.49	– 1.80	0.55	0.33	0.49	0.26	(a)
Real external value of CHF	EVR	0.49	– 1.38	– 3.15	– 0.12	0.43	0.52	0.31	(a)
Exchange rate CHF/euro	EFREURO	1.61	1.60	1.56	1.55	1.55	1.54	1.54	(c)
Exchange rate CHF/USD	EFRDO	1.45	1.50	1.69	1.73	1.70	1.66	1.64	(c)
Long-term interest rate	LRATE	2.81	3.01	4.01	4.14	4.10	4.10	4.10	(b)
Output gap	GDPGAP	– 4.89	– 5.29	– 1.94	– 1.45	– 1.51	– 1.45	– 1.23	(b)
Unemployment rate (seco)	UROFF	3.86	2.72	1.99	1.82	1.80	1.77	1.71	(b)

(a) Rate of change in % (b) Level in % (c) Level (d) Contribution to GDP growth rate in percentage points

Table 2a

Alternative 1 (tighter monetary policy)

		1998	1999	2000	2001	2002	2003	2004	
Swiss monetary policy:									
Short-term interest rate	SRATE	1.55	1.40	3.60	4.50	4.50	4.50	4.50	(b)
Endogenous:									
Private consumption	CONSP	2.24	2.21	2.03	1.69	1.41	1.16	1.35	(a)
Real disp. household income	YDISPBR	3.80	1.98	2.06	1.83	1.17	0.98	1.36	(a)
Construction investment	ICNSTR	0.92	– 6.24	2.25	– 1.16	0.53	1.93	2.33	(a)
Investm in mach and equipment	IME	8.89	8.82	2.41	3.08	1.49	2.42	4.27	(a)
Exports (incl services & tourism)	EXTOT	5.03	5.82	9.49	4.03	3.58	4.12	4.62	(a)
Imports (incl Services & tourism)	IMTOT	9.60	5.50	7.33	1.94	2.65	3.85	4.95	(a)
Inventory investment	IINVWB	1.61	– 0.09	0.63	– 0.35	– 0.42	– 0.23	– 0.05	(d)
Gross domestic product	GDP	2.35	1.53	3.34	1.96	1.24	1.37	1.70	(a)
Employment (labour input in hours)	LVOLUS	1.32	0.34	1.52	0.77	– 0.04	– 0.15	0.08	(a)
Labour productivity	LPROD	1.01	1.18	1.79	1.18	1.28	1.53	1.62	(a)
Labour producitiviy, technical	LTPROD	1.05	0.94	1.32	1.42	1.45	1.47	1.52	(a)
Labour productivity, new equipment	LCPROD	1.55	1.67	2.18	2.45	2.08	2.31	2.32	(a)
Consumer price (CPI)	PCI	0.02	0.81	1.72	2.41	2.42	1.99	1.70	(a)
Construction price (NaAcc deflator)	PICNSTR	– 0.25	2.90	2.12	1.07	0.55	0.30	0.43	(a)
Housing rents	PHR	0.05	0.69	1.83	5.19	5.30	4.39	3.82	(a)
Price of IME (NaAcc deflator)	PIME	– 0.05	– 2.00	– 2.50	– 1.34	– 0.83	– 1.88	– 1.73	(a)
Export price (NaAcc deflator)	PEXTOT	– 0.94	1.17	1.89	1.44	1.19	0.80	0.95	(a)
Import price (NaAcc deflator)	PIMTOT	– 3.88	– 1.24	3.68	– 0.09	– 0.60	– 0.90	– 0.67	(a)
GDP deflator	PGDP	0.24	0.55	0.91	1.75	2.18	1.75	1.61	(a)
Nominal wage (BfS index)	WAGE	0.70	1.21	1.44	2.22	2.61	2.34	2.13	(a)
Nominal wage (NaAcc concept)	WINCI	1.12	1.69	2.63	3.33	3.45	3.15	2.97	(a)
Real consumer wage	WRINC	1.10	0.87	0.89	0.89	1.01	1.14	1.25	(a)
External value of CHF	EVN	1.71	– 0.49	– 1.40	2.03	1.00	1.00	0.84	(a)
Real external value of CHF	EVR	0.49	– 1.38	– 2.76	1.34	0.93	0.55	0.30	(a)
Exchange rate CHF/euro	EFREURO	1.61	1.60	1.56	1.52	1.51	1.50	1.49	(c)
Exchange rate CHF/USD	EFRDO	1.45	1.50	1.68	1.70	1.65	1.61	1.58	(c)
Long-term interest rate	LRATE	2.81	3.01	4.10	4.34	4.30	4.30	4.30	(b)
Output gap	GDPGAP	– 4.89	– 5.29	– 1.95	– 1.65	– 1.99	– 1.99	– 1.64	(b)
Unemployment rate (seco)	UROFF	3.86	2.72	2.00	1.91	2.03	2.11	2.09	(b)

(a) Rate of change in % (b) Level in % (c) Level (d) Contribution to GDP growth rate in percentage points

Table 2b

Effects of tighter monetary policy

(Alternative 1 versus baseline: differences in growth rates or levels)

		2000	2001	2002	2003	2004	
Private consumption	CONSP	– 0.01	– 0.12	– 0.29	– 0.45	– 0.37	(a)
Construction investment	ICNSTR	– 0.03	– 0.58	– 0.98	– 0.52	– 0.16	(a)
Investm in mach and equipment	IME	– 0.01	– 0.59	– 1.28	– 0.56	0.36	(a)
Exports (incl services & tourism)	EXTOT	– 0.07	– 0.74	– 0.61	– 0.17	– 0.02	(a)
Imports (incl Services & tourism)	IMTOT	– 0.04	– 0.47	– 0.63	– 0.37	0.00	(a)
Gross domestic product	GDP	– 0.02	– 0.29	– 0.53	– 0.40	– 0.20	(a)
Employment (labour input in hours)	LVOLUS	– 0.01	– 0.16	– 0.41	– 0.38	– 0.21	(a)
Labour productivity	LPROD	– 0.01	– 0.13	– 0.12	– 0.01	0.01	(a)
Labour producitiviy, technical	LTPROD	0.00	0.00	0.00	0.00	0.01	(a)
Labour productivity, new equipment	LCPROD	0.02	0.19	0.24	0.25	0.22	(a)
Consumer price (CPI)	PCI	– 0.01	– 0.07	– 0.11	– 0.31	– 0.48	(a)
Construction price (NaAcc deflator)	PICNSTR	0.00	– 0.13	– 0.52	– 0.84	– 0.89	(a)
Housing rents	PHR	0.00	0.12	0.27	0.04	– 0.19	(a)
Price of IME (NaAcc deflator)	PIME	– 0.18	– 0.85	– 1.03	– 1.34	– 1.30	(a)
Export price (NaAcc deflator)	PEXTOT	– 0.11	– 0.54	– 0.55	– 0.57	– 0.52	(a)
Import price (NaAcc deflator)	PIMTOT	– 0.29	– 1.30	– 0.96	– 0.71	– 0.61	(a)
GDP deflator	PGDP	0.00	– 0.01	– 0.18	– 0.49	– 0.60	(a)
Nominal wage (NaAcc concept)	WINCI	0.00	– 0.06	– 0.26	– 0.54	– 0.69	(a)
Real consumer wage	WRINC	0.01	0.02	– 0.15	– 0.22	– 0.20	(a)
External value of CHF	EVN	0.40	1.48	0.68	0.51	0.59	(a)
Real external value of CHF	EVR	0.39	1.46	0.50	0.03	– 0.01	(a)
Long-term interest rate	LRATE	0.10	0.20	0.20	0.20	0.20	(b)
Unemployment rate (seco)	UROFF	0.00	0.08	0.23	0.34	0.38	(b)

(a) Rate of change in % (b) Level

Table 3a

Alternative 2 (higher productivity growth)

		1998	1999	2000	2001	2002	2003	2004	
Swiss monetary policy:									
Short-term interest rate	SRATE	1.55	1.40	3.10	3.50	3.50	3.50	3.50	(b)
Endogenous:									
Private consumption	CONSP	2.24	2.21	2.04	1.76	1.59	1.49	1.61	(a)
Real disp household income	YDISPBR	3.80	1.98	2.07	1.93	1.59	1.51	1.68	(a)
Construction investment	ICNSTR	0.92	– 6.24	2.28	– 0.61	1.48	2.45	2.52	(a)
Investm in mach and equipment	IME	8.89	8.82	2.39	3.54	2.91	3.40	4.46	(a)
Exports (incl services & tourism)	EXTOT	5.03	5.82	9.56	4.81	4.30	4.41	4.73	(a)
Imports (incl services & tourism)	IMTOT	9.60	5.50	7.37	2.34	3.21	4.20	4.99	(a)
Inventory investment	IINVWB	1.61	– 0.09	0.63	– 0.40	– 0.36	– 0.15	– 0.03	(d)
Gross domestic product	GDP	2.35	1.53	3.35	2.26	1.80	1.82	1.97	(a)
Employment (labour input in hours)	LVOLUS	1.32	0.34	1.53	0.92	0.33	0.18	0.22	(a)
Labour productivity	LPROD	1.01	1.18	1.80	1.33	1.47	1.64	1.74	(a)
Labour producitiviy, technical	LTPROD	1.05	0.94	1.32	1.44	1.52	1.59	1.67	(a)
Labour productivity, new equipment	LCPROD	1.55	1.67	2.24	2.71	2.45	2.74	2.82	(a)
Consumer price (CPI)	PCI	0.02	0.81	1.74	2.43	2.32	1.95	1.70	(a)
Construction price (NaAcc deflator)	PICNSTR	– 0.25	2.90	2.12	1.16	0.89	0.82	0.87	(a)
Housing rents	PHR	0.05	0.69	1.83	5.07	5.02	4.31	3.91	(a)
Price of IME (NaAcc deflator)	PIME	– 0.05	– 2.00	– 2.33	– 0.85	– 0.65	– 1.67	– 1.79	(a)
Export price (NaAcc deflator)	PEXTOT	– 0.94	1.17	1.99	1.84	1.44	0.97	0.95	(a)
Import price (NaAcc deflator)	PIMTOT	– 3.88	– 1.24	3.97	1.20	0.22	– 0.48	– 0.50	(a)
GDP deflator	PGDP	0.24	0.55	0.91	1.61	1.97	1.68	1.53	(a)
Nominal wage (BfS index)	WAGE	0.70	1.21	1.44	2.20	2.58	2.40	2.20	(a)
Nominal wage (NaAcc concept)	WINCI	1.12	1.69	2.63	3.35	3.57	3.42	3.27	(a)
Real consumer wage	WRINC	1.10	0.87	0.88	0.90	1.22	1.45	1.54	(a)
External value of CHF	EVN	1.71	– 0.49	– 1.80	0.58	0.53	0.89	0.82	(a)
Real external value of CHF	EVR	0.49	– 1.38	– 3.15	– 0.24	0.24	0.37	0.19	(a)
Exchange rate CHF/euro	EFREURO	1.61	1.60	1.56	1.55	1.54	1.53	1.52	(c)
Exchange rate CHF/USD	EFRDO	1.45	1.50	1.69	1.73	1.69	1.65	1.62	(c)
Long-term interest rate	LRATE	2.81	3.01	4.01	4.14	4.10	4.10	4.10	(b)
Output gap	GDPGAP	– 4.89	– 5.29	– 1.94	– 1.45	– 1.45	– 1.32	– 1.04	(b)
Unemployment rate (seco)	UROFF	3.86	2.72	2.00	1.83	1.82	1.81	1.77	(b)

(a) Rate of change in % (b) Level in % (c) Level (d) Contribution to GDP growth rate in percentage points

Table 3b

Effects of higher productivity growth

(Alternative 2 versus baseline: differences in growth rates or levels)

		2000	2001	2002	2003	2004	
Private consumption	CONSP	0.00	– 0.05	– 0.12	– 0.13	– 0.11	(a)
Construction investment	ICNSTR	0.00	– 0.02	– 0.03	0.00	0.04	(a)
Investm in mach and equipment	IME	– 0.03	– 0.13	0.14	0.41	0.55	(a)
Exports (incl services & tourism)	EXTOT	0.00	0.04	0.11	0.11	0.09	(a)
Imports (incl services & tourism)	IMTOT	– 0.01	– 0.08	– 0.08	– 0.02	0.03	(a)
Gross domestic product	GDP	0.00	0.01	0.03	0.05	0.06	(a)
Employment (labour input in hours)	LVOLUS	0.00	– 0.02	– 0.04	– 0.05	– 0.07	(a)
Labour productivity	LPROD	0.00	0.02	0.07	0.10	0.13	(a)
Labour producitiviy, technical	LTPROD	0.00	0.03	0.07	0.11	0.15	(a)
Labour productivity, new equipment	LCPROD	0.08	0.46	0.61	0.69	0.72	(a)
Consumer price (CPI)	PCI	0.00	– 0.06	– 0.20	– 0.35	– 0.48	(a)
Construction price (NaAcc deflator)	PICNSTR	0.00	– 0.05	– 0.18	– 0.32	– 0.46	(a)
Housing rents	PHR	0.00	0.00	– 0.01	– 0.04	– 0.10	(a)
Price of IME (NaAcc deflator)	PIME	– 0.01	– 0.36	– 0.84	– 1.13	– 1.36	(a)
Export price (NaAcc deflator)	PEXTOT	– 0.01	– 0.14	– 0.29	– 0.41	– 0.51	(a)
Import price (NaAcc deflator)	PIMTOT	0.00	– 0.02	– 0.14	– 0.30	– 0.44	(a)
GDP deflator	PGDP	– 0.01	– 0.15	– 0.39	– 0.56	– 0.69	(a)
Nominal wage (NaAcc concept)	WINCI	0.00	– 0.04	– 0.14	– 0.27	– 0.40	(a)
Real consumer wage	WRINC	0.00	0.02	0.06	0.08	0.09	(a)
External value of CHF	EVN	0.00	0.03	0.20	0.40	0.56	(a)
Real external value of CHF	EVR	0.00	– 0.12	– 0.19	– 0.15	– 0.12	(a)
Long-term interest rate	LRATE	0.00	0.00	0.00	0.00	0.00	(b)
Unemployment rate (seco)	UROFF	0.00	0.01	0.02	0.04	0.06	(b)

(a) Rate of change in % (b) Level

Table 4

Alternative 3 (higher productivity growth and tighter monetary policy)

		1998	1999	2000	2001	2002	2003	2004	
Swiss monetary policy:									
Short-term interest rate	SRATE	1.55	1.40	3.60	4.50	4.50	4.50	4.50	(b)
Endogenous:									
Private consumption	CONSP	2.24	2.21	2.03	1.64	1.29	1.03	1.24	(a)
Real disp household income	YDISPBR	3.80	1.98	2.06	1.77	1.05	0.86	1.25	(a)
Construction investment	ICNSTR	0.92	– 6.24	2.25	– 1.18	0.50	1.92	2.36	(a)
Investm in mach and equipment	IME	8.89	8.82	2.38	2.95	1.61	2.80	4.83	(a)
Exports (incl services & tourism)	EXTOT	5.03	5.82	9.49	4.07	3.68	4.23	4.71	(a)
Imports (incl services & tourism)	IMTOT	9.60	5.50	7.32	1.86	2.57	3.82	4.98	(a)
Inventory investment	IINVWB	1.61	– 0.09	0.64	– 0.35	– 0.43	– 0.23	– 0.05	(d)
Gross domestic product	GDP	2.35	1.53	3.34	1.96	1.27	1.42	1.76	(a)
Employment (labour input in hours)	LVOLUS	1.32	0.34	1.52	0.76	– 0.08	– 0.20	0.01	(a)
Labour productivity	LPROD	1.01	1.18	1.79	1.20	1.35	1.63	1.75	(a)
Labour producitiviy, technical	LTPROD	1.05	0.94	1.32	1.44	1.51	1.58	1.67	(a)
Labour productivity, new equipment	LCPROD	1.55	1.67	2.26	2.90	2.69	3.00	3.06	(a)
Consumer price (CPI)	PCI	0.02	0.81	1.72	2.35	2.21	1.63	1.22	(a)
Construction price (NaAcc deflator)	PICNSTR	– 0.25	2.90	2.11	1.02	0.37	– 0.02	– 0.03	(a)
Housing rents	PHR	0.05	0.69	1.83	5.19	5.29	4.34	3.72	(a)
Price of IME (NaAcc deflator)	PIME	– 0.05	– 2.00	– 2.51	– 1.70	– 1.67	– 3.02	– 3.11	(a)
Export price (NaAcc deflator)	PEXTOT	– 0.94	1.17	1.88	1.30	0.89	0.38	0.43	(a)
Import price (NaAcc deflator)	PIMTOT	– 3.88	– 1.24	3.68	– 0.11	– 0.74	– 1.20	– 1.12	(a)
GDP deflator	PGDP	0.24	0.55	0.91	1.60	1.79	1.19	0.92	(a)
Nominal wage (BfS index)	WAGE	0.70	1.21	1.44	2.16	2.39	1.96	1.62	(a)
Nominal wage (NaAcc concept)	WINCI	1.12	1.69	2.62	3.29	3.31	2.88	2.58	(a)
Real consumer wage	WRINC	1.10	0.87	0.89	0.92	1.07	1.23	1.34	(a)
External value of CHF	EVN	1.71	– 0.49	– 1.40	2.07	1.20	1.40	1.42	(a)
Real external value of CHF	EVR	0.49	– 1.38	– 2.76	1.22	0.74	0.40	0.18	(a)
Exchange rate CHF/euro	EFREURO	1.61	1.60	1.56	1.52	1.50	1.49	1.47	(c)
Exchange rate CHF/USD	EFRDO	1.45	1.50	1.68	1.70	1.65	1.60	1.56	(c)
Long-term interest rate	LRATE	2.81	3.01	4.10	4.34	4.30	4.30	4.30	(b)
Output gap	GDPGAP	– 4.89	– 5.29	– 1.95	– 1.64	– 1.94	– 1.86	– 1.43	(b)
Unemployment rate (seco)	UROFF	3.86	2.72	2.00	1.91	2.05	2.15	2.16	(b)

(a) Rate of change in % (b) Level in % (c) Level (d) Contribution to GDP growth rate in percentage points

Table 5a

Alternative 4 (housing rents linked to CPI)

		1998	1999	2000	2001	2002	2003	2004	
Swiss monetary policy:									
Short-term interest rate	SRATE	1.55	1.40	3.10	3.50	3.50	3.50	3.50	(b)
Endogenous:									
Private consumption	CONSP	2.24	2.21	2.08	2.17	2.19	2.05	2.07	(a)
Real disp household income	YDISPBR	3.80	1.98	2.15	2.56	2.35	2.19	2.23	(a)
Construction investment	ICNSTR	0.92	– 6.24	2.29	– 0.48	1.64	2.50	2.44	(a)
Investm in mach and equipment	IME	8.89	8.82	2.43	3.92	3.40	3.44	4.00	(a)
Exports (incl services & tourism)	EXTOT	5.03	5.82	9.57	4.86	4.33	4.36	4.67	(a)
Imports (incl services & tourism)	IMTOT	9.60	5.50	7.41	2.82	3.88	4.63	5.16	(a)
Inventory investment	IINVWB	1.61	– 0.09	0.62	– 0.42	– 0.31	– 0.10	– 0.02	(d)
Gross domestic product	GDP	2.35	1.53	3.36	2.33	1.97	1.96	2.03	(a)
Employment (labour input in hours)	LVOLUS	1.32	0.34	1.53	0.98	0.50	0.38	0.39	(a)
Labour productivity	LPROD	1.01	1.18	1.80	1.34	1.47	1.57	1.63	(a)
Labour producitiviy, technical	LTPROD	1.05	0.94	1.32	1.42	1.46	1.49	1.52	(a)
Labour productivity, new equipment	LCPROD	1.55	1.67	2.16	2.24	1.79	1.98	2.04	(a)
Consumer price (CPI)	PCI	0.02	0.81	1.65	1.74	1.71	1.69	1.70	(a)
Construction price (NaAcc deflator)	PICNSTR	– 0.25	2.90	2.12	1.23	1.19	1.36	1.53	(a)
Housing rents	PHR	0.05	0.69	1.56	2.73	2.72	2.70	2.71	(a)
Price of IME (NaAcc deflator)	PIME	– 0.05	– 2.00	– 2.32	– 0.55	0.11	– 0.54	– 0.48	(a)
Export price (NaAcc deflator)	PEXTOT	– 0.94	1.17	2.00	1.95	1.71	1.37	1.43	(a)
Import price (NaAcc deflator)	PIMTOT	– 3.88	– 1.24	3.97	1.20	0.32	– 0.23	– 0.14	(a)
GDP deflator	PGDP	0.24	0.55	0.88	1.48	2.05	2.04	2.05	(a)
Nominal wage (BfS index)	WAGE	0.70	1.21	1.43	2.00	2.36	2.42	2.44	(a)
Nominal wage (NaAcc concept)	WINCI	1.12	1.69	2.62	3.23	3.43	3.45	3.47	(a)
Real consumer wage	WRINC	1.10	0.87	0.95	1.47	1.69	1.73	1.74	(a)
External value of CHF	EVN	1.71	– 0.49	– 1.80	0.60	0.47	0.63	0.38	(a)
Real external value of CHF	EVR	0.49	– 1.38	– 3.18	– 0.36	0.27	0.47	0.27	(a)
Exchange rate CHF/euro	EFREURO	1.61	1.60	1.56	1.55	1.54	1.54	1.53	(c)
Exchange rate CHF/USD	EFRDO	1.45	1.50	1.69	1.73	1.69	1.65	1.63	(c)
Long-term interest rate	LRATE	2.81	3.01	4.01	4.14	4.10	4.10	4.10	(b)
Output gap	GDPGAP	4.89	– 5.29	– 1.94	– 1.38	– 1.32	– 1.20	– 1.00	(b)
Unemployment rate (seco)	UROFF	3.86	2.72	1.99	1.80	1.73	1.65	1.56	(b)

(a) Rate of change in % (b) Level in % (c) Level (d) Contribution to GDP growth rate in percentage points

Table 5b

Effects of linking housing rents to CPI

(Alternative 4 versus baseline: differences in growth rates or levels)

		2000	2001	2002	2003	2004	
Private consumption	CONSP	0.04	0.36	0.49	0.44	0.35	(a)
Construction investment	ICNSTR	0.01	0.11	0.13	0.05	– 0.04	(a)
Investm in mach and equipment	IME	0.01	0.26	0.63	0.46	0.10	(a)
Exports (incl services & tourism)	EXTOT	0.01	0.10	0.14	0.07	0.03	(a)
Imports (incl Services & tourism)	IMTOT	0.04	0.40	0.59	0.42	0.20	(a)
Gross domestic product	GDP	0.00	0.09	0.20	0.19	0.13	(a)
Employment (labour input in hours)	LVOLUS	0.00	0.04	0.14	0.15	0.10	(a)
Labour productivity	LPROD	0.00	0.04	0.06	0.03	0.02	(a)
Labour producitiviy, technical	LTPROD	0.00	0.00	0.01	0.01	0.01	(a)
Labour productivity, new equipment	LCPROD	0.00	– 0.01	– 0.04	– 0.07	– 0.06	(a)
Consumer price (CPI)	PCI	– 0.08	– 0.75	– 0.81	– 0.61	– 0.48	(a)
Construction price (NaAcc deflator)	PICNSTR	0.00	0.03	0.12	0.21	0.21	(a)
Housing rents	PHR	– 0.27	– 2.34	– 2.30	– 1.65	– 1.30	(a)
Price of IME (NaAcc deflator)	PIME	0.00	– 0.06	– 0.09	0.00	– 0.05	(a)
Export price (NaAcc deflator)	PEXTOT	0.00	– 0.03	– 0.03	– 0.01	– 0.04	(a)
Import price (NaAcc deflator)	PIMTOT	0.00	– 0.02	– 0.04	– 0.05	– 0.08	(a)
GDP deflator	PGDP	– 0.03	– 0.29	– 0.31	– 0.20	– 0.16	(a)
Nominal wage (NaAcc concept)	WINCI	– 0.01	– 0.15	– 0.28	– 0.25	– 0.20	(a)
Real consumer wage	WRINC	0.07	0.59	0.53	0.36	0.29	(a)
External value of CHF	EVN	0.00	0.04	0.14	0.14	0.12	(a)
Real external value of CHF	EVR	– 0.03	– 0.24	– 0.17	– 0.06	– 0.04	(a)
Long-term interest rate	LRATE	0.00	0.00	0.00	0.00	0.00	(b)
Unemployment rate (seco)	UROFF	0.00	– 0.02	– 0.07	– 0.12	– 0.15	(b)

(a) Rate of change in % (b) Level

Table 6a

Alternative 5 (housing rents linked to CPI, tighter monetary policy)

		1998	1999	2000	2001	2002	2003	2004	
Swiss monetary policy:									
Short-term interest rate	SRATE	1.55	1.40	3.60	4.50	4.50	4.50	4.50	(b)
Endogenous:									
Private consumption	CONSP	2.24	2.21	2.07	2.11	2.02	1.78	1.88	(a)
Real disp. household income	YDISPBR	3.80	1.98	2.14	2.47	1.96	1.71	1.96	(a)
Construction investment	ICNSTR	0.92	– 6.24	2.26	– 1.04	0.69	1.99	2.30	(a)
Investm. in mach. and equipment	IME	8.89	8.82	2.42	3.36	2.19	3.03	4.57	(a)
Exports (incl services & tourism)	EXTOT	5.03	5.82	9.49	4.14	3.74	4.22	4.69	(a)
Imports (incl services & tourism)	IMTOT	9.60	5.50	7.37	2.40	3.36	4.45	5.35	(a)
Inventory investment	IINVWB	1.61	– 0.09	0.63	– 0.38	– 0.39	– 0.18	– 0.03	(d)
Gross domestic product	GDP	2.35	1.53	3.34	2.06	1.48	1.62	1.88	(a)
Employment (labour input in hours)	LVOLUS	1.32	0.34	1.52	0.82	0.13	0.06	0.24	(a)
Labour productivity	LPROD	1.01	1.18	1.79	1.22	1.35	1.56	1.64	(a)
Labour producitiviy, technical	LTPROD	1.05	0.94	1.32	1.42	1.45	1.48	1.54	(a)
Labour productivity, new equipment	LCPROD	1.55	1.67	2.18	2.43	2.03	2.23	2.25	(a)
Consumer price (CPI)	PCI	0.02	0.81	1.63	1.58	1.41	1.17	1.03	(a)
Construction price (NaAcc deflator)	PICNSTR	– 0.25	2.90	2.12	1.10	0.70	0.56	0.71	(a)
Housing rents	PHR	0.05	0.69	1.54	2.57	2.42	2.18	2.03	(a)
Price of IME (NaAcc deflator)	PIME	– 0.05	– 2.00	– 2.50	– 1.41	– 0.95	– 1.93	– 1.81	(a)
Export price (NaAcc deflator)	PEXTOT	– 0.94	1.17	1.89	1.41	1.14	0.77	0.90	(a)
Import price (NaAcc deflator)	PIMTOT	– 3.88	– 1.24	3.68	– 0.10	– 0.66	– 0.97	– 0.76	(a)
GDP deflator	PGDP	0.24	0.55	0.88	1.43	1.80	1.46	1.36	(a)
Nominal wage (BfS index)	WAGE	0.70	1.21	1.43	1.94	2.09	1.86	1.73	(a)
Nominal wage (NaAcc concept)	WINCI	1.12	1.69	2.62	3.16	3.12	2.83	2.69	(a)
Real consumer wage	WRINC	1.10	0.87	0.96	1.56	1.68	1.64	1.65	(a)
External value of CHF	EVN	1.71	– 0.49	– 1.41	2.08	1.17	1.18	1.01	(a)
Real external value of CHF	EVR	0.49	– 1.38	– 2.80	1.07	0.72	0.44	0.22	(a)
Exchange rate CHF/Euro	EFREURO	1.61	1.60	1.56	1.52	1.50	1.49	1.48	(c)
Exchange rate CHF/USD	EFRDO	1.45	1.50	1.68	1.70	1.65	1.60	1.57	(c)
Long-term interest rate	LRATE	2.81	3.01	4.10	4.34	4.30	4.30	4.30	(b)
Output gap	GDPGAP	– 4.89	– 5.29	– 1.95	– 1.57	– 1.76	– 1.66	– 1.30	(b)
Unemployment rate (seco)	UROFF	3.86	2.72	2.00	1.88	1.94	1.95	1.90	(b)

(a) Rate of change in % (b) Level in % (c) Level (d) Contribution to GDP growth rate in percentage points

Table 6b

Effects of tighter monetary policy - housing rents linked to CPI

(Alternative 5 versus Alternative 4: differences in growth rates or levels)

		2000	2001	2002	2003	2004	
Private consumption	CONSP	– 0.01	– 0.06	– 0.17	– 0.27	– 0.19	(a)
Construction investment	ICNSTR	– 0.03	– 0.56	– 0.95	– 0.51	– 0.14	(a)
Investm in mach. and equipment	IME	– 0.01	– 0.56	– 1.21	– 0.42	0.57	(a)
Exports (incl services & tourism)	EXTOT	– 0.07	– 0.72	– 0.59	– 0.14	0.02	(a)
Imports (incl services & tourism)	IMTOT	– 0.04	– 0.42	– 0.51	– 0.18	0.19	(a)
Gross domestic product	GDP	– 0.02	– 0.28	– 0.49	– 0.34	– 0.15	(a)
Employment (labour input in hours)	LVOLUS	– 0.01	– 0.15	– 0.38	– 0.33	– 0.15	(a)
Labour productivity	LPROD	– 0.01	– 0.12	– 0.11	– 0.01	0.01	(a)
Labour producitiviy, technical	LTPROD	0.00	0.00	0.00	0.00	0.01	(a)
Labour productivity, new equipment	LCPROD	0.02	0.19	0.24	0.25	0.21	(a)
Consumer price (CPI)	PCI	– 0.02	– 0.16	– 0.30	– 0.52	– 0.67	(a)
Construction price (NaAcc deflator)	PICNSTR	0.00	– 0.13	– 0.50	– 0.79	– 0.82	(a)
Housing rents	PHR	– 0.02	– 0.16	– 0.30	– 0.53	– 0.68	(a)
Price of IME (NaAcc deflator)	PIME	– 0.18	– 0.86	– 1.06	– 1.40	– 1.33	(a)
Export price (NaAcc deflator)	PEXTOT	– 0.11	– 0.54	– 0.56	– 0.60	– 0.53	(a)
Import price (NaAcc deflator)	PIMTOT	– 0.29	– 1.30	– 0.98	– 0.74	– 0.62	(a)
GDP deflator	PGDP	0.00	– 0.05	– 0.26	– 0.58	– 0.69	(a)
Nominal wage (NaAcc concept)	WINCI	0.00	– 0.07	– 0.31	– 0.62	– 0.78	(a)
Real consumer wage	WRINC	0.02	0.09	– 0.01	– 0.09	– 0.09	(a)
External value of CHF	EVN	0.39	1.49	0.71	0.55	0.63	(a)
Real external value of CHF	EVR	0.38	1.43	0.45	– 0.02	– 0.06	(a)
Long-term interest rate	LRATE	0.10	0.20	0.20	0.20	0.20	(b)
Unemployment rate (seco)	UROFF	0.00	0.08	0.21	0.30	0.33	(b)

(a) Rate of change in % (b) Level

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