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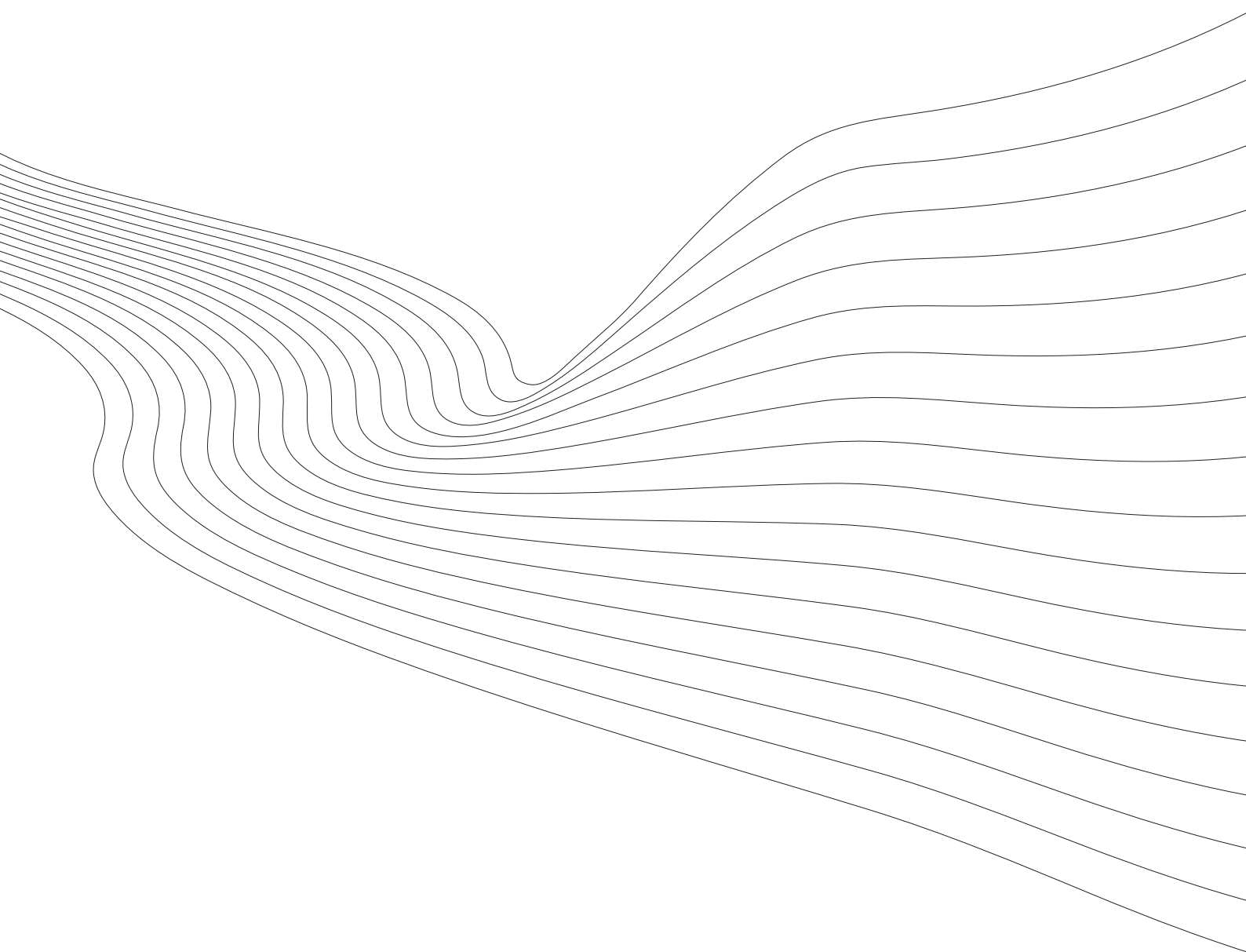
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Nominal Stability and Swiss Monetary Regimes over two Centuries

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Nominal Stability and Swiss Monetary Regimes over two Centuries*

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Abstract

This paper documents nominal stability in Switzerland from 1805 to 2013 using a data set on annual price, wage and nominal GDP changes. The trends of these indicators are estimated by an unobserved-components stochastic-volatility model in order to control for short-term fluctuations and measurement error. Based on a narrative analysis of these trends five main findings emerge. (i) Fiat currency regimes in Switzerland provided a relatively stable monetary background even compared to the metal-currency regimes before WW1. (ii) The flexible inflation targeting regime adopted in December 1999 has performed best over the last two centuries measured by today's definition of nominal stability. (iii) Fiat currency regimes without clearly communicated nominal price anchor (Bretton Woods System and monetary targeting) were characterised by an inflation bias. (iv) The metal-currency regimes (competing currencies and bimetallism before World War 1, and to some extent flexible inflation targeting, were associated with a deflation bias. (v) Persistent deflations in terms of the CPI only occurred under metallic regimes before WW2. These episodes were accompanied by falling nominal GDP, falling employment but relatively stable hourly wages.

JEL classification: E31, C22

Keywords: Nominal stability, price stability, monetary regimes, monetary history, unobserved-components stochastic-volatility model.

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Ultimately, it appears, one can check to see if an economy has a stable monetary background only by looking at macroeconomic indicators such as nominal GDP growth and inflation. On this criterion it appears that modern central bankers have taken Milton Friedman's advice to heart.

— Ben S. Bernanke, October 24, 2003

1 Introduction

Today's monetary regimes are often characterised by an explicit promise to stabilise inflation around a pre-specified target. Indeed, most central banks of industrialised economies currently conduct a form of flexible inflation targeting (see Baltensperger et al. 2007). The Swiss National Bank (SNB) has recently adopted a monetary strategy with a target range for CPI inflation that has to be met in the medium-run. This paper asks whether the new monetary strategy adopted fifteen years ago has delivered what it promised and compares its performance to other monetary regimes during the last two centuries.

The quote by Bernanke (2003) suggests that a monetary regime should be assessed against the backdrop of macroeconomic indicators, at least if the criterion of interest is nominal stability. Therefore, a novel Swiss data set is analysed covering consumer prices, wholesale prices, hourly wages, and nominal GDP over the last two centuries. The variety of indicators avoids a potential bias of the analysis in favour of today's monetary regime which explicitly focuses on CPI inflation. In order to abstract from short-term fluctuations over which the central bank has no control, the nominal trend is extracted from the indicators by means of an univariate unobserved component-stochastic volatility model suggested by Stock and Watson (2007).

Based on a narrative analysis of these nominal trends, five main findings emerge. (i) Fiat currency regimes in Switzerland provided a relatively stable monetary background even compared to the metal-currency regimes before WW1. (ii) The flexible inflation targeting regime adopted in December 1999 has performed best over the last two centuries measured by today's definition of nominal stability. (iii) Fiat currency regimes without clearly

communicated nominal price anchor (Bretton Woods System and monetary targeting) were characterised by an inflation bias. (iv) The metal-currency regimes (competing currencies and bimetallism before World War 1, and to some extent flexible inflation targeting, were associated with a deflation bias in terms of today's definition of nominal stability. (v) Persistent deflations in terms of the CPI only occurred under metallic regimes before WW2. These episodes were accompanied by falling nominal GDP, falling employment but relatively stable hourly wages.

This paper adds to a growing literature analysing inflation dynamics and monetary policy transmission over long sample periods using models controlling for stochastic volatility (see e.g. Cogley and Sargent 2005, Primiceri 2005, Stock and Watson 2007, Cogley and Sbordone 2008, Cogley et al. 2010, Feldkircher and Huber 2015). It is closely related to recent papers by Cogley and Sargent (2015) on the US and Cogley et al. (2015) on the UK. The main contribution is to apply a narrative approach similar to D'Agostino and Surico (2012) to analyse clearly defined monetary regimes for Switzerland using a variety of indicators of nominal stability. The statistical model applied allows to disentangle short-term from more persistent deflationary episodes and therefore complements the analysis by Bordo and Filardo (2005), who analyse deflationary episodes based on CPI inflation for various countries including Switzerland. Moreover, the results line up well with Benati (2008) who finds that inflation is not very persistent under monetary regimes with clearly defined nominal anchors, and Gürkaynak et al. (2010) who find that the adoption of an inflation target in the UK has anchored inflation expectations at low frequencies.

The paper is structured as follows. Section 2, briefly reviews the monetary regimes in Switzerland over the last two centuries, followed by a description of the data set. After presenting the methodology, the main results are given by Section 5. The last section offers some conclusions.

2 Historical background

Analysing Swiss monetary regimes over two centuries requires some historical background on the objectives of the regimes, how they were integrated in the global monetary system, and whether they were subordinated to fiscal policy during wars. Therefore, a historical

review is in order. The regimes are categorised as competing currencies, bimetallism, fiat money during WW1 and WW2, fixed exchange rates under Bretton Woods, monetary targeting, and flexible inflation targeting. Of course, this is only a rough categorisation and, in what follows, gradual changes of the regimes are discussed.

The historical review is based on other authors' more detailed work: see Baltensperger (2012) for Swiss monetary regimes from 1805 to 2013, Swiss National Bank (2007) for the history of the SNB from 1907 to 2007, Zurlinden (2003) for Switzerland during the Great Depression, Jordan et al. (2010) for the SNB's new monetary policy strategy from 2000 to 2010, Maissen (2015) for an overview of Swiss history since the 13th century, Eichengreen (2008) for the global monetary system, and Bernholz (2003) for a general assessment of various monetary regimes and their implications for inflation.

Competing currencies until 1849

During the first half of the 19th century, a large number of different currencies were in use in the Old Swiss Confederation; there was no single currency and no central bank with a monopoly on issuing banknotes. Researchers view this episode as an example of denationalised competing currencies (see Baltensperger 2012, p. 59-61). Hayek (1978) argued that competition among currency issuers avoids inflation because, if they would issue too many banknotes or reduce the fineness of metallic coins, the public would switch to other currencies.

The large number of different currencies was a result of the loose association of sovereign cantons (*Kantone*), associates (*Zugewandte Orte*), and condominiums (*Gemeine Herrschaften*) forming the Old Swiss Confederation (see Maissen 2015, p. 331). Only during the short period of the Helvetic Republic (1798–1803), which was an affiliated republic under French control, some centralised government services were introduced. In particular, the Swiss franc emerged as a single currency (see Maissen 2015, p. 165). However, after the Helvetic Republic collapsed the prerogative of coinage was again in the hands of the cantons and they partly reissued their old currencies. Moreover, many foreign coins were in use because domestically issued currencies were often of dubious quality (see Baltensperger 2012, p. 49-50). Despite a lack of regulation, banknotes played a minor role in payment transactions. In fact, the defining element of the monetary regime was

the metallic content and the fineness of the various coins that were in use. Private banks and larger cities started to emit banknotes in 1825, which were often denominated in, and convertible to, foreign currencies.

In the Old Swiss Confederation, political uncertainty was substantial as cantons and cities were engaged in many local conflicts. Examples are the war leading to the secession of the canton of Basel into Basel-city (*Stadt*) and Basel-rural area (*Landschaft*), and wars between conservative cantons and liberal rebels. Although these conflicts were local at first they ultimately led to a war between the Swiss Confederation and an association of conservative cantons starting in 1847, the so-called *Sonderbund* War. As the Swiss Confederation quickly won this war, the cantons agreed on a new republican constitution in 1848 (see Maissen 2015, p. 202).

Bimetallism and a single market from 1850–1906

With the new constitution, the prerogative of coinage moved to the Swiss Confederation and, in 1850, the Swiss franc finally replaced the large number of different currencies. The metallic content was still the defining element of the monetary regime and paper money was rarely used, although banking activities were only loosely regulated and private and cantonal banks were allowed to emit banknotes. In this paper, the regime is characterised as a bimetallic silver and gold standard. However, originally, the Swiss franc was designed as a silver currency, where one franc was equivalent to 4.5 grams silver, exactly the same as the French franc. Because France was on a bimetallic standard, the Swiss Confederation accepted gold coins as legal tender as of 1860.¹ In 1865, France, Switzerland, Belgium, Italy, and later on Greece, formed the Latin Monetary Union agreeing on the silver content of their currencies.²

The new constitution paved the way for forming a single market and moving towards a

¹Because of increases in the relative price of silver in the 1850s, silver coins were driven out of circulation and gold coins were minted instead of silver coins (Baltensperger 2012, p. 83). Consequently, French gold coins were increasingly used also in Switzerland which put pressure on the Swiss Confederation to introduce gold coins.

²The agreement became necessary because market forces repeatedly revealed unsustainable monetary arrangements (see Eichengreen 2008). In 1862, Italy reduced the metallic content of the small-denominated silver coins to 83.5%, whereas the silver content of the French franc was still 90%. Therefore, whenever possible, Italian coins were used in transactions and the French coins were hoarded. Therefore, the French coins were driven out of circulation by the Italian coins. Although France reduced the silver content in 1864, Switzerland reduced the silver content even more. As a consequence, the Swiss currency tended to drive the other currencies out of circulation.

more integrated currency union. Besides the single currency, important economic elements of the single market included abolishing internal tariffs, unifying external tariffs, generating income for central government services, and guaranteeing freedom of establishment for Christian citizens (see Maissen 2015, p. 204-205). However, one missing element was a single central bank.

Fiat currency and the World War period from 1907–1944

Although the transition of the Swiss franc from a metal currency to a modern fiat currency was gradual, an important element was the foundation of the SNB in 1907 receiving the monopoly on issuing banknotes.³ During the first four decades of its existence, the SNB showed a strong willingness to hold on to a metallic standard, whenever monetary policy was not subordinated to war-related government expenditures. The main objective was to keep the price of gold in Swiss francs fixed; a price stability objective in terms of inflation, if it existed implicitly, was clearly subordinated. This is also mirrored by the fact that nation-wide statistics for the CPI and WPI were only introduced as of 1921.

During the World War period, the SNB abandoned its main objective several times. Before WW1, the SNB promised to convert banknotes into the silver and gold currencies of the Latin Monetary Union (see Bordo and James 2007, p. 33). With the outbreak of WW1 convertibility was suspended and money in circulation increased strongly also because the SNB contributed to finance war-related government spending (see Baltensperger 2012, p. 144-146). After WW1, the SNB's primary aim was to establish the pre-war gold-parity and, as of December 1929, the SNB reenacted convertibility but only with respect to gold and not with respect to silver, abandoning bimetallism and adopting a gold standard. In the aftermath of the Great Depression, the SNB was determined to hold on to the gold standard until 1936, longer than other countries, even though this has exacerbated and prolonged the crisis (see Zurlinden 2003, Rosenkranz et al. 2014).

Fixed exchange rates under Bretton Woods from 1945–1972

In the after-war period, Switzerland fixed the Swiss franc/US Dollar exchange rate joining other countries under the Bretton Woods System. Between 1945 and 1972, the Bretton

³Baltensperger (2012), p. 26-27, suggests that the transition ended definitively with the end of the Bretton Woods System.

Woods System evolved gradually. Before 1951, the US kept the interest rate pegged for most of the time and therefore could not pursue an independent monetary policy (see D'Agostino and Surico 2012). Afterwards, changes in US monetary policy had limited international spill-overs because capital controls were in place. Eichengreen (2008), p. 112, suggests that the Bretton Woods System has come into full operation only by January 1959, when the major currencies became fully convertible for current-account transactions. Bernholz (2007), p. 147, argues that this has led to larger capital flows into Switzerland and, because of large interventions to defend the peg to the US Dollar, to substantial increases in the monetary base. Indeed the Swiss franc was often undervalued (see Bernholz 2007, p. 111-112). Towards the end of the Bretton Woods System, the peg was adjusted two times, in 1971 and 1972, and in January 1973, the SNB decided to let the Swiss franc float freely. All three adjustments implied an appreciation of the Swiss currency.

According to Baltensperger (2012), p. 215, letting the Swiss franc float was not voluntary.⁴ The SNB and the Swiss government judged the interventions required to maintain the peg as unsustainable, against the backdrop of massive speculative capital flows. Although inflation increased steadily already during the 1960s, the willingness to keep the exchange rate fixed was stronger suggesting that an implicit price stability objective was subordinated to an exchange rate stability objective. Indeed, although the exchange rate peg was, in principle, adjustable under specific conditions this option was rarely exercised (see Eichengreen 2008, p. 91). This subordination is also presaged by Bernholz (2007), p. 110-111. He identifies two dominant themes for the SNB under the Bretton Woods System: First, the SNB wanted to keep a fixed price for gold in Swiss francs; this goal was widely shared by the government, politicians and academics. Second, it wanted to allow the money supply to rise only as much as the growth of the economy, in order to keep inflation in check, as far as possible.

Monetary targeting from 1973–1999

With a floating exchange rate, the SNB obtained the possibility to conduct an independent monetary policy and, starting in 1974, a strategy for managing the money supply was

⁴In fact, Switzerland applied to join other European countries in a system of managed exchange rates, the so-called currency snake. However, the application was vetoed by France in 1975 (Bernholz 2007, p. 170-172).

developed. The monetary growth targets were not an end but an intermediate target to maintain price stability. Therefore, this was the first time price stability emerged as the main objective. Jordan et al. (2010) suggest that, implicitly, an annual CPI inflation objective of roughly one percent was consistent with the SNB's communicated monetary targets. However, no explicitly announced inflation target existed. Although the Swiss franc was floating, it was still taken into account in policy decisions. In October 1978 the SNB set a minimum exchange rate against the German Mark. There is evidence that maintaining price stability was not the main reason for introducing this policy. The lowest annual CPI inflation rate recorded in 1978 still amounted to 1.0%, in line with the SNB's implicit policy objective, while it was higher than 2% before and after. Moreover, Bernholz (2007), p. 179-181, suggests that internal worries about the export industry and political pressures have played a role for introducing the minimum exchange rate.

Flexible inflation targeting since 2000

In December 1999, the SNB adopted a new monetary policy strategy. Instead of announcing growth targets for monetary aggregates it moved to a flexible form of inflation targeting. The main differences relative to monetary targeting are reflected in the way the price stability objective and the policy decisions are communicated, as well as in the choice of the operative target. The new monetary policy strategy rests on three main principles (see Jordan et al. 2010). Firstly, the SNB announced an explicit definition of price stability as an annual CPI inflation rate that remains between 0% and 2% in the medium term. The target range centered around 1% is justified by measurement issues stemming from quality changes leading to an overstated inflation rate (Swiss National Bank 2015). This suggests that the SNB's actual inflation target would be centered around 0% in the absence of such measurement issues. Secondly, the SNB publishes an inflation forecast over three years, conditional on an unchanged 3M Libor, as the main indicator on which monetary policy decisions are based. Thirdly, it sets a range for the 3M Libor as an operational target. Although the strategy was officially adopted in December 1999, Baltensperger (2012), p. 237, emphasises that there was a gradual shift away from money growth targets since the mid-1990s.

The new monetary policy strategy was complemented by unconventional measures

since the Global Financial Crisis (GFC) and the euro area debt crisis. Some of the complementary measures are similar to those taken under monetary targeting. However, an important difference to earlier episodes was that most of the measures were taken in order to pursue an explicitly announced price stability objective. As the 3M Libor fell to close to 0% in early 2009, the Swiss franc came under substantial appreciation pressure implying deflationary tendencies. Therefore, the SNB conducted regular interventions in the foreign exchange market (see e.g. Swiss National Bank 2009). As the Swiss franc appreciated to unprecedented highs in August 2011, the most prominent unconventional measure was the announcement of a minimum exchange rate against the euro as an additional operational target.⁵ Moreover, to defend the minimum exchange rate, the SNB introduced negative interest rates on sight deposits in December 2014 and moved the target range for the 3M Libor into negative territory.

3 Data and descriptive statistics

This section presents the indicators of nominal stability by which the monetary regimes are assessed. As the quote by Bernanke (2003) at the beginning of this paper suggests nominal stability has to be measured by macroeconomic indicators. Because it is difficult to take an a priori stand on which indicator is most appropriate to assess nominal stability fluctuations in consumer prices, wholesale prices, hourly wages, and nominal GDP are analysed. Each of these indicators has a justification of serving as an indicator of nominal stability.

CPI inflation is an obvious candidate because the SNB currently uses it as its main indicator of nominal stability. Frankel (2012b) suggests that a central bank of a small open economy should instead stabilise an index of producer prices because it includes export commodities. The central bank thus avoids to respond to terms of trade shocks over which it has no control. Moreover, Erceg et al. (2000) show that, if nominal wages are less regularly adjusted than consumer prices, a central bank optimally puts more weight on stabilising wage inflation. Finally, researchers have suggested that the central bank

⁵Less well known unconventional measures include a purchase program of covered and non-bank corporate bonds from the markets between 2009 and 2010 (see Kettemann and Krogstrup 2014), and several increases of bank's sight deposits in August 2011.

should target the growth rate or level of nominal GDP. Although this idea is not new, it was already proposed by Meade (1978), it regained attention in the wake of the GFC and the euro area debt crisis (see e.g. Frankel 2012a, Sumner 2014, and references therein).

The indicators are constructed based on various data sources. The historical data for the 19th century stem from the historical database of the Swiss Federal Statistical Office (SFSO) and Historical Statistics of Switzerland Online (HSSO) of the University of Zurich. All indicators are of annual frequency and end in 2013.⁶ Two of them, the consumer price index (CPI) and the wholesale price index (WPI), are available since 1804 from the historical data base of the SFSO (2015b). These estimates are linked with the official CPI and WPI series obtained from the SFSO (2015a).⁷ The hourly wage index (HWI) is available only from 1821 onwards. It is constructed from nominal hourly wages in the manufacturing sector for the three cantons Zurich, Glarus and Basel-City for 1821–1831 (HSSO 2015, Table G2), linked with an estimate of average hourly wages for the entire Swiss economy for 1831–1942 (HSSO 2015, Table G1), and the wage index of the Swiss Statistical Office from 1943 onwards (SFSO 2015c, Table T39). The series measuring nominal GDP (NGDP) starts in 1851. Before 1980, three different nominal GDP sources are linked (HSSO 2015, Tables Q1a, Q17a, Q6a). After 1980, the official annual nominal GDP series from the State Secretariat for Economic Affairs is used (SECO 2015).

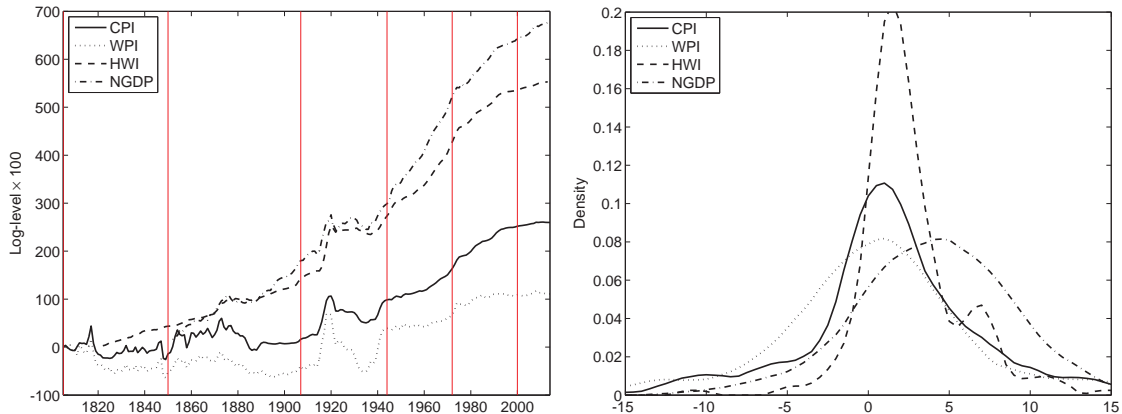
Figure 1 shows the four series in logarithms, where changes in the six monetary regimes discussed in the previous section are indicated by vertical lines. The indicators display different trends. The CPI rises less strongly, on average, than NGDP and the wage index, but more strongly than wholesale prices. This indicates positive real output and real wage growth.⁸ Moreover, the HWI rarely declines whereas the CPI and the WPI display periods with substantial deflation. During the deflationary phase after 1873, the CPI as well as the WPI fell substantially, while the HWI remained relatively stable. A similar pattern occurred during the two deflationary episodes between WW1 and WW2. The CPI and the WPI declined more strongly than hourly wages. By contrast, and in line with findings

⁶The end date is chosen because the nominal wage index for 2014 was not yet available. Expanding the analysis to 2014 for the remaining indicators does not alter any of the results. Because of the sample range the analysis neither includes the effects of introducing negative interest rates nor of abandoning the minimum exchange rate in January 2015.

⁷All series are linked in growth rates rather than levels. If two sources overlap, it has been verified that the corresponding growth rates are highly correlated.

⁸To assess the correct real growth rate one should use a GDP deflator rather than the CPI.

FIGURE 1 — LEVEL AND DISTRIBUTION OF THE DATA



Note: The left panel shows log-levels indexed to zero at the first observation, where vertical lines indicate changes in monetary regimes. The right panel shows the density of the log-changes, in percent. The density is estimated using an Epanechnikov kernel.

in other countries (see e.g. Bernholz 2003, p. 3), the largest and most persistent increases in all nominal variables occurred in the 20th century during fiat money regimes.

The second panel of Figure 1 shows the estimated density of the log-changes of all indicators, in percent. We see that changes in the CPI, WPI and NGDP are quite symmetrically distributed. This supports Honoré et al. (2012) who find no relevant downward nominal price rigidities for Switzerland based on CPI micro data. Only the distribution of HWI changes appears to be positively skewed and most of the mass is concentrated in positive territory. This confirms the visual impression that wage cuts are rare relative to wage increases and supports Fehr and Götte (2005) finding relevant downward nominal wage rigidities for Switzerland during a low-inflation period. Table 1 shows the skewness of the distribution for each indicator across the various monetary regimes. The HWI is the only indicator where the distribution is positively skewed under all monetary regimes.

Table 1 gives the average growth rates during various monetary regimes. During the period before WW1 consumer prices did not rise much, on average. The mean CPI inflation rate amounted to -0.58% under competing currencies and to 0.66% under bimetallism. During the World War period, the average inflation rate was higher. However, Figure 1 shows that this period was characterised by high inflation during WW1, two deflationary episodes in the inter-war period and somewhat higher inflation in WW2. Thereafter, inflation remained higher than what was observed before. This was the case with fixed

TABLE 1 — DESCRIPTIVE STATISTICS

	CPI			WPI		
	μ	σ	γ	μ	σ	γ
Competing currencies	-0.58	10.49	-1.47	-1.42	10.70	-0.90
Bimetallism	0.66	8.67	-0.20	0.30	5.56	-0.23
World War period	2.29	8.05	0.28	2.27	14.48	0.09
Bretton Woods	2.32	2.11	0.02	0.98	3.26	0.80
Monetary targeting	3.21	2.48	0.84	1.44	4.10	1.58
Flexible inflation targeting	0.68	0.81	0.16	0.41	1.96	-0.45

	HWI			NGDP		
	μ	σ	γ	μ	σ	γ
Competing currencies	1.53	1.24	0.03	—	—	—
Bimetallism	1.65	1.91	1.24	3.18	4.67	0.15
World War period	3.59	7.41	1.54	3.26	9.04	-0.86
Bretton Woods	5.50	2.88	0.24	7.98	3.91	0.63
Monetary targeting	3.95	2.90	1.17	4.30	3.24	-0.35
Flexible inflation targeting	1.36	0.55	0.65	2.70	2.29	-0.16

Note: Mean (μ), standard deviation (σ), and skewness (γ) of log-changes, in percent.

exchange rates under the Bretton Woods System (2.32%) as well as with flexible exchange rates under monetary targeting (3.21%). Under the current monetary regime, flexible inflation targeting, average CPI inflation declined to values last observed before WW1 (0.68%). Recall that the SNB currently defines price stability as an annual increase in CPI inflation between 0% and 2%, which was also in line with the implicit price stability objective under monetary targeting. CPI inflation was on average consistent with this target range only under flexible inflation targeting and under bimetallism. Qualitatively, the other indicators confirm these findings. Flexible inflation targeting provided very low growth rates for the WPI, HWI and NGDP, largely comparable with the bimetallic standard. Under competing currencies, the average growth rate was negative for the CPI and the WPI but positive for the HWI. During the other fiat currency regimes, the growth rates were on average higher according to all indicators.

Average growth rates over long sample periods possibly conceal persistent episodes with high inflation which are offset by deflationary episodes. Figure 1 shows that, in particular before WW1, this was the case for the CPI and the WPI.⁹ If the low average rate of

⁹This is in line with Bernholz (2003) suggesting that before WW1, despite long-lasting fluctuations, the CPI level did not exhibit a long-term trend.

inflation is because of offsetting periods with inflation and deflation, we would expect that inflation is rather volatile. Table 1 shows that inflation for both, consumer and wholesale prices, was very volatile before WW1 but the volatility declined under the fiat currency regimes after WW2. Under flexible inflation targeting, the volatility even declined to all-time lows for all indicators.

The lower volatility after the World War period can have different causes. Bordo and Filardo (2005) suggest that volatile supply shocks make up for a larger share of the variation during the early sample period due to changes in the consumption basket. Meanwhile, Cogley and Sargent (2015) control for measurement error only in the retrospective estimates of the CPI suggesting that these measurement errors are not present in the post-WW2 period. However, the declining volatility may also reflect a more stable monetary background. While supply shocks and measurement errors are likely to affect the short-run dynamics of the indicators, a well managed monetary regime is likely to lead to a more stable trend. Therefore, in the subsequent analysis, I apply a statistical model to disentangle idiosyncratic from persistent fluctuations.

4 Methodology

Nominal stability is measured in terms of the trend change, defined as the best long-run forecast given the current state of information, following Beveridge and Nelson (1981) and the bulk of the literature on trend inflation (see Ascari and Sbordone 2014, and references therein). The trend is estimated based on the univariate unobserved component-stochastic volatility model put forward by Stock and Watson (2007). This model controls for time-varying volatility in the short-term fluctuations over which the central bank has no control while also allowing for time-varying volatility in the nominal trend. Moreover, it allows for shifts in the unconditional mean of the nominal indicator.¹⁰

Assume that the log-change of the indicator of nominal stability (π_t) can be decomposed into a permanent component and an idiosyncratic component:

$$\pi_t = \tau_t + \sqrt{\sigma_t^\eta} \eta_t \quad ,$$

¹⁰As Stock and Watson (2007) show, this model performed well for forecasting quarterly US inflation over various historical episodes.

where the permanent component (τ_t) follows a random walk process:

$$\tau_t = \tau_{t-1} + \sqrt{\sigma_t^\varepsilon} \varepsilon_t .$$

The two shock processes (η_t, ε_t) are assumed to be i.i.d. standard normal. The shock ε_t has a permanent effect on the indicator whereas the shock η_t has only a transitory effect. The stochastic volatility processes ($\sigma_t^\varepsilon, \sigma_t^\eta$) are modelled as geometric random walks with independent shocks following a normal distribution:

$$\log(\sigma_t^\varepsilon) = \log(\sigma_{t-1}^\varepsilon) + \sqrt{\gamma^\varepsilon} \nu_t^\varepsilon$$

$$\log(\sigma_t^\eta) = \log(\sigma_{t-1}^\eta) + \sqrt{\gamma^\eta} \nu_t^\eta$$

The degree at which the stochastic volatility changes over time is governed by the two parameters $\gamma^\varepsilon, \gamma^\eta$.

Several aspects of the model are informative of the evolution of the nominal trend. The estimated permanent component is equivalent to the best long-run forecast of the model at time t given the information at the sample end T . It abstracts from short-term fluctuations over which the central bank has no control and can be interpreted as the implicit nominal target (Ascari and Sbordone 2014). But also, the standard deviation of the permanent shocks ($\sqrt{\sigma_t^\varepsilon}$) is interesting as it measures how well the nominal trend was anchored. It has the advantage that it is independent from the actual level of the nominal trend.

Two other measures used in this paper are closely related to Cogley and Sargent (2015). First, nominal stability is measured by the conditional forecast error standard deviation of the indicator level given all data. Let $\omega_t = [\tau_t, \sigma_t^\varepsilon, \sigma_t^\eta]$ collect the states at time t and $W = [\gamma^\varepsilon, \gamma^\eta]$ the coefficients governing the stochastic volatility processes, while $p_t = \pi_t + p_{t-1}$ gives the level of the indicator. Conditional on the states and parameters, the conditional forecast error standard deviation can be written as (see Cogley and Sargent 2015, Appendix B for a derivation):

$$\sigma[p_{t+h} - p_t | \omega_t, W] = \sqrt{\sigma_t^\varepsilon \sum_{j=1}^h (h-j+1)^2 \exp(j\gamma^\varepsilon/2) + \sigma_t^\eta \sum_{j=1}^h \exp(j\gamma^\eta/2)}$$

This statistic measures how uncertain the evolution of the future price level was under various monetary regimes. Second, we can calculate the probability that the nominal trend remained in a range of nominal stability at some future horizon. Let I_{stable} be an indicator variable assuming 1 if the permanent component h periods ahead remains within $[\underline{\tau}, \bar{\tau}]$ and zero otherwise, given a sequence ξ_t^h of potential future shocks $\{\varepsilon_s, \nu_s^\varepsilon\}_{s=t+1}^{t+h}$. A measure of the likelihood of nominal stability can therefore be calculated as:

$$Pr[\underline{\tau} < \tau_{t+h} < \bar{\tau} | \omega_t, W] = \int I_{stable}(\tau_{t+h}(\xi_t^h, \omega_t, W)) p(\xi_t^h) d\xi_t^h$$

By assumption, the density of the shocks $p(\xi_t^h)$ is independent normal. For every time period, this probability can be approximated by Monte Carlo integration. Cogley and Sargent (2015) calculate instead the probability that the price level declines at a five year horizon. The measure preferred here closely matches today's monetary policy strategy of the SNB to stabilise inflation in a specific range in the medium term. The focus on the nominal trend ensures that the analysis is not driven by short-term fluctuations over which the central bank has no or limited control.

The model is estimated using Bayesian methods; I use the algorithm proposed by Del Negro and Primiceri (2013) applying the procedure by Kim et al. (1998) to estimate the model with stochastic volatility (a sketch of the MCMC algorithm is given in the Appendix).¹¹ The prior distributions are standard. Priors for $\gamma^\eta, \gamma^\varepsilon$ are distributed as independent inverse-Gamma. The priors for the initial states $(\tau_0, \log(\sigma_0^\eta), \log(\sigma_0^\varepsilon))$ are assumed to be normally distributed. The parametrisation implies only weakly informative priors for the initial states (see Appendix for a discussion of the specific choices). Notice that Stock and Watson (2007) calibrate the parameters controlling the smoothness of the stochastic volatility process $(\gamma^\eta, \gamma^\varepsilon)$ whereas these coefficients are estimated in this paper. The prior distributions are parameterised so that their means correspond to the calibrated value by Stock and Watson (2007). The analysis is based on 20,000 iterations of the MCMC algorithm where the first 5,000 iterations are discarded for convergence.

¹¹I thank Dimitris Korobilis for sharing his Matlab code to estimate the model.

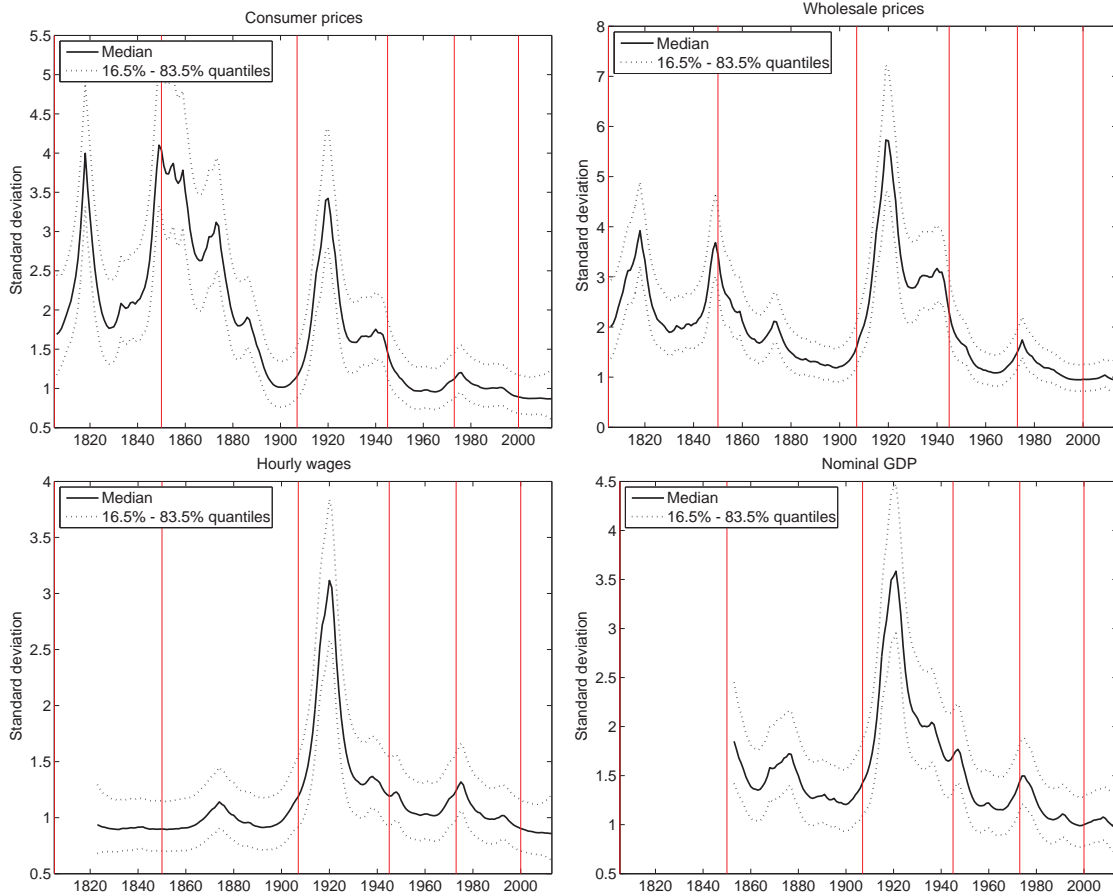
5 Results

The estimates suggest that the fiat currency regimes after WW2 provided a stable monetary background, relative to the metal-currency regimes before WW1. Figure 2 shows that the volatility of permanent shocks to the CPI, WPI and NGDP, was at least as high under competing currencies and bimetallism as after WW2. In particular, after the volatility of the World War period, the Bretton Woods System led to a quick decline in the volatility of permanent shocks suggesting that the nominal trend became increasingly anchored. Towards the end of the Bretton Woods System, the volatility increased somewhat but still remained relatively low. After the Bretton Woods System was abandoned, the volatility declined gradually under monetary targeting and assumed historically low values under flexible inflation targeting. The results based on the HWI support that flexible inflation targeting provided a very stable nominal trend. However, according to this indicator, competing currencies and bimetallism before WW1 performed equally well as flexible inflation targeting.

The uncertainty about the level of the variables five years ahead tells a similar story (see Figure 3). This uncertainty was higher under the metallic regimes before WW1 than under the fiat money regimes after WW2. Under flexible inflation targeting, it fell to historically low values for the CPI, WPI and NGDP, whereas for the HWI, it was as low as under the metallic standards before WW1. This suggests that, except for hourly wages, it was more difficult to predict nominal measures over the next five years under metallic regimes before WW1 than under fiat currency regimes. All indicators suggest that the price level uncertainty was particularly large during the world war period.

Figure 4 shows the posterior probability that the nominal trend remained within the nominal stability range at a horizon of five years. For the CPI, this stability range amounts to the SNB's current definition of price stability ($[0\%, 2\%]$), whereas for the other indicators no official target ranges exist. To account for the fact that the indicators have different average growth rates, the CPI target range is adapted by subtracting the average growth rate of the CPI and adding the average growth rate of the various indicators. According to the CPI flexible inflation targeting performed equally well or better than the metallic regimes before WW1. We observe three periods with an elevated posterior

FIGURE 2 — STANDARD DEVIATION PERMANENT SHOCKS

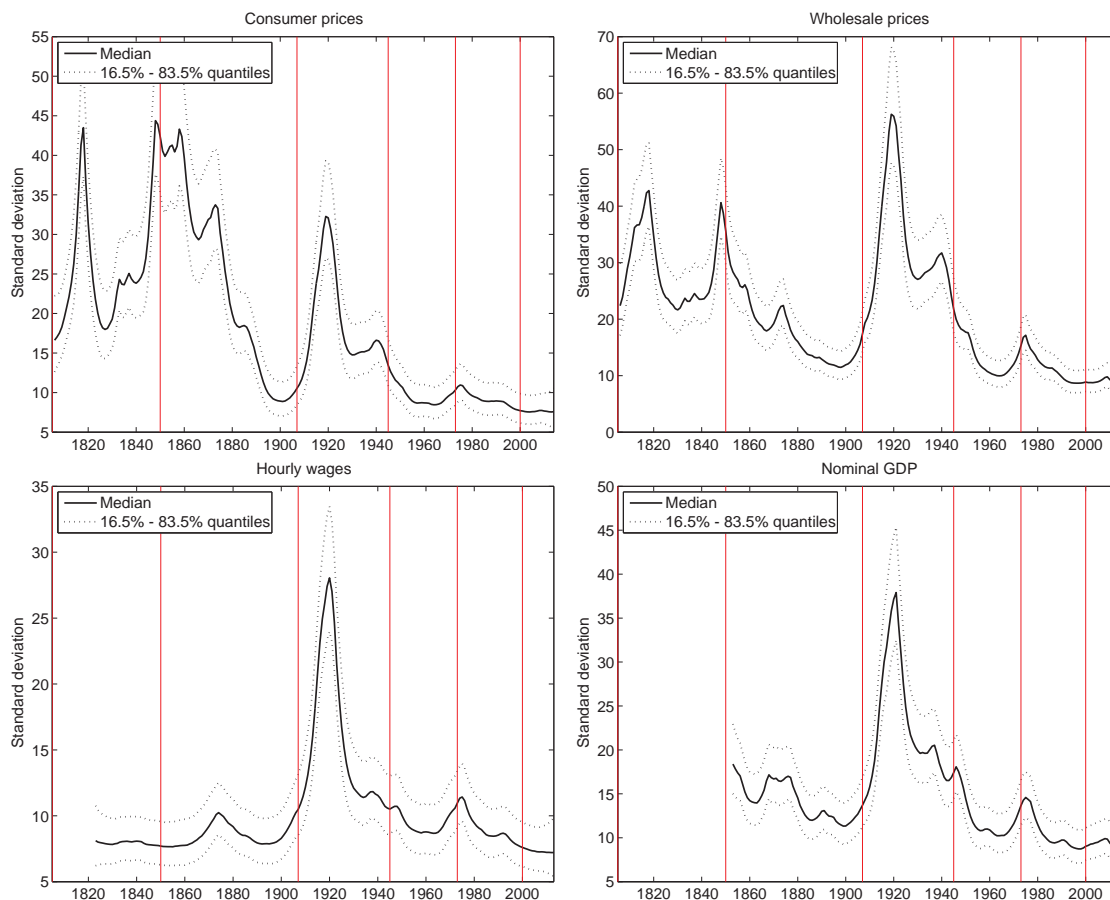


Note: Estimated standard deviation of permanent shocks ($\sqrt{\sigma_{\tilde{\pi}}}$). Red vertical lines represent changes in monetary policy regimes.

probability of nominal stability. The first starts in the mid-1880s and lasts until WW1. The second corresponds to the early Bretton Woods period. The last starts by the end of monetary targeting and largely corresponds to the flexible inflation targeting period. Measured by the posterior median for the CPI, the flexible inflation targeting period provided the highest probability of nominal stability over the last two centuries. The other indicators confirm that the largest probability of nominal stability occurred under flexible inflation targeting. However, for the WPI and NGDP, the probability increased somewhat earlier during monetary targeting and, for the HWI, we observe a similar episodes under competing currencies and bimetallism before WW1.

On average, flexible inflation targeting performed well in providing nominal stability compared to the other monetary regimes. The first panel of Table 2 shows that the posterior probability of nominal stability was on average highest under flexible inflation

FIGURE 3 — LEVEL UNCERTAINTY

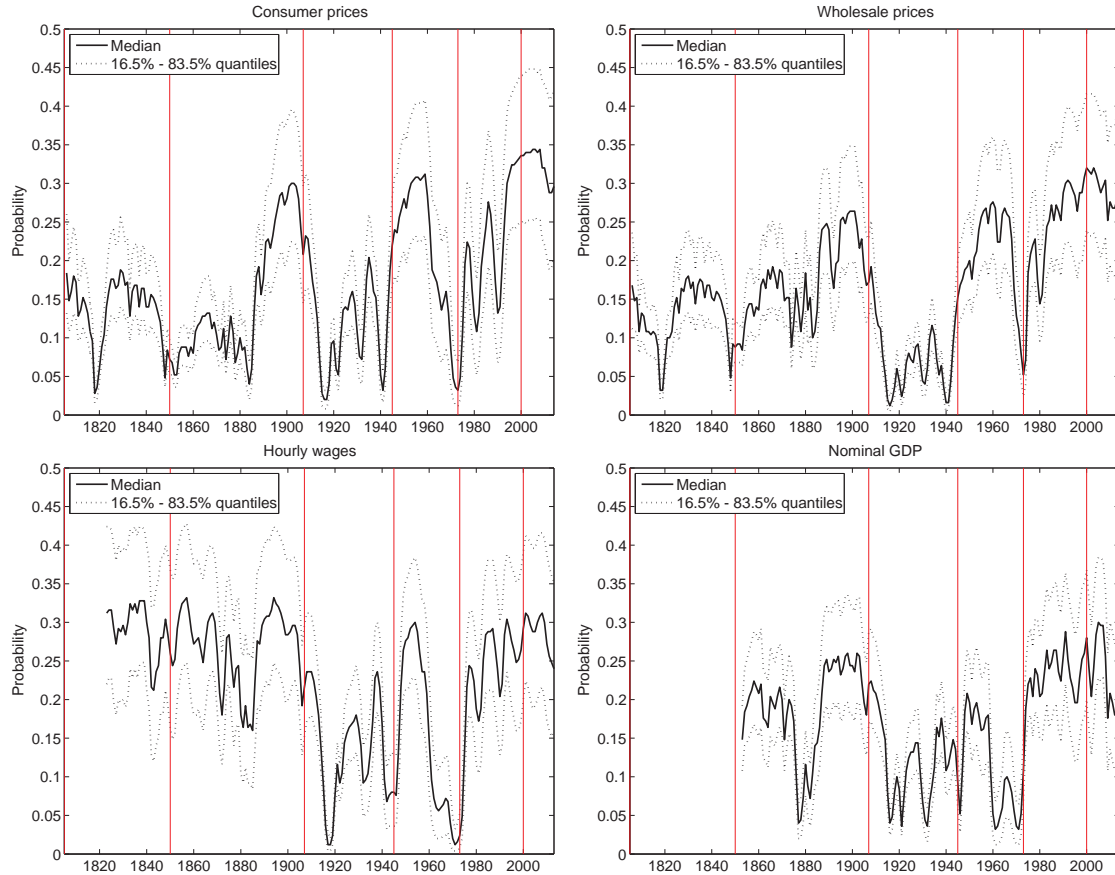


Note: Conditional forecast error standard deviation for the levels of the indicators at a forecast horizon of five years ($\sigma[p_{t+h} - p_t | \omega_t, W]$). Red vertical lines represent changes in monetary policy regimes.

targeting for the CPI, WPI and NGDP. The other regimes generally display a lower probability of nominal stability. The only exception are the metal-currency regimes before WW1 which, according to the HWI, exhibited a probability of nominal stability roughly equal to flexible inflation targeting.

Today's definition of nominal stability is a range centered around 1% for CPI inflation. Recall that the SNB justifies the positive range by measurement error due to quality changes (see Swiss National Bank 2015). In the absence of such measurement issues, the SNB would therefore target an inflation rate in a range around 0%. On the one hand, this may lead to an unfair comparison because measurement error due to quality changes are likely a more serious issue after WW2 than before. On the other hand, the SFSO has improved CPI measurement in the last 15 years in several ways to take quality changes into account (see e.g. SFSO 2011). To avoid a potential bias towards the current

FIGURE 4 — PROBABILITY OF NOMINAL STABILITY



Note: Probability that the nominal trend is in line with today's definition of nominal stability at a horizon of five years ahead ($Pr[\underline{\tau} < \tau_{t+h} < \bar{\tau} | \omega_t, W]$). The definition of nominal stability differs among the various indicators. For CPI inflation, the official target range amounts to $[0\%, 2\%]$, whereas, for the other indicators, no official target ranges exist. To account for the fact that the indicators have different trend growth rates, the CPI target range is adapted by subtracting the average growth rate of the CPI and adding the average growth rate of the various indicators. To obtain a stability range that would be applied in practice, the numbers are rounded to half a percentage point for the WPI ($[-0.5\%, 1.5\%]$), the HWI ($[1.5\%, 3.5\%]$) and NGDP ($[3\%, 5\%]$). Red vertical lines represent changes in monetary policy regimes.

monetary policy regime, we can define an alternative nominal stability range around 0% CPI inflation.¹² The results were replicated for a lower definition of nominal stability amounting to $[-1\%, 1\%]$ for CPI inflation. Qualitatively, the results prove robust to this alternative and are therefore not shown for reasons of brevity.

The model can be used to judge whether a monetary regime exhibited an inflation or deflation bias by looking at the posterior probability that the nominal trend exceeded or fell short of the nominal stability range five years ahead. The second and third

¹²This exercise does not imply that the SNB should lower its target to zero CPI inflation. Indeed, a higher inflation target is often justified also because it makes the zero lower bound on nominal interest rates less likely to bind (see e.g. Summers 1991, Reifschneider and Williams 2000) or because of downward nominal wage rigidities.

TABLE 2 — AVERAGE PROBABILITY OF NOMINAL STABILITY

	CPI	WPI	HWI	NGDP
<i>Probability of nominal stability $Pr[\underline{\tau} < \tau_{t+h} < \bar{\tau} \omega_t, W]$</i>				
Competing currencies	0.14 [0.13, 0.16]	0.13 [0.12, 0.15]	0.30 [0.26, 0.34]	—
Bimetallism	0.15 [0.14, 0.17]	0.18 [0.16, 0.19]	0.27 [0.25, 0.30]	0.20 [0.18, 0.21]
World War period	0.12 [0.11, 0.14]	0.07 [0.07, 0.08]	0.14 [0.13, 0.16]	0.13 [0.12, 0.14]
Bretton Woods	0.23 [0.20, 0.26]	0.22 [0.19, 0.25]	0.16 [0.14, 0.18]	0.12 [0.10, 0.13]
Monetary targeting	0.21 [0.19, 0.24]	0.24 [0.21, 0.27]	0.23 [0.21, 0.27]	0.23 [0.21, 0.26]
Flexible inflation targeting	0.33 [0.28, 0.39]	0.30 [0.26, 0.35]	0.29 [0.24, 0.35]	0.24 [0.21, 0.29]
<i>Probability of overshooting $Pr[\tau_{t+h} > \bar{\tau} \omega_t, W]$</i>				
Competing currencies	0.37 [0.35, 0.40]	0.35 [0.33, 0.37]	0.19 [0.14, 0.24]	—
Bimetallism	0.37 [0.34, 0.39]	0.36 [0.34, 0.39]	0.25 [0.21, 0.28]	0.31 [0.28, 0.34]
World War period	0.50 [0.47, 0.53]	0.53 [0.51, 0.55]	0.46 [0.43, 0.49]	0.42 [0.39, 0.44]
Bretton Woods	0.57 [0.52, 0.62]	0.48 [0.43, 0.53]	0.71 [0.67, 0.76]	0.78 [0.74, 0.82]
Monetary targeting	0.62 [0.57, 0.68]	0.43 [0.38, 0.48]	0.51 [0.46, 0.56]	0.41 [0.36, 0.45]
Flexible inflation targeting	0.26 [0.19, 0.35]	0.31 [0.23, 0.38]	0.16 [0.10, 0.23]	0.19 [0.13, 0.25]
<i>Probability of undershooting $Pr[\tau_{t+h} < \underline{\tau} \omega_t, W]$</i>				
Competing currencies	0.48 [0.46, 0.51]	0.52 [0.49, 0.54]	0.51 [0.44, 0.58]	—
Bimetallism	0.48 [0.45, 0.51]	0.46 [0.43, 0.48]	0.48 [0.44, 0.52]	0.49 [0.46, 0.52]
World War period	0.37 [0.35, 0.40]	0.40 [0.38, 0.42]	0.39 [0.36, 0.42]	0.46 [0.43, 0.48]
Bretton Woods	0.20 [0.16, 0.25]	0.30 [0.26, 0.34]	0.13 [0.09, 0.16]	0.10 [0.07, 0.13]
Monetary targeting	0.16 [0.12, 0.20]	0.32 [0.28, 0.37]	0.25 [0.21, 0.30]	0.36 [0.31, 0.41]
Flexible inflation targeting	0.40 [0.31, 0.49]	0.39 [0.31, 0.47]	0.54 [0.45, 0.63]	0.56 [0.49, 0.64]

Note: Posterior median probability that the nominal trend (τ_{t+h}) is in line, above or below today's definition of nominal stability five years ahead. 16.5% and 83.5% quantiles are given in brackets. See also note to Figure 4.

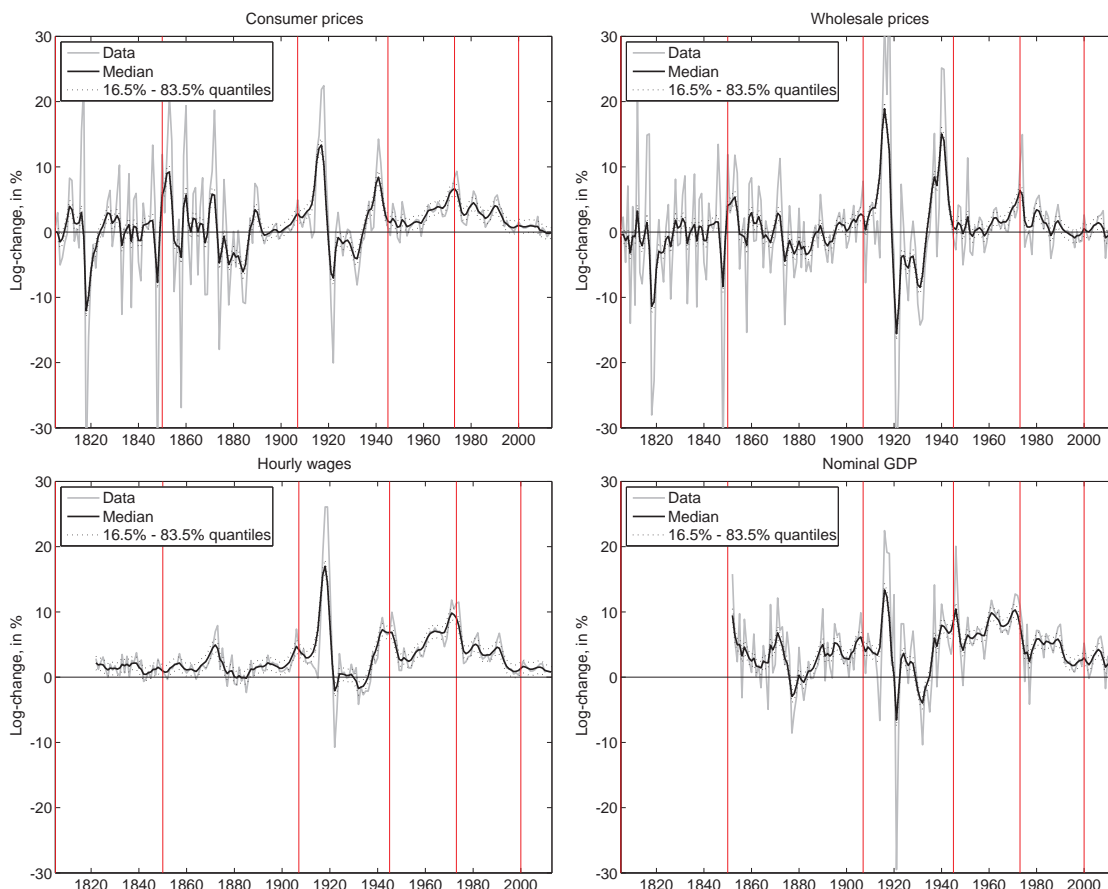
panels of Table 2 show that for all indicators under the Bretton Woods System and monetary targeting, the probability of overshooting the stability range is higher than the probability of undershooting. For example, for the CPI the median probability of overshooting the stability range amounted to 57% under Bretton Woods and to 62% under monetary targeting. The corresponding probabilities of undershooting the stability range amounted to only 20% and 16%, respectively. This suggests that, on average, the fiat currency regimes without an explicitly announced nominal anchor exhibited an inflation bias. As Baltensperger (2012) and Bernholz (2007) emphasise, the stability provided by the monetary targeting regime with flexible exchange rates was still a success in relative terms, against the backdrop of high inflation rates observed internationally. The results presented here are in line with this view by showing that the nominal trend remained relatively well anchored in terms of the standard deviation of the permanent shocks although at an elevated level in terms of the nominal trend.

The third panel of Table 2 shows that several regimes are associated with a relevant probability of undershooting today's nominal stability range. For all indicators the probability of undershooting the nominal stability range is higher than the probability of overshooting under flexible inflation targeting, bimetallicism and competing currencies. For CPI inflation, the probability of undershooting amounted to 48% under the metallic standards and to 40% under flexible inflation targeting.¹³ For the CPI and WPI the probability is smaller under flexible inflation targeting than under bimetallicism and competing currencies. Before WW2 the nominal trend for CPI, WPI and NGDP also exceeded the stability range regularly which is reflected in a relevant posterior probability of overshooting the nominal stability range.

Figure 5 shows the estimated permanent component of the nominal indicators. We see that deflation biases are different in nature under inflation targeting than under the metallic regimes. Under flexible inflation targeting, the nominal trend was low but stable. Under the metallic regimes, the deflation bias stems from several deflationary episodes which were only partly compensated by periods with a higher nominal trend. Therefore,

¹³For CPI inflation, Bordo and Filardo (2005) report for Switzerland a frequency of deflationary episodes of 36% between 1880 and WW1, 15% between 1950 and 1969 and 0% until 2002. Their exercise differs as they examine the frequency of CPI deflation, whereas, I examine the probability that future trend inflation is outside of the SNB's definition of nominal stability.

FIGURE 5 — PERMANENT COMPONENT



Note: Estimated permanent component of the indicators (τ_t). Red vertical lines represent changes in monetary policy regimes.

the persistent deflationary episodes before WW2 are discussed in more detail. The first deflationary episode started in 1817, against the backdrop of substantial deflation abroad. By 1821, Great Britain managed to return to a gold standard after convertibility was suspended in 1797 amid the Napoleonic War. The return to the gold standard triggered a deflationary episode in Great Britain but also affected the Old Swiss Confederation. This persistent deflationary episode is also visible in the WPI.

The second persistent deflationary episode started in 1873 and lasted for more than ten years, measured by the median permanent component of the CPI. Again this episode can be explained against the backdrop of international developments. In the early 1870s, Germany and other European countries adopted the gold standard and liquidated their silver currency reserves. The result was a strong deflation in Great Britain, which adopted the gold standard already in the early 19th century, and other countries because the

increased global demand for monetary gold was not matched by an equal increase in supply (Eichengreen 2008, p. 17).¹⁴ The bimetallic standard which prevailed in Switzerland did not prevent a prolonged deflationary episode during this move towards an international gold standard.

Although the World War period does not exhibit a deflationary bias on average, two more deflationary episodes occurred that were related to the corresponding metal standard. As the SNB suspended convertibility in WW1, the nominal trend picked up strongly, with trend growth rates of more than 10% for the CPI, HWI, and NGDP, and almost 20% for the WPI. After WW1 ended, the SNB reestablished the pre-war parity to gold. According to the CPI, WPI and NGDP, this implied that the nominal trend fell into negative territory. When the Great Depression hit in 1929, and the SNB held on to the gold standard until 1936, a second deflationary episode occurred. All estimated permanent components fell to negative values, with the HWI trend assuming only slightly negative values.

Bordo and Filardo (2005) compare such deflationary episodes for a large panel of countries and find that some of them were good because they were associated with positive growth rates. During these episodes many countries experienced productivity booms leading to falling prices under the gold standard. Indeed, if a deflationary episode stems from a productivity boom, nominal GDP should largely remain stable because lower prices are offset by higher real GDP growth.¹⁵ However, this differs from a deflation triggered by a reduction of the money supply relative to money demand, which occurs when various countries adopt the gold standard at the same time or when the central bank reestablishes the gold-parity after a substantial inflationary episode. In such cases, NGDP falls because the decline in the price level is not accompanied by higher real GDP growth.

Against this backdrop, the data set allows to shed light on three of the deflationary

¹⁴The literature does not fully agree why the silver standard or the bimetallic systems were replaced by the gold standard. Some authors argue that the bimetallic system, which was in particular implemented by France, tended to be unstable since changes in the relative price of silver and gold tended to drive one of the two currencies out of circulation. Other authors, such as Eichengreen (2008) emphasise that network externalities may have been a major force pushing countries towards adopting uniformly the gold standard.

¹⁵Productivity changes are a major argument for adopting a NGDP target (see e.g. Sumner 2014). Stabilising NGDP accounts for the fact that prices may fluctuate in response to productivity shocks but a central bank may not want to respond to these shocks. In other words, if positive productivity shocks lead to lower prices but higher real GDP, nominal GDP remains unchanged. By contrast, if a deflationary episode occurs because of a restrictive monetary policy stance rather than a positive supply shock nominal GDP declines.

episodes for which the sample contains data on the consumer prices, hourly wages and nominal GDP. Productivity gains do not fully explain the deflationary episodes. The permanent component of NGDP fell to negative territory during the deflationary episodes starting in the 1870s and during the inter-war period. The largest declines are observed for the WPI and CPI trend, while the NGDP trend fell by less. Meanwhile, trend HWI fell even less than the NGDP trend. This suggests that real wages increased considerably during a time with a restrictive monetary background.

This view is also supported by looking at the evolution of employment during these periods. Between 1870 and 1880, the number of employed workers (excluding part-time workers) increased by an annualised 1%.¹⁶ However, between 1880 and 1888, employment fell by an annualised 0.1%. Between 1888 and 1900, when the NGDP trend picked up again, employment grew by 1.5%. But also, the inter-war deflations were associated with falling employment.¹⁷ Not surprisingly, perhaps, employment fell during WW1 by 0.2%. However, from 1918 to 1921, during the years of the most pronounced decline in NGDP, employment fell by an annualised 10.1%. Afterwards, employment recovered quickly and grew by 3.4% until 1929. During the last deflationary episode starting with the Great Depression until the SNB depreciated the Swiss franc in 1936, employment fell by 7.6%. Afterwards, employment grew by an annualised 16.4% until WW2.

6 Conclusions

Many central banks in industrialised economies currently aim to stabilise inflation in the medium term. Often, this aim is made explicit by announcing a target or target range for a measure of consumer price inflation. From a historical perspective the Swiss National Bank has only recently explicitly announced such a target, although a price stability objective was implicit since the failure of the Bretton Woods System. This paper applies recent statistical methods on a data set for consumer prices, wholesale prices, hourly wages and nominal GDP to compare the performance of Swiss monetary regimes over the last two centuries.

The narrative analysis suggests that a fiat currency regime can perform well in terms of

¹⁶The employment data are available only for a couple of years and stem from HSSO (2015), Table F9.

¹⁷The data stem from HSSO (2015), Table F29a.

providing nominal stability. In contrast to other fiat currency regimes with no explicitly announced nominal anchor, flexible inflation targeting did not exhibit an inflation bias. Measured by the SNB's official definition of price stability we even observe a slight deflation bias. This reminds of the performance of metallic regimes before WW2. However, the metallic regimes performed worse because they featured persistent deflationary episodes accompanied by falling employment and falling nominal GDP amid almost unchanged hourly wages. To sum up, the results suggest that fiat currency regimes, in particular, flexible inflation targeting, have provided a relatively stable monetary background in Switzerland compared to the metallic regimes during and before the world war period.

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Appendix A Prior specification

The prior distributions for the initial states are parameterised as follows.

$$\tau_0 \sim N(0, 40)$$

$$\log(\sigma_0^\eta) \sim N(0, 4)$$

$$\log(\sigma_0^\varepsilon) \sim N(0, 4) \ .$$

This parametrisation makes the prior only weakly informative about the initial nominal trend and variances. The prior distributions for the initial states are centered around zero with a large variance because I lack a strong prior belief about the initial trend rate and initial stochastic volatilities. Furthermore, I set:

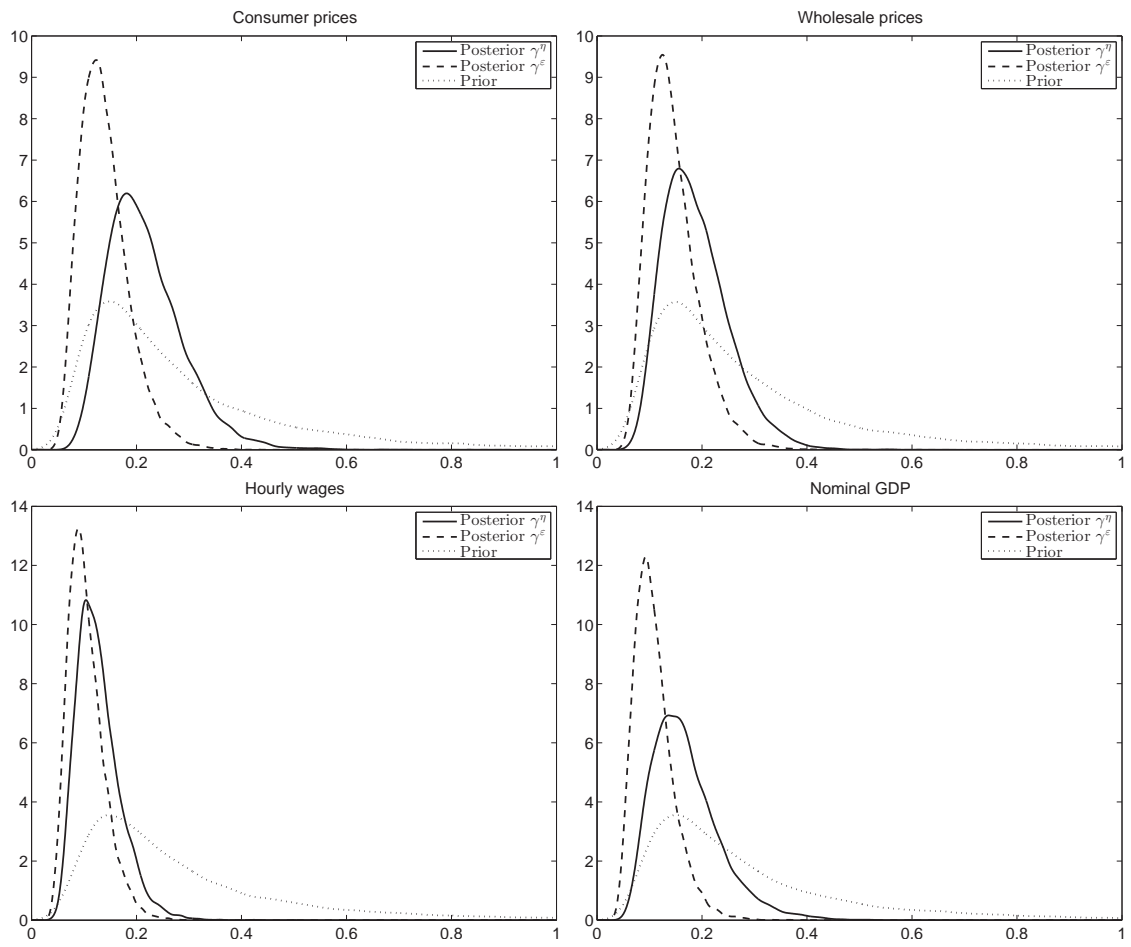
$$\gamma^\eta \sim IG(2.5, 0.5)$$

$$\gamma^\varepsilon \sim IG(2.5, 0.5) \ .$$

This sets the prior mean on the values calibrated by Stock and Watson (2007) ($\gamma^\eta = \gamma^\varepsilon = 0.2$) while remaining relatively uninformative. Figure 6 shows the prior and posterior distributions for these parameters. We see that the posterior is narrower than the prior and, for all variables except the HWI, the posterior-mode is clearly lower for γ^η than for γ^ε .

I experimented with other prior parameterisations. In particular, I imposed more information by calibrating $\gamma^\varepsilon = \gamma^\eta = 0.2$ as in Stock and Watson (2007). Then, I imposed less information by increasing the dispersion of the inverse-Gamma distribution, while leaving the mean unchanged. Finally, I used prior distributions with higher and lower means. The main results remained qualitatively the same and therefore these robustness checks are not reported for brevity.

FIGURE 6 — PRIOR AND POSTERIOR OF γ^ε AND γ^η



Appendix B MCMC algorithm

This section briefly sketches the MCMC algorithm to simulate draws from the posterior distribution. Notice that the model is a special case of Primiceri (2005). Stochastic volatilities are drawn taking into account the correction in Del Negro and Primiceri (2013).

Step 1 Initialise the parameters of the model

Step 2 Conditional on the data, initial states and stochastic volatilities sample $\tau^T = \{\tau_t\}_{t=1}^T$ using the Carter and Kohn (1994) algorithm. Obtain ε^T using $\varepsilon_t = \pi_t - \tau_t$

Step 3 Conditional on τ^T , sample the stochastic volatilities $\sigma^{\eta,T}$ following Kim et al. (1998)

Step 4 Conditional on ε^T , sample the stochastic volatilities $\sigma^{\varepsilon,T}$ following Kim et al. (1998)