

Jokipii, Terhi; Nyffeler, Reto; Riederer, Stéphane

Article

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ORIGINAL ARTICLE

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Exploring BIS credit-to-GDP gap critiques: the Swiss case

Terhi Jokipii^{*} , Reto Nyffeler and Stéphane Riederer

Abstract

A growing body of literature has highlighted two important caveats to the credit-to-GDP gap as advocated by the Bank for International Settlements (BIS). The first relates to the approach used to normalise credit (i.e. dividing nominal credit by GDP). In this regard, critics have argued that GDP movements, that may or may not be relevant, run the risk of affecting a normalised measure of credit. The second relates to the use of the Hodrick-Prescott (HP) filter to estimate the gap's trend component. In this regard, critics have emphasised several measurement problems associated with using the HP filter. In this paper, we assess the relevance of these critiques for Switzerland. Our findings show that despite its drawbacks, the BIS gap is a reliable measure of excess credit in Switzerland. Alternatives do not provide clear advantages, rather they are considerably more complex to estimate and come with their own set of pitfalls. For policymaking purposes, the BIS gap's signal should be complemented with narratives based on a broader set of credit metrics to ensure that an all-encompassing risk assessment is made.

Keywords: BIS gap, Credit-to-GDP, Macroprudential policy, HP filter

JEL classification: E61, E44, E51, G01, G21

1 Introduction

Strong credit growth has preceded many historic episodes of financial instability. Most recently, in the run up to the global financial crisis, strong credit growth resulted in high leverage and ultimately the materialisation of systemic banking crises. Identifying and measuring “excess” credit as precisely as possible has therefore become a priority among academics and policy makers alike (see among others Jimenez & Saurina, 2006; Dell’Ariccia & Marques, 2006 & Dell’Ariccia et al., 2016; Drehmann et al., 2012, Schularick & Taylor, 2012; Jordà et al., 2013 Aikman et al., 2015).

A commonly adopted excess credit measure proposed by Borio and Lowe (2002) is the credit-to-GDP gap indicator. It is estimated as the credit-to-GDP ratio's deviation from a one-sided Hodrick-Prescott (Hodrick & Prescott, 1980; Hodrick & Prescott, 1997) filter (hereafter the HP filter) with a large smoothing parameter

(400,000 for quarterly data). The credit-to-GDP ratio provides credit volume normalisation to allow credit demand and credit supply to grow in line with the economy's size. The credit-to-GDP ratio's deviation from its long-term trend (the credit-to-GDP gap) accounts for possible changes in the long-run level of the ratio due to, for example, financial deepening. Conceptually, the credit-to-GDP gap is based on Kindleberger (2000) and Minsky's (1982) views on the mechanism that leads to crisis. Empirically, it is consistent with the historical link between unusually strong credit growth and banking crisis. However, the credit-to-GDP gap is essentially a statistical measure and is therefore not necessarily an equilibrium concept of credit for the economy (see Drehmann et al., 2010; Drehmann & Tsatsaronis, 2014). It can identify excesses in the credit market provided that the build-up of such excesses follows patterns observed in the past. By nature, the reliability of such an indicator for measuring excess credit will be limited in the presence of sudden structural changes that affect the sustainable path

* Correspondence: Terhi.Jokipii@snb.ch

Financial Stability Department, Swiss National Bank, Börsenstrasse 15, CH-8022 Zürich, Switzerland



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for leverage in an economy (e.g. a permanent decrease in economic growth or interest rates). Moreover, the signal should be interpreted with caution during boom phases that are longer lasting than those observed in the past.

The international literature has consistently demonstrated the credit-to-GDP gap's early warning properties and has highlighted its status as the single best early warning indicator. In assessing its average performance for a group of countries, one set of authors has confirmed it to be the single leading indicator for systemic banking crises associated with excessive credit growth (Alessi & Detken, 2011; Borio & Drehmann, 2009 and Drehmann et al., 2010, 2011). Similarly, at the individual country level, the gap has gained support with authors documenting its reliability (Denmark: Harmsen, 2010; Germany: Deutsche Bundesbank, 2012; the Netherlands: De Nederlandsche Bank, 2010; Norway: Gerdrup et al., 2013; Portugal: Bonfim & Monteiro, 2013; Sweden: Juks & Melander, 2012; and the United Kingdom: Giese et al., 2014). However, it should be noted that the credit-to-GDP gap has performed less well as a financial crisis predictor in Belgium (Keller, 2011) and Austria (Eidenberger et al., 2013).

As a reliable early warning indicator and measure of cyclical risk, the credit-to-GDP gap has become an integral part of macroprudential policy. In fact, the Basel Committee for Banking Supervision (BCBS) singled out the credit-to-GDP gap put forward by the BIS as a useful guide for making countercyclical capital buffer (CCyB) decisions (BCBS, 2010). It has been argued that the signal provided is one that comes early enough, ensuring sufficient time for authorities and banks to react. Moreover, the signal does not fluctuate unnecessarily. Rather, it provides a relatively stable signal that is useful in reducing uncertainty and allowing for decisive policy action.

Despite its broad acceptance, a growing body of literature has focused on highlighting and assessing two important critiques of the credit-to-GDP gap computed according to the BIS/BCBS approach (hereafter the BIS gap). The first, the normalisation critique, centres on the approach adopted to normalise credit, i.e. the definition of the relevant denominator of the credit-to-GDP ratio. Here, the literature has argued that the method adopted by the BCBS (dividing credit by nominal GDP) is problematic. Given that policy-relevant gaps are estimated in real time, subsequent statistical revisions to either credit or GDP can considerably affect the gap's quarterly signal (Edge & Meisenzahl, 2011). While credit revisions occur seldom in Switzerland, the frequency and intensity of revisions to Swiss GDP data renders the normalisation critique of particular relevance for Switzerland.

The second critique, the HP filter critique, questions the approach to estimate the long-run trend component¹. Here, the literature focuses on three challenges relevant to the calculation of the credit-to-GDP gap. First, it has been shown that depending on the data's starting point, trend estimations can vary considerably (Drehmann & Tsatsaronis, 2014), affecting gap estimates. Second, authors have questioned the reliability of basing policy decisions on real-time estimates (Canova, 1998; Pedersen, 2001), as considerable differences between gap estimates based on real-time estimates (one-sided) and those based on ex-post measures (two-sided) can arise (Farrell, 2016; Watson, 2007). Edge and Meisenzahl (2011) argue that these differences render the real-time estimates unreliable for policy purposes. Third, the credit-to-GDP gap has been shown to underestimate cyclical systemic risks (Lang and Welz, 2017 and Lang et al., 2019). This is particularly relevant during a long boom phase and in the subsequent bust phase.

In this paper, we explore the relevance of the BIS gap's normalisation and HP filter critiques for the Swiss case. Switzerland's debt to GDP level is very high both by historical and international standards. Most of this debt is mortgage related. Given the potential risks that high debt levels can pose for financial stability if cyclical risks on the mortgage and real estate markets correct,² accurately measuring excess credit is particularly important for Swiss policy makers. It can provide them with an assessment of the current state of the financial cycle and allow them to take counteracting measures.

Our findings show that despite its drawbacks, the BIS gap is a reliable measure of excess credit in Switzerland and should remain an integral part of the macroprudential decision-making framework. Alternatives do not provide clear advantages, rather they are considerably more complex to estimate and come with their own set of pitfalls. It is important, however, that the signal provided by the BIS gap is complemented with narratives based on a broader set of credit metrics to ensure that policy decisions are based on an all-encompassing assessment of risks.

In particular, on the normalisation critique, our analysis shows that the BIS gap performs as well as an alternative gap measure (hereafter the modified BIS gap), which replaces nominal GDP in the denominator with a "smoothed GDP" series. Smoothing is achieved by applying a two-sided HP filter to GDP. While the BIS gap is more sensitive to GDP variability, both from a point-in-time (i.e. influence of GDP revisions on past gap signals) and an over-the-time (i.e. impact of GDP variability on

¹For a detailed discussion of the use of the HP filter to de-trend credit measures, see Hamilton (2017) and Drehmann and Yetman (2018).

²The volume of credit (mainly mortgages) relative to GDP in Switzerland is one of the largest among OECD countries (Financial Indicators – Stocks: Private sector debt (oecd.org)).

the gap's real-time signal over time) perspective, the modified gap is subject to other important drawbacks. Through the approach adopted to smooth GDP, the modified BIS gap is subject to the end-point problem and is therefore revised each time new information becomes available, affecting its past values. Taking this additional effect into account, the total impact of GDP movements on past gap signals can be greater for the modified BIS gap than for the BIS gap. Moreover, our assessment of gap signals over time suggests that the modified BIS gap's signal consistently lags that of the BIS gap in the build-up phase of the financial cycle, indicating inferior early warning properties.

An analysis of the HP filter critique shows the following: (i) the start-point problem can have significant implications for the BIS gap's signal, but structural developments that occurred in Switzerland in the 1990s no longer affect the current signal. (ii) Improving the reliability of end-of-sample estimates comes at a price of greater complexity without providing clear advantages. (iii) As the current long-lasting boom phase in Switzerland has started to become part of the long-run trend, the BIS gap tends to underestimate cyclical risk in the current situation. However, its tendency to do so is comparable to the other filtering approaches assessed in this paper. In addition, it appears that the most pressing issue for the Swiss credit market has shifted from being one of excess credit growth to a credit quality issue. As a measure of excess credit, the BIS gap would not be expected to capture these risks. This further emphasises the need for policy makers to complement the BIS gap with other credit indicators to ensure a comprehensive assessment of whether developments in the credit market are sustainable or whether they are a source of aggregate vulnerability.

2 The Swiss credit-to-GDP ratio and associated credit-to-GDP gap

The credit-to-GDP ratio forms the basis for estimating the credit-to-GDP gap. In Switzerland, good quality data on both credit and GDP are available from 1965. Between 1965 and 2018, the credit-to-GDP ratio³ increases from 89 to 170% (Fig. 1)⁴.

³The stock of domestic credit (the sum of mortgages and credit to customers for all banks in Switzerland) is divided by GDP. GDP is the rolling four-quarter sum of Swiss nominal GDP.

⁴In this paper, non-bank domestic claims are not considered due to the relatively short length of the series and their lower frequency. We consider banks' domestic credit to non-financial customers, which accounts for roughly 92% of relevant broader domestic credit exposures as of 2018.12 (Source: Swiss National Bank (2018b), SNB). Relevant broader domestic credit includes loans to households and non-financial corporates, bonds and loans from foreign bank entities into the country. For the latter, we discard inter-company foreign loans, which are important in Switzerland, as their focus is mainly tax optimisation.

We observe particularly strong growth between the mid-1970s and late 1980s⁵. In Switzerland, this period coincides with the formation of a Swiss real estate and bank lending bubble. The build-up of risks was in part driven by measures taken by the Swiss National Bank (SNB), together with other central banks, to mitigate the impact of the stock market crash of 1987 and to stimulate economic growth. In particular, the SNB reduced interest rates, thereby increasing liquidity in the banking system (SNB, 1987). However, since this coincided with other important changes in the financial system⁶, the monetary supply increased even further. Speculative investments in the real estate market followed and drove prices up significantly (Baltensperger, 2007). Prices of single-family homes and apartments almost doubled between 1980 and 1990. Particularly strong growth occurred between 1987 and 1990 with annual growth rates of single-family houses averaging approximately 12% between 1988 and 1989⁷. The eventual bursting of the Swiss real estate and bank lending bubble in 1990 and the banking crisis that followed had major impacts on the domestic banking system⁸. Following the crisis, lending growth decreased and the credit-to-GDP ratio remained relatively subdued between 1990 and 2008 (Fig. 1). Since early 2009, momentum in the credit-to-GDP ratio has picked up again.

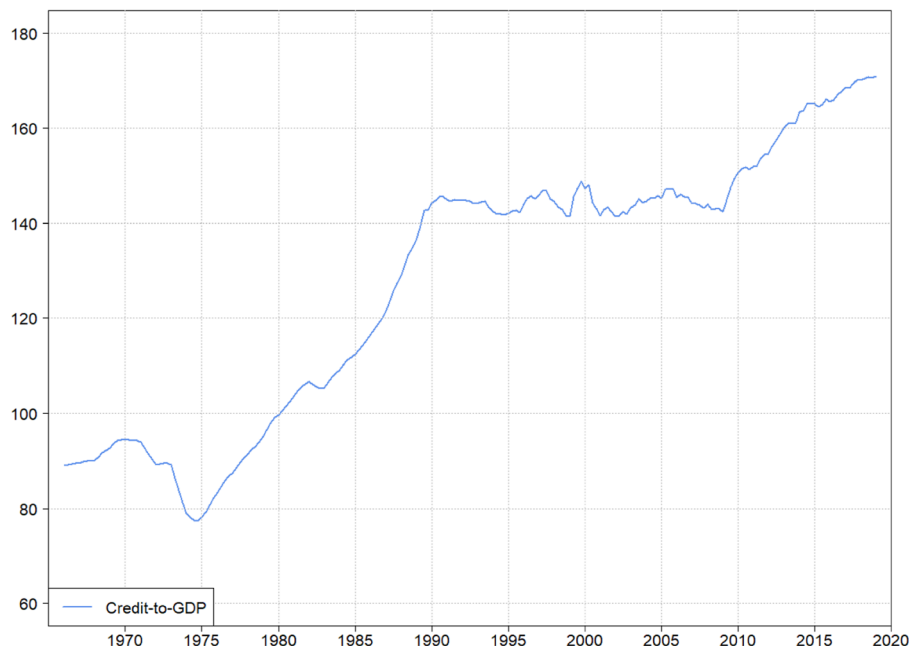
Drehmann and Tsatsaronis (2014) have argued that the signalling properties of a gap measure may not work well for countries that have undergone structural change. The authors show that since a gap estimate is based on the deviation of the ratio from its long-run trend, it is difficult to distinguish growing financial sector vulnerabilities from convergence to a new steady state. This is the case because the HP filter is applied to the full series, fitting a "best-guess" estimate through all available observations and even a disjointed or structurally broken series. As such, series that are subject to

⁵Between 1975 and 1989, average annual growth amounted to roughly 4% compared to an average annual growth of roughly 1.3% for the full sample period (1965–2018).

⁶In January 1988, new liquidity requirements came into force, affecting the supply and demand for money. The new rules put an end to month-end volatility and allowed banks to reduce their sight deposits at the central bank. Moreover, the SNB initiated the introduction of a new electronic payment system, Swiss Interbank Clearing (SIC), allowing commercial banks to reduce their liquidity needs for payments significantly.

⁷Quarterly growth of single-family houses amounted to almost 20% in 1988.

⁸The Spar- und Leihkasse Thun was the only institution that went bankrupt while many acquisitions and mergers also occurred. After the bankruptcy of Spar- und Leihkasse Thun, the SNB and Swiss Federal Banking Commission (SFBC) put pressure on large banks to take over smaller, troubled institutions to avoid negatively affecting the Swiss banking sector as a whole. The SFBC closed Spar- und Leihkasse Thun on October 3, 1991.



Sources: SECO, SFSO, SNB

Fig. 1 Evolution of the credit-to-GDP ratio in Switzerland:1965-2019

breaks or shifts, even if they are perfectly justified given economic developments, could distort signal reliability.

The Swiss credit-to-GDP gap (Fig. 2) appears to do well in capturing the build-up of credit excesses towards the end of the 1980s. This is evident from the gap's rapid increase between the mid-1980s and 1990. However, given the frequency and intensity of revisions to Swiss GDP data⁹ (Fig. 3) together with the structural impact that the crisis has had on the Swiss credit-to-GDP ratio, it is unclear how reliable the signal provided by a gap-type measure truly is for Switzerland. Thus, in what follows, we assess the reliability of the Swiss credit-to-GDP gap by focusing on the two main critiques associated with the gap measure: the normalisation critique and HP filter critique.

3 The normalisation critique

The normalisation critique centres on how the nominal credit level is converted to a magnitude that is

comparable both across time and across countries. According to the BCBS's approach, nominal credit is divided by nominal GDP. In Switzerland, GDP revisions occur regularly and for several reasons¹⁰. These revisions can be significant and can extend backwards, affecting several years. Hence, any indicator that employs Swiss GDP in its function is subject to considerable volatility stemming from revisions and adjustments. A normalised measure of credit therefore runs the risk of being affected by movements that may or may not be directly relevant. In this section, we assess the relevance of the normalisation critique by comparing the BIS gap's sensitivity to GDP volatility to an alternative gap measure that smooths the impact of GDP as it enters the denominator of the credit-to-GDP ratio.

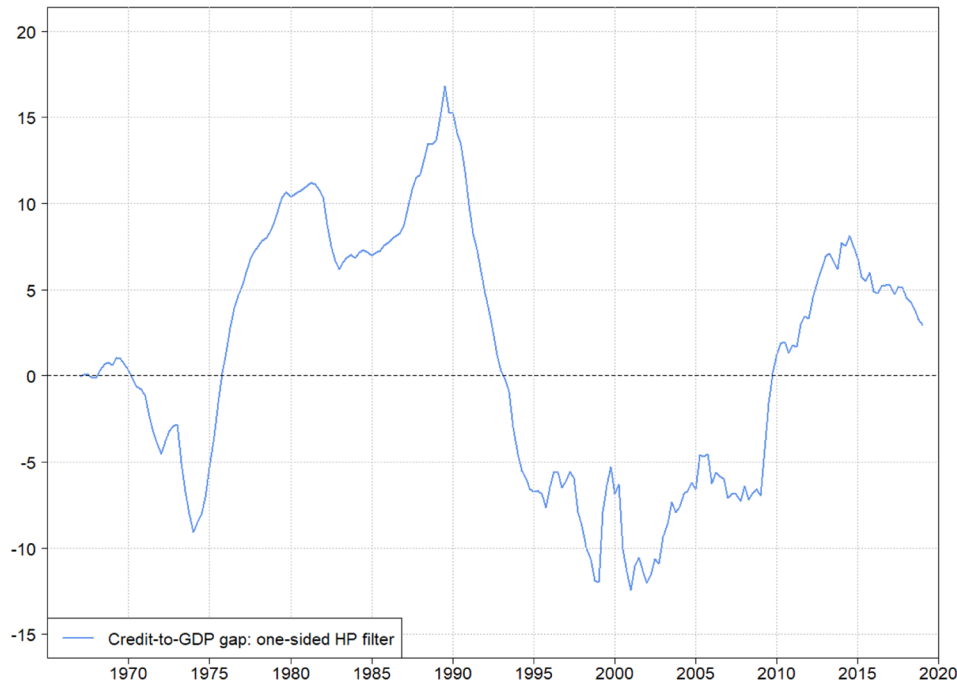
3.1 Two ways of estimating the gap: BIS gap vs. modified BIS gap

The BCBS provides methodological guidance for calculating the BIS credit-to-GDP gap (BCBS, 2010). In this framework, the quarterly credit-to-GDP ratio x_t^{BIS} is computed as the ratio between the stock of domestic credit c_t and nominal GDP summed over the four previous quarters.

⁹In Switzerland, two institutions are currently responsible for estimating Swiss GDP values: SECO and the Swiss Federal Office of Statistics (SFSO). SECO estimates and publishes quarterly values while the SFSO is responsible for annual figures. Release schedules vary by institution. SECO publishes quarterly figures at the end of the second or beginning of the third month of the following quarter while the SFSO publishes annual values for the previous year in September. Once annual estimates have been published or revised, the four affected quarters are adjusted to match the annual value.

¹⁰Revisions to the Swiss credit series seldomly occur.

In percentage points



Note: The Swiss credit-to-GDP gap is estimated according to the BCBS guidelines. The gap denotes the deviation of the credit-to-GDP ratio from its long-run trend. The long-term trend is estimated using a one-sided HP filter with a large smoothing parameter (400,000). Figure 2 is estimated with data starting in 1965.

Fig. 2 The Swiss credit-to-GDP gap. In percentage points

$$x_t^{BIS} = \frac{c_t}{\sum_{t'=t-3}^t GDP_{t'}} \quad (1)$$

According to the BCBS guidelines, the BIS gap y_t^{BIS} is then estimated as the deviation of the ratio from its trend.

$$y_t^{BIS} = x_t^{BIS} - HP_{[1,t]}^{1s}(x_t^{BIS}), \quad (2)$$

where $HP_{[1,t]}^{1s}(x_t^{BIS})$ is the filtered value of x at time t using a one-sided HP filter with a smoothing parameter of 400,000¹¹ and where $[1, t]$ is the time interval used to run the filter.

¹¹The literature suggests that the appropriate lambda of the HP filter should be set according to the expected length of the cycle. As emphasised by Drehmann et al. (2012), credit cycles are significantly longer in length than the business cycle. Moreover, typical cycle lengths can vary significantly from country to country. Empirical analysis for a broad set of heterogeneous countries by Drehmann et al. (2010) reveals that a trend calculated using a lambda of 400,000 performs well in picking up the long-term trend in private-sector indebtedness. This corresponds to a financial cycle that is, on average, around four times as long as the business cycle.

To assess the relevance of the normalisation critique for the Swiss case, we compare the BIS gap with an alternative gap: the modified BIS gap. The modified BIS gap accounts for the normalisation critique by smoothing GDP before it enters into the equation denominator. Smoothing is achieved by applying a two-sided HP filter to GDP, which is annualised by multiplying quarterly GDP by four. The SNB has considered the modified BIS gap as a relevant metric in the measurement of excess credit (SNB, 2018a).

$$x_t^{ModBIS} = \frac{c_t}{HP_{[1,t]}^{2s}(4 \cdot GDP_t)}, \quad (3)$$

where $HP_{[1,t]}^{2s}(x_t^{ModBIS})$ is the filtered value of x at time t using a two-sided HP filter with a smoothing parameter of 1,600 and where $[1, t]$ is the time interval used to run the filter.

As before, modified BIS gap y_t^{ModBIS} is then estimated as the deviation of the ratio from its trend computed

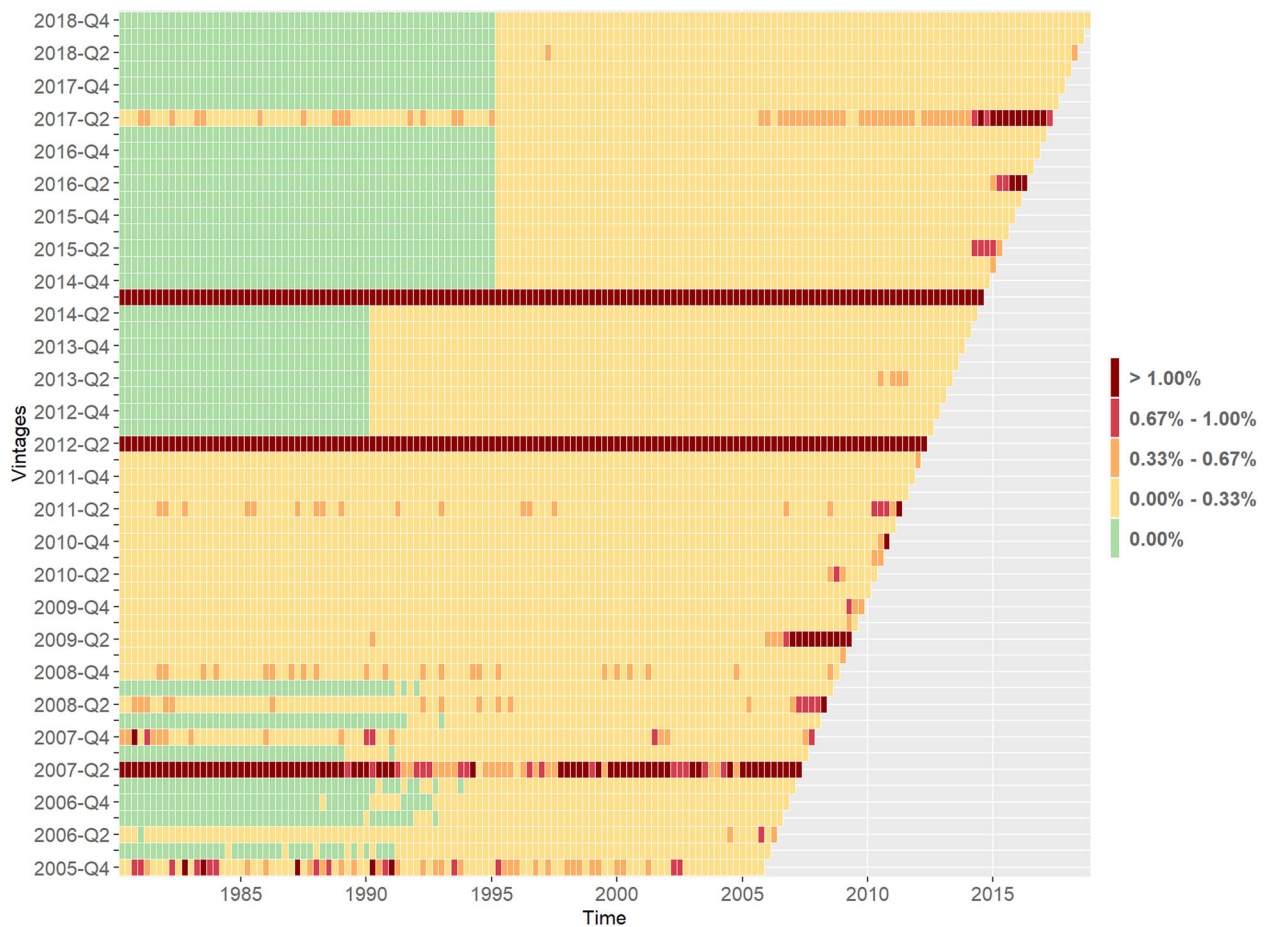


Fig. 3 GDP revisions in Switzerland since 2005. Quarter to quarter GDP absolute difference, in %. Sources: SECO, SFSO, SNB. Note: For each GDP vintage since 2005Q4, we present the relative difference, in absolute terms, relative to the previous quarter release. Dark red rectangles represent revisions of greater than 1% (11 GDP vintages concerned). Red rectangles represent revisions of between 0.66% and 1% (4 additional GDP vintages concerned)

using a one-sided HP filter with a large smoothing parameter (400,000 for quarterly data).

$$y_t^{ModBIS} = x_t^{ModBIS} - HP_{[1,t]}^{1s}(x_t^{ModBIS}) \quad (4)$$

To compare the relative performance of the two gap measures, we assess the impact of GDP volatility on the gap measurement. We conduct assessments of point-in-time, and over time, signal volatility.

3.2 Point-in-time signal volatility

A point-in-time assessment considers how the signal provided by gaps estimated at time t evolves in reaction to (i) GDP revisions and (ii) the availability of new information (for the modified BIS gap). In other words, it is an assessment of how the gaps estimated at time t change once one-period ahead ($t + 1$) data are available. Therefore, it is by definition not an assessment of the

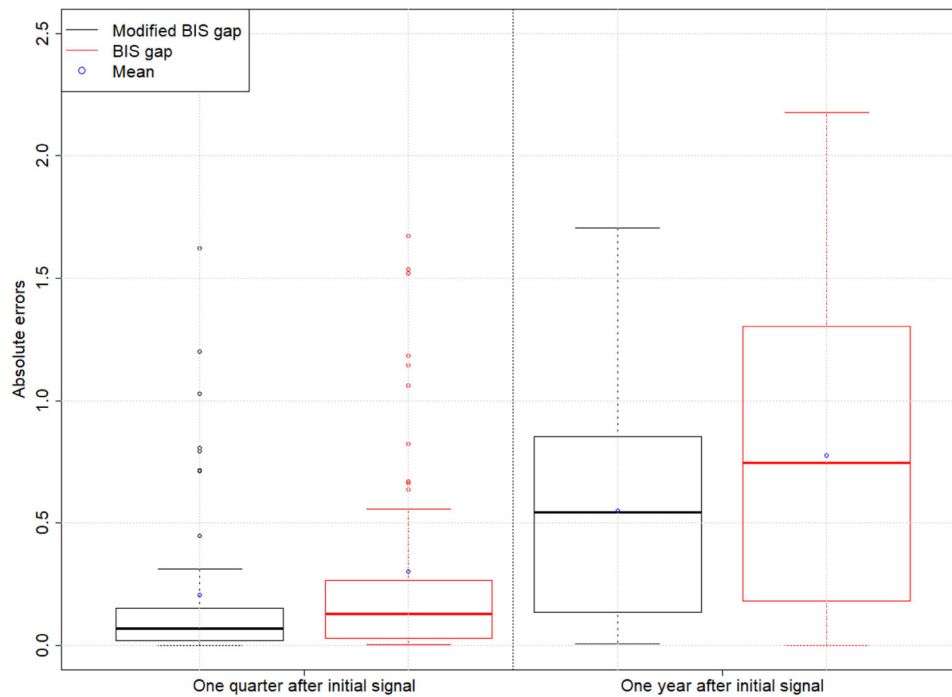
gaps' real-time signal but of how past gap signals change due to new data becoming available. The assessment is conducted using GDP vintages between 2005Q3 and 2018Q4¹² and considers both a quarterly and an annual perspective. The credit series is considered as of 2018Q4, as revisions for this series occur rarely and are generally of low amplitude.

3.2.1 The impact of GDP revisions on signal stability

To assess the BIS gap's signal sensitivity to GDP revisions, we compare absolute error levels for the gaps (Section 3.1). The error levels refer to signal differences resulting solely from revisions to GDP. For each quarter, the absolute difference (or absolute error level) is computed as:

¹²For the 2005Q3 and 2018Q4 GDP vintages GDP data availability starts in 1980Q4. Hence, the analysis covers the 1980Q4 – 2018Q4 period only.

Point in time perspective in percentage points



Note: The vertical line in each box represents median (50th percentile) errors with the upper panel denoting the 75th percentile (P75) and the bottom panel denoting the 25th percentile (P25), which determine the box size ($IQR = P75 - P25$). As such, the upper and lower whiskers are defined as $\min(\max(x), P75 + 1.5 * IQR)$ and $\max(\min(x), P25 - 1.5 * IQR)$. Outliers are plotted as individual points.

Fig. 4 Absolute quarterly error distribution of gap estimates resulting purely from GDP revisions. Point in time perspective in percentage points

$$\Delta_t^{gap} = |y_{t,t} - \tilde{y}_{t,t+a}|, \quad (5)$$

where $y_{t,t}$ is the gap defined as in (2) and (4) using the GDP vintage at time t and where

$$\tilde{y}_{t,t+a} = x_{t,t+a} - HP_{[1,t]}^{1s}(x_{t,t+a}) \quad (6)$$

is the gap at time t based on the GDP vintage available at $t + a$, with $a \in \{1, 4\}$ for the quarterly or annual perspective, respectively. $HP_{[1,t]}^{1s}$ indicates that while the GDP vintage available at $t + a$ is used, the estimation of the credit-to-GDP ratio's trend is based only on data for the interval $[1, t]$.

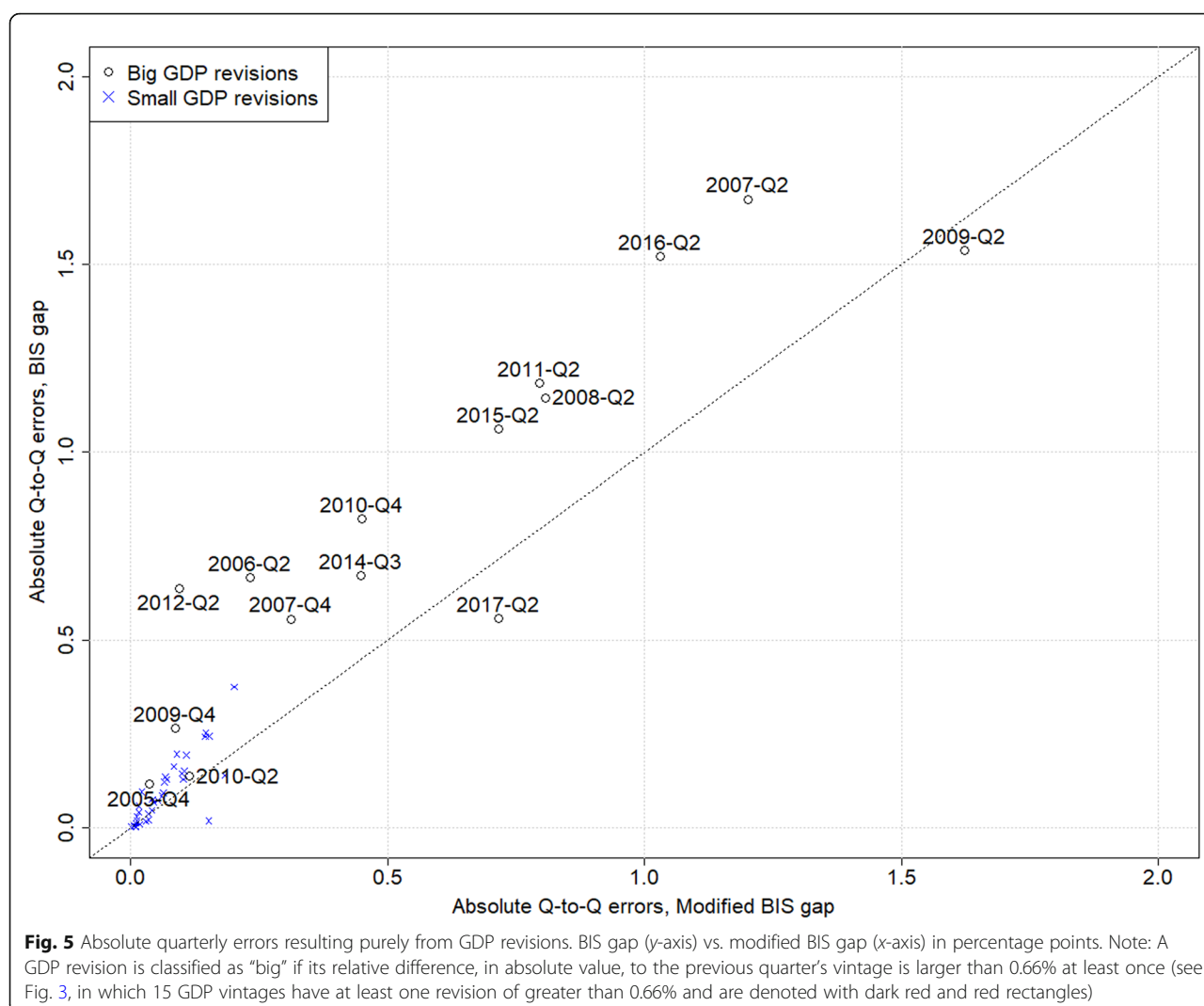
Figure 4 shows the absolute error distribution in gap estimates Δ_t^{gap} resulting purely from GDP revisions for the two gap measures. On average, the modified BIS gap's absolute errors display less error volatility than the BIS gap's. The modified BIS gap's signal therefore appears to be less sensitive to GDP revisions than the BIS gap's. This finding holds true at both quarterly and annual frequencies. This is hardly a surprising finding since, by construction, the modified BIS gap smooths GDP fluctuations, thereby underplaying the importance of GDP movements (Section

3). However, it is important to note that at the quarterly frequency, significant outliers are observed for both gaps, suggesting that both measures have the potential to perform relatively poorly in certain quarters.

To shed some light on the above findings, we classify GDP revisions by size. Major revisions (Fig. 3, dark red and red rectangles) are those that either resulted in a parallel shift of the underlying series (e.g. 2012Q2 and 2014Q3)¹³ or that mainly affected observations towards the end of the series (e.g. the last 5 to 10 observations, e.g. 2009Q2 and 2017Q2). The remaining revisions are minor and relatively insignificant (Fig. 3, yellow and orange rectangles). In classifying GDP revisions, we observe a certain degree of seasonality. In general, revisions occurring between Q1 and Q2 are large. This is the case for 2007, 2008, 2009, 2011, and 2015 and again most recently for 2016 (Fig. 3, red and dark red rectangles)¹⁴. This is an interesting but hardly surprising finding given that the release of Q2 data in early September

¹³In these cases, the entire GDP series is impacted. The parallel shift of the series generally corresponds to a modification of the underlying methodology used to compute GDP.

¹⁴This correspond to the Swiss Federal Statistical Office's (SFSO) annual data release.



generally¹⁵ coincides with the release of annual estimates. It is therefore to be expected that quarterly estimates are affected by incoming annual data and that the impact on the signal, particularly when compared to other quarters, is considerable. Figure 5 plots the modified BIS gap’s absolute quarterly errors against those of the BIS gap based on the above classification. In line with the findings presented in Fig. 4, the modified BIS gap’s signal appears to be less sensitive to GDP revisions than that of the BIS gap. This holds true for all revision classifications. For the sake of brevity, we only present the quarterly results. However, a similar pattern is observed at the annual frequency. In fact,

the effect is more pronounced at the annual frequency, reflecting the fact that up to four GDP revisions can take place over a one-year period.

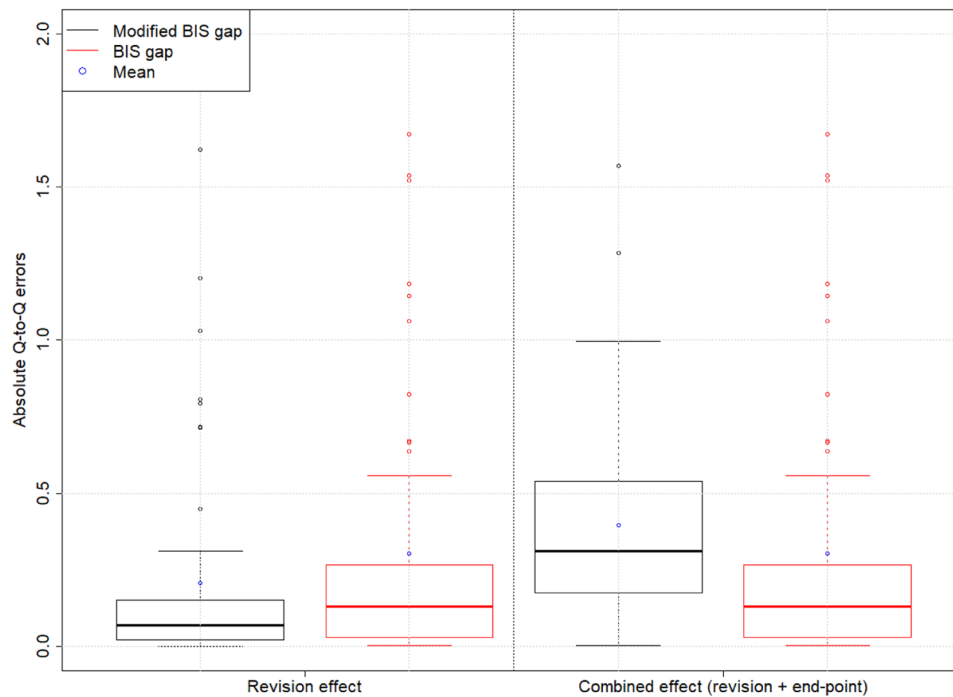
3.2.2 Effect of the end-point problem for the modified BIS gap

Gap signal sensitivity to new information works predominantly through the credit-to-GDP ratio’s denominator. More specifically, it depends on how GDP enters the credit-to-GDP ratio’s function and impacts the signal provided. As detailed in Section 3.1, GDP enters the BIS ratio’s denominator as the sum of GDP over the four previous quarters. As prescribed by the BIS, the long-term trend is obtained by applying a one-sided filter to the credit-to-GDP ratio. This means that the trend component is calculated recursively and consisting solely of end points¹⁶. This approach is

¹⁵An exception to this is the case of 2014Q3, when the Swiss Federal Statistics Office postponed the release of annual figures to the end of September 2014 due to a revision of national accounts (<https://www.bfs.admin.ch/bfs/en/home/statistics/catalogues-databases/press-releases.assetdetail.38598.html>).

¹⁶Thus, a trend calculated for, say, end-1988 considers information for up to 1988 only, even if more observations have since become available.

Quarterly gap differences in percentage points



Note: The vertical line in each box represents median (50th percentile) errors with the upper panel denoting the 75th percentile (P75) and the bottom panel denoting the 25th percentile (P25), which determine the box size ($IQR = P75 - P25$). As such, the upper and lower whiskers are defined as $\min(\max(x), P75 + 1.5 * IQR)$, and $\max(\min(x), P25 - 1.5 * IQR)$. Outliers are plotted as individual points.

Fig. 6 Absolute error distribution in gap estimates resulting purely from the end-point problem. Quarterly gap differences in percentage points

beneficial in that the final point, and hence the gap's signal, cannot change as information becomes available in the future. In contrast, our comparative measure (modified BIS gap), which focuses on dampening potential GDP volatility, adopts a smoothed GDP series in its denominator (Section 3.1). This is achieved by applying a two-sided HP filter to GDP before it enters the denominator of the modified BIS ratio (Eq. 2). The two-sided filter differs from the one-sided filter in that it uses all available information to provide more precise estimates. As such, trend GDP and therefore the modified BIS gap at time t may be revised each time new information becomes available (end-point problem). This is the case because the denominator of the ratio is revised backwards as new data become available, also affecting past values of the modified BIS gap.

To quantify the impact of new information on signal stability, we estimate the combined errors by combining the effects of GDP revisions and new information. We can then compare the results to those shown in Section 3.2.1 to isolate the impact of new information. For each quarter t , the absolute difference is calculated as

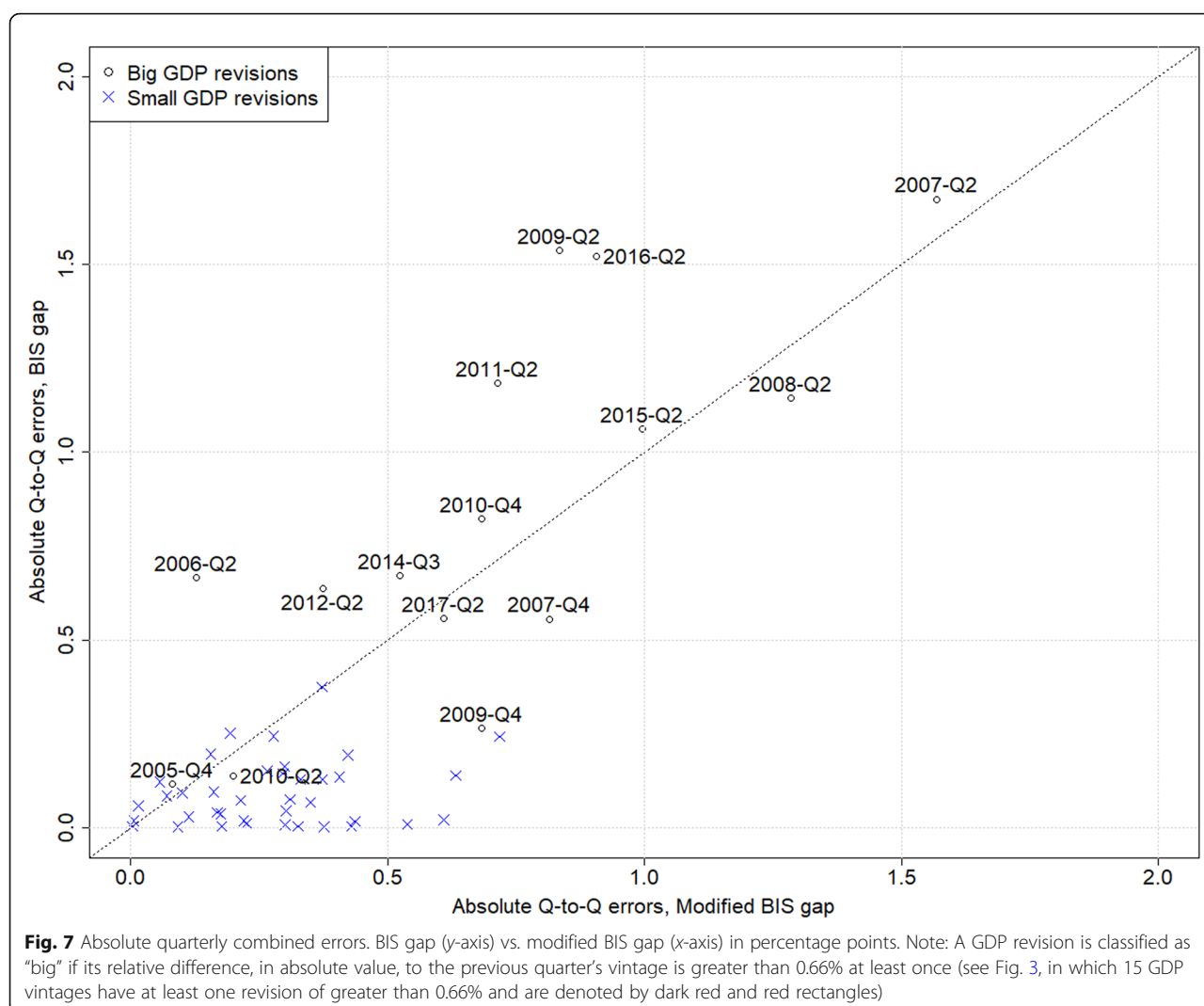
$$\Delta_t^{gap} = |y_{t,t} - \tilde{y}_{t,t+a}|, \quad (7)$$

where $y_{t,t}$ is the gap at time t defined in (2) and (4) using the GDP vintage at time t and where

$$\tilde{y}_{t,t+a} = x_{t,t+a} - HP_{[1,t+a]}^{ls}(x_{t,t+a}) \quad (8)$$

is the gap at time t using the GDP vintage available at $t + a$ with $a \in \{1, 4\}$ for the quarterly or annual perspective, respectively. $HP_{[1,t+a]}^{ls}(x_{t,t+a})$ is the credit-to-GDP ratio's estimated trend for interval $[1, t + a]$ evaluated at time t .

In line with expectations, our results show that new information does not affect the BIS gap in any way (red boxes, left and right panels, Fig. 6). This is the case because the gap is estimated recursively. For the modified BIS gap, however, the error distribution shifts upwards as new information is received. The mean of the distribution of absolute errors increases from 0.21 pp to 0.39 pp (+ 18 bp) while the median increases from 0.07 pp to 0.31 pp (+ 24 bp). Interestingly, the modified BIS gap's



errors are now higher than those estimated for the BIS gap: 0.30 pp (mean) and 0.13 pp (median).

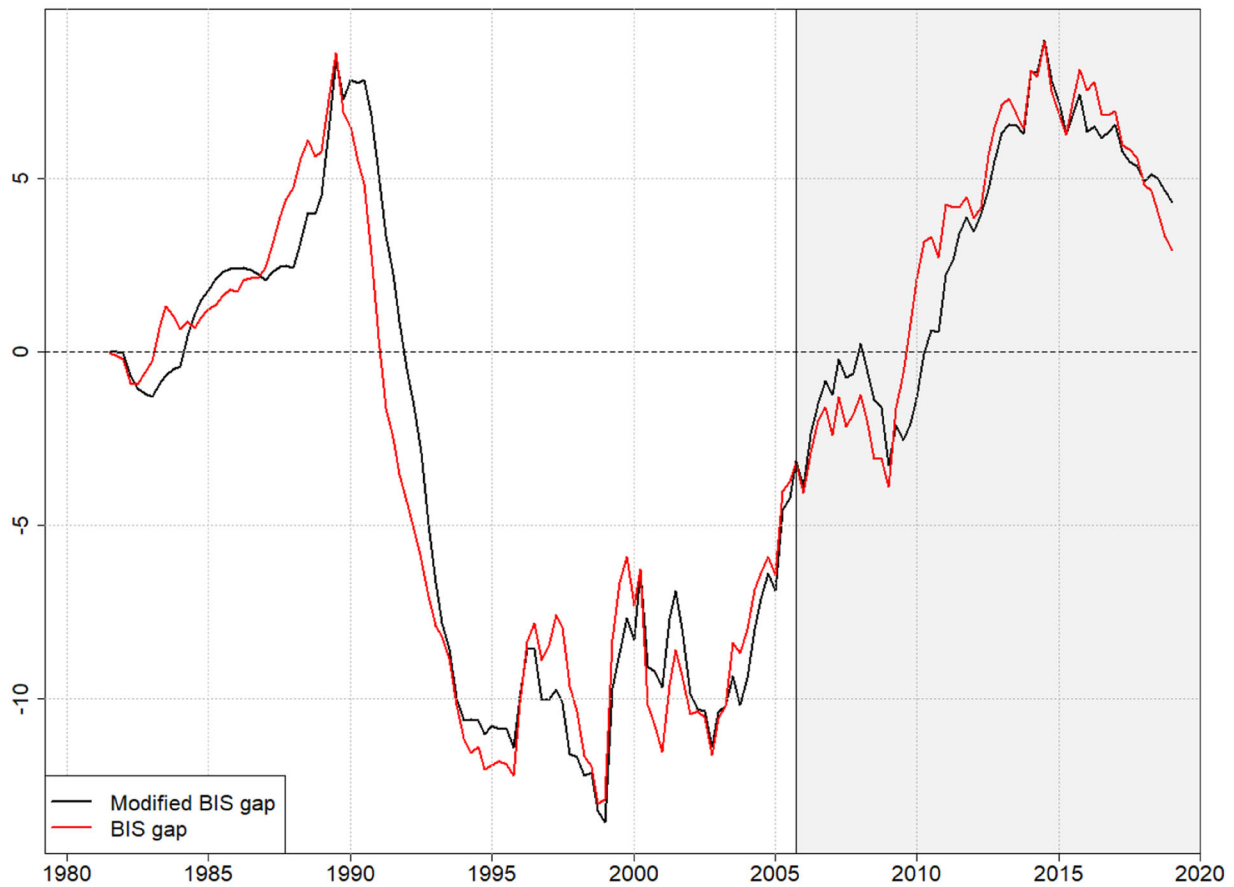
Figure 7 plots the combined quarterly errors of the BIS gap against those of the modified BIS gap for different types of revisions. It is evident that for minor revisions, the modified BIS gap’s absolute errors are systematically higher than the BIS gap’s. This explains why we observe higher mean and median errors for the modified BIS gap than for the BIS gap in Fig. 6. From a policy perspective, this result has two implications. First, when taking the impact of new information into account, the total impact of GDP movements on the gap’s signal can be greater for the modified BIS gap than for the BIS gap. Second, as the modified BIS gap’s signal may move every time new information becomes available, past values of the modified BIS gap are also affected in the absence of GDP revisions. These frequent movements of past gap signals can complicate the interpretation and communication of the modified BIS gap considerably.

3.3 Signal volatility over time

In this section, we assess the evolution of the gap’s real-time signal to gauge how extreme GDP movements and GDP revisions affect its reliability over time. The real-time signal provided by the credit-to-GDP gap at time t is estimated using the most up-to-date information available at time t . Importantly, for this assessment, fluctuations that arise due to the end-point problem (modified BIS gap, Section 3.2) are excluded since the end-point problem does not affect real-time observations.

As in Section 3.1, our assessment considers GDP vintages between 2005Q3 and 2018Q4. To start, we estimate the BIS gap and modified BIS gap using the 2005Q3 vintage¹⁷. For each subsequent quarter, the gap is re-estimated using the GDP series that would have been available in real time in that quarter (e.g. 2005Q4, 2006Q1 etc.). Individual gap observations are

¹⁷The series starts in 1980Q4.

Percentage points

Note: The grey shaded region denotes gaps estimated using real time GDP vintages.

Fig. 8 Real-time evolution of the modified BIS gap and BIS gap between 2005 and 2018. Percentage points

then combined to derive an estimate for the series (Fig. 8).

Between 2008 and 2010, the BIS gap's and the modified BIS gap's signals differ considerably, by up to 3.5 pp. This period coincides with extraordinary GDP movement in Switzerland together with a significant upward revision of GDP in 2009Q2. Year-on-year Swiss GDP growth averaged approximately 6.1% between 2006 and end-2008 before turning negative and remaining negative for three consecutive quarters. The sharp slowdown in GDP growth accelerated the growth of the credit-to-GDP ratio, which in turn translated into a rapidly increasing gap. For the modified BIS gap, the impact of GDP growth (both the increase and decrease) was minor in comparison¹⁸. Trend GDP grew roughly 3.9% on

average (year-on-year) between 2006 and end-2008 and slowed to 2.9% through 2009. Subsequent growth in the modified BIS credit-to-GDP ratio (Eq. 3) was moderate, resulting in a much more gradual increase in the modified BIS gap, as observed in Fig. 8. Importantly, signal differences remain considerable even when the 2009Q2 GDP revision is accounted for (Section 3.2.3).

A similar trend emerges towards the end of the sample period. Since the beginning of 2018, GDP has been growing steadily¹⁹ following 6 years of subdued growth²⁰. This dynamic has contributed to a slowdown in the credit-to-GDP ratio and a subsequent swift decline of the BIS gap. While the modified BIS gap tends towards the same

¹⁸Based on the 2018Q4 series, trend GDP growth year-on-year increased from 3.7% (2005) to 4.3% (2006).

¹⁹Year-on-year GDP growth increased from 1.9% (2018Q1) to 3.2% (2018Q4).

²⁰Between 2012 and 2017, annual GDP growth amounted to roughly 1.2% on average.

direction, the GDP growth impact is again comparatively subdued resulting in a far more gradual adjustment of the modified BIS gap's signal. Taken together, these findings suggest that over time, the BIS gap has been more sensitive to sudden and large GDP movements and that its volatility driven by GDP movements, which may or may not be policy relevant, is considerably greater.

However, from Fig. 8 we note that a trade-off between signal stability and early warning properties of the gap indicator may exist. It seems that the signal provided by the modified BIS gap tends to lag the BIS gap in the build-up phase. This is evident in the 2008–2010 high GDP growth period where the modified BIS gap lags the BIS gap by up to 6 quarters. The modified BIS gap continues to lag the BIS gap after 2010 despite more convergence in the signals. We observe a similar effect in the lead up to the 1990s crisis in Switzerland.

To summarise, our assessment thus far has shown that for the Swiss case, the BIS gap performs as well as the modified BIS gap against the normalisation critique. Hence, based on an assessment of the normalisation critique, we find no compelling evidence for a need to deviate from using the BIS gap as a reliable measure of excess credit in the Swiss credit market. Importantly, we note that the modified BIS gap tends to lag the BIS gap in the build-up phase, suggesting a trade-off between signal stability and early warning properties of the indicator. From a policy-making perspective, if confined to the use of one single indicator, a measure with superior early warning properties would likely dominate. The fact that the indicator provides a signal early ensures enough time for authorities and banks to react when credit excesses are building up. However, as shown above, both measures are prone to their own caveats. This highlights the importance of basing policy decisions on a broader set of information. As such, authorities should consider supplementing guiding indicators with additional metrics or plausible narratives based on a wide-ranging set of relevant indicators.

4 The HP filter critique

A second critique of the BIS credit-to-GDP gap centres on the use of the HP filter to estimate the long-run trend. In particular, critics have questioned the gap's sensitivity to the starting point of the underlying series (start-point problem), the reliability of real-time estimates for policy purposes and the estimates during extensive credit boom periods. In what follows, we discuss these drawbacks and their impacts on the Swiss credit-to-GDP ratio, estimated as the BIS ratio (Eq. 1, Section 3.1).

4.1 The start-point problem

The start-point problem is a well-documented drawback of any filtering method. It relates to the signal differences that arise solely as a result of the underlying series' starting point. Importantly, it relates to the amount of data needed for stable parameters. Drehmann and Tsatsaronis (2014) show that in the context of estimating the BIS gap, the starting point for deriving trend estimates can have major implications. For example, in a case where the underlying series' starting point coincides with either the financial cycle's peak or trough, considerable differences between gaps can arise. In such situations, the trend tends to remain too high or low for a considerable amount of time. A similar problem has been found for series with trends encompassing a structural shift or break (see the discussion in Section 2). In these situations, even a data series extending to 1965 that captures several complete cycles could provide a distorted view of actual developments.

To assess the sensitivity of the Swiss credit-to-GDP gap to the start-point problem, we consider three series with differing start points. Series 1 starts at the beginning of the sample period, 1965Q4. Series 2 starts in 1974Q1, coinciding with the start of the build-up phase in Switzerland. Series 3 starts in 1990Q1, coinciding with bursting of the real estate bubble and the onset of the ensuing banking crisis (Fig. 1). For each series, we estimate the credit-to-GDP gap as per Eq. (4) (Section 3.1). Figure 9 illustrates the evolution of the one-sided HP gaps.

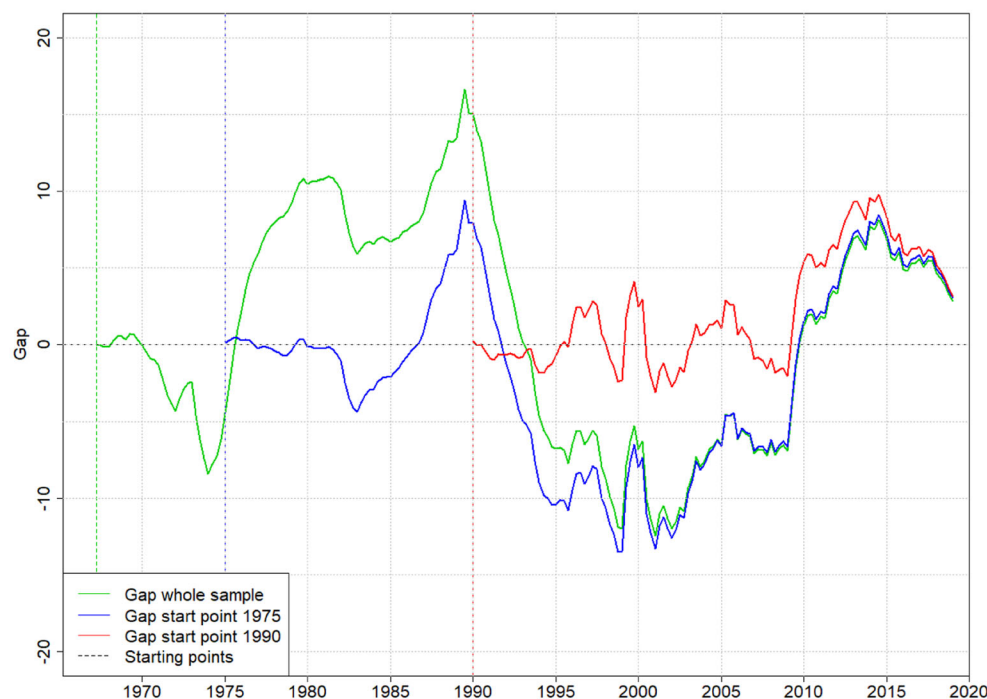
The graph suggests that the starting point can have major implications for the gap's measurement. In fact, even after 10 years²¹, our gap measures deviate from one another by almost 10 percentage points²². In comparing series 1 (green line) and series 2 (blue line) we find that the estimated gaps gradually converge. After approximately 25 years, the signals deviate from one another by roughly 1pp. After 30 years, the series deviate by approximately 0.15 pp. The two series reach convergence shortly thereafter in 2005. In comparing series 3 (red line) with series 1, we find that the series have almost fully converged by end-2018. After 28 years, the series deviate from one another by approximately 0.05 pp. These findings suggest that for the Swiss case, roughly 30 years of data are needed to eradicate the impact of shifts or breaks in the underlying data. This corresponds to Drehmann and Tsatsaronis (2014), who show that for the case of Japan, more than 20 years of data were required for the effect of a 10 percentage point jump²³ in the

²¹The BCBS adopts a practical rule of thumb for estimating reliable gaps. They advise authorities to estimate the credit gap only when 10 years of underlying data are readily available (Borio & Lowe, 2002).

²²Series 2 deviates from series 1 by 9pp in 1984Q1. Similarly, series 3 deviates from series 1 by 9pp in 2001Q1.

²³In 1998, a change in the compilation of the Japanese credit series resulted in a jump.

Percentage points



Note: The credit-to-GDP gap is estimated according to the BCBS guidelines (deviation from a one-sided HP filter with a large smoothing parameter (400,000)). The whole sample starts in 1965 (green line), and sub-samples start in 1975 and 1990 (blue and red lines).

Fig. 9 Credit-to-GDP gap, start-point problem assessment. Percentage points

underlying series to fully disappear. Importantly, this result also emphasises the need to consider signals provided by series with caution until enough data have become available, particularly if the signal is being used as a driver of policy decisions.

4.2 Reliability of real-time estimates

Another important drawback associated with the HP filter relates to the fact that the series' final points can change considerably when new information becomes available. As such, critics have questioned the reliability of basing policy decisions on real-time estimates (Canova, 1998; Edge & Meisenzahl, 2011; Pedersen, 2001), as considerable differences can arise between gap estimates based on real-time estimates (one-sided) and those based on ex-post measures (two-sided) (Farrell, 2016; Watson, 2007).

There is, however, no evidence that ex-post measures of the credit-to-GDP gap are better predictors of system-wide risk than the one-sided measures (Van Norden, 2011). In fact, the BCBS (2010) and Drehmann et al. (2010) argue that ex-ante or one-sided deviations from trends are useful leading indicators of system-wide risk. Based on a broad sample of countries and financial crises, Drehmann et al. (2011)

shows that the one-sided credit-to-GDP gap's signalling ability is strong. His findings advocate the use of the ex-ante measure of the credit-to-GDP gap for making real-time policy decisions. As a result, the BCBS (2010) emphasises the use of the credit-to-GDP gap as a useful common reference point for authorities wanting to protect the banking system against potential future losses when excess credit growth is associated with an increase in system-wide risk.

Nevertheless, authorities in some jurisdictions have opted for ex-post approaches to solve the problem of trend stability at the end of the series. Gerdrup et al. (2013) assess the impact of augmenting historical observations of the credit-to-GDP gap with forecasted data on the real-time estimation of the two-sided HP gap²⁴. The authors conclude that an augmented gap, based on a simple four-quarter moving average forecast of the credit-to-GDP ratio, outperforms the BIS gap in terms of early warning properties. Farrell (2016) investigates the effect of this procedure for South Africa and shows that a forecast-

²⁴Gerdrup et al. (2013) adopt three approaches to forecast indicator values by five years: rolling average forecasts, linear forecasts and rolling linear forecasts (pp. 12).

augmented alternative to the one-sided filter is not always the best approach. Farrell argues that the benefit of forecast augmentation depends heavily on the quality of the forecast. Alessandri et al. (2015) adopt a similar approach whereby they systematically adjust the gap's signal with a forecast correction between the one- and two-sided HP filters. The authors find that for the Italian case, this approach improves indicator performance and provides more consistent estimates of the gap.

To assess whether the Swiss BIS gap could benefit from an ex-post adjustment, we apply the approaches proposed by Gerdrup et al. (2013) and Alessandri et al. (2015) to the Swiss case. As per Gerdrup et al. (2013), we project the credit-to-GDP ratio 5 years ahead using three forecast approaches: rolling average, linear and rolling linear forecasting. The augmented gap is then estimated using a two-sided HP filter.

$$y_t = x_t - HP_{[1,t+5]}^{2s}(F_{t+5}(x_t)), \quad (9)$$

where augmented gap y_t is the difference between credit-to-GDP ratio x_t and its trend at time t . The trend is estimated using a two-sided HP filter over interval $[1, t+5]$ of the 5-year forecasted credit-to-GDP ratio, evaluated at time t . We find that for the Swiss case, of the forecast approaches adopted, the rolling 20-year linear forecast approach performs best with respect to timing and consistency²⁵. The linear-forecast augmented gap is depicted in Fig. 10 (orange line).

For the second ex-post approach, we follow Alessandri et al. (2015) and project the correction between the one- and two-sided HP filters up to time t . Two forecast approaches are considered: random walk and dynamic equation approaches. We find that the random walk approach, a standard benchmark for forecasting, is the most relevant for the Swiss series²⁶. Two-year projected correction is then added to the one-sided HP filter at time t to obtain a proxy for the “real-time” two-sided gap.

$$y_t = HP_{[1,t]}^{1s}(x_t) + \left(HP_{[1,t-2]}^{2s}(x_{t-2}) - HP_{[1,t-2]}^{1s}(x_{t-2}) \right) \quad (10)$$

The random walk augmented gap is depicted in Fig. 10 (blue line). The correlation between the one-sided BIS gap (green line) and both the linear-forecast augmented gap (orange line) and random walk gap (blue

line) is strong. As such, both augmented gaps perform well in terms of timing and consistency. Regarding the relative performance of the indicators, there is no clear winner. Rather, it seems that strategies applied by other jurisdictions to reduce differences between real-time and ex-post gap estimates add complexity without providing a clear advantage for Switzerland.

4.3 Tendency to underestimate cyclical risk in certain situations

An additional drawback of the HP filter relates to its tendency to generate a gap estimate that underestimates cyclical risk in certain situations (Lang et al., 2019; Lang & Welz, 2017). This is because part of the credit excesses of boom periods are incorporated into the statistical trend estimate with the effect becoming ever more pronounced the longer the boom phase continues.

Depending on the cycle stage, this mechanism has distinct implications for the gap estimate. In the boom phase, it has the potential to reduce the positive estimate of the gap, compared to that estimated when the boom phase was still young. Strong growth in the credit-to-GDP ratio sets the trend on a higher growth path, leading to a decrease in the gap level, even in an unchanged risk environment. In the Netherlands, for example, the credit gap signalled vulnerabilities from 1998 to 2004. However, a systemic banking crisis emerged only in 2008. Similarly, in Sweden, authorities have assessed systemic risks in the financial sector to be elevated despite a decreasing and even negative credit gap since end-2014 (Finansinspektionen, 2019).

After a bust phase, the negative gap can be “too slow” to react to increasing risks, resulting in a gap estimate that does not accurately capture the current risk environment. As risks start to increase again, an inflated trend level results in a gap that stays negative for too long. According to Banco de España, this is currently the case in Spain, where the negative gap observed since 2012 is not consistent with the current stage of credit and economic cycles (Banco de España, 2019). A similar effect can be observed for Ireland where a CCyB has been activated to 1% despite a negative gap (Central Bank of Ireland, 2019; Lang & Welz, 2017).

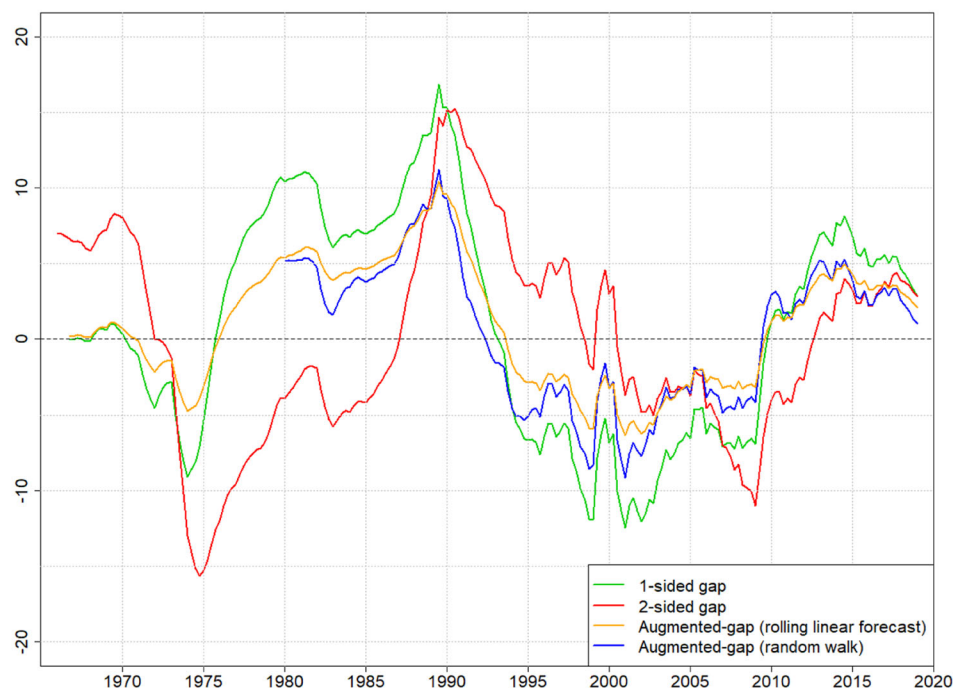
4.3.1 The current situation in Switzerland

Switzerland is currently facing a situation similar to that of Sweden and to that observed in the Netherlands after 2004 (Section 4.3). Despite Swiss authorities assessing risks from the Swiss mortgage and real estate markets to be elevated and at a level that has not changed materially over the past couple

²⁵The results of the forecast exercise are not presented here for brevity but are available from the authors on request.

²⁶Using the dynamic equation approach, we find that the signal seems to be quite noisy, particularly as the projection window increases. The results of the forecast exercise are not presented here for brevity but are available from the authors on request.

Percentage points



Note: One- and two-sided credit-to-GDP gaps (green and red lines) are estimated with the one-sided or two-sided HP filter. A large smoothing parameter (400,000) is adopted. The series extends from 1965 to 2018. The first augmented gap series (blue line) is obtained by applying a two-sided HP filter to a 5-year augmented credit-to-GDP ratio, which is forecasted using a 20-year rolling linear approach (only the last points are reported to obtain a real time series). The second augmented gap series (blue line) is obtained by applying a correction factor to the one-sided HP filter. This correction factor is calculated using a random walk approach as the difference between the one- and two-sided gaps 2 years before (only the last points are reported to obtain a real time series).

Fig. 10 Credit-to-GDP gap, impact of augmenting historical observations with forecasted data. Percentage points

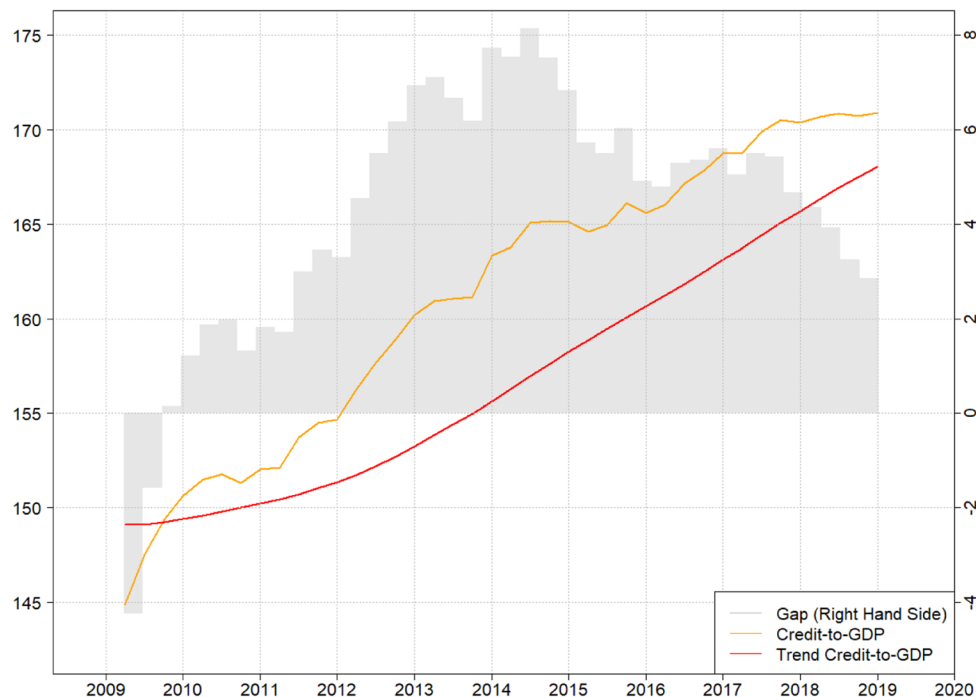
of years, the BIS gap has been declining steadily since 2014 (Fig. 11, grey bars). The declining gap appears to be partly attributable to the gap's tendency to underestimate cyclical risks in long boom phases (Lang et al., 2019; Lang & Welz, 2017). The trend's higher growth path has contributed significantly to the decline of the gap (Figs. 11 and 12). However, this can only partly explain the declining Swiss gap in the current environment, which has also resulted from changed dynamics in both credit and GDP (Fig. 12). The combination of lower than average credit growth, which has slowed to a moderate pace since 2015, with strong GDP growth, which has been higher than its historical average since 2017, has led to a stabilisation of the credit-to-GDP ratio.

In contrast, affordability risks have increased substantially over the past few years (SNB, 2019). This increase in credit risk despite lower growth together with the gap's tendency to underestimate risks in long boom phases explains the discrepancy between authorities' assessments and the BIS gap's signal. As a

measure of excess credit, the BIS gap is not designed to capture such credit quality deterioration. As such, the Swiss case emphasises the need for authorities to comprehensively assess whether developments in the credit market are sustainable or a source of aggregate vulnerability. An obvious way to strengthen the decision-making framework involves broadening the set of relevant credit indicators.

4.3.2 HP filter relative to other approaches

To compare the HP filter's tendency to generate a gap estimate that underestimates cyclical risk in certain situations relative to other approaches, we estimate a set of alternative trends using moving average (5- and 10-year) and linear time-trend approaches (10- and 20-year). As depicted in Fig. 13, the impact of the current environment on alternative trends (upper panel) and gap signals (lower panel) is similar to the effect on the BIS gap. In some cases (10- and 20-year linear trends), the trend appears to adjust considerably faster than under the other approaches.



Note: The credit-to-GDP gap is estimated according to the BCBS guidelines (deviation from a one-sided HP filter with a large smoothing parameter (400,000)).

Fig. 11 Decomposition of the credit-to-GDP gap (2009–2018)

However, the signal provided by the gap estimates remains homogeneous: credit excesses appear to be decreasing. By nature, statistical measures based on time-varying trends progressively incorporate long-term boom phases in their estimates. When a prolonged boom phase is (mainly) cyclically rather than structurally driven, such indicators will underestimate the level of risk to a growing extent.

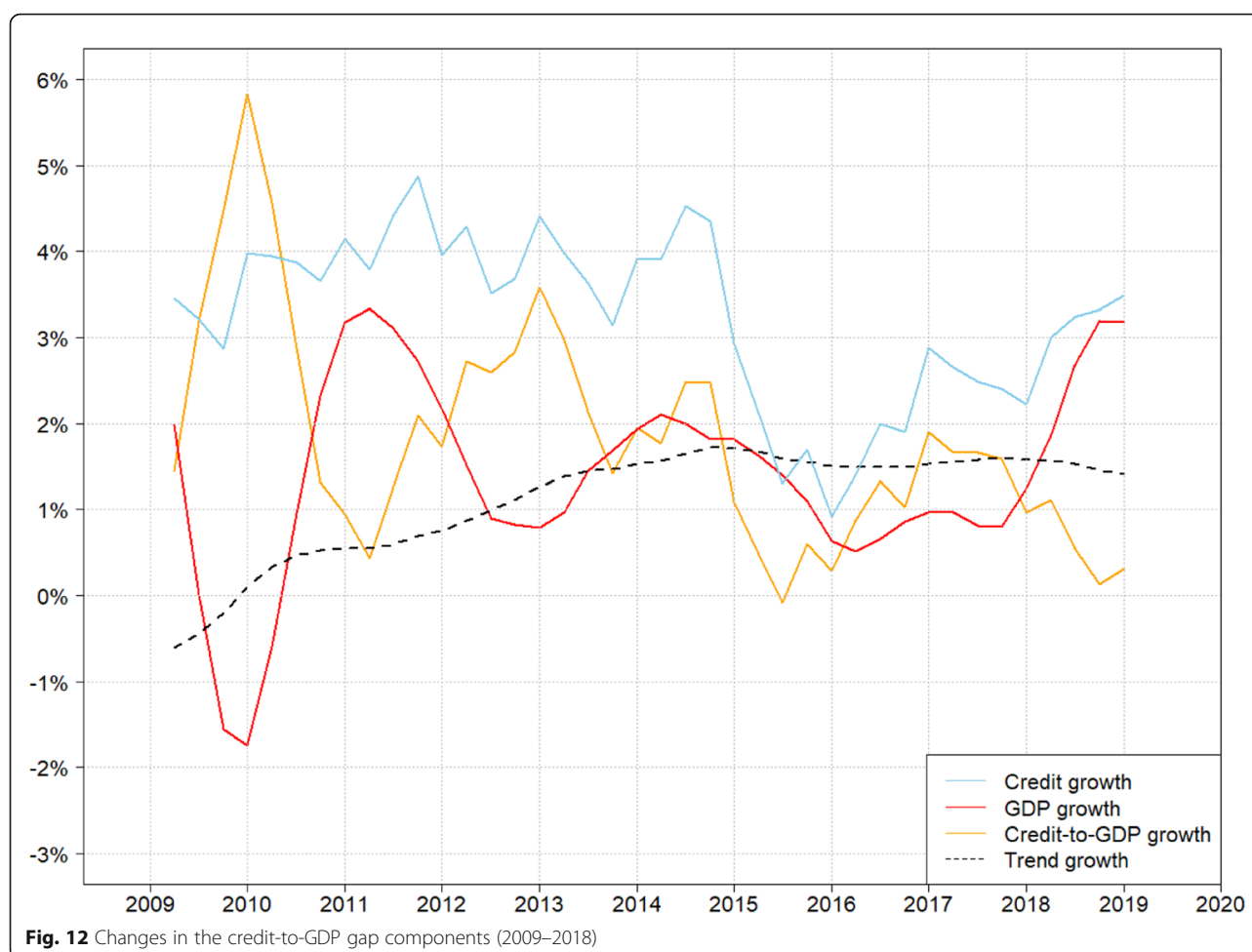
Therefore, our results provide no evidence of a need to deviate from the BIS approach as a measure of excess credit. However, they do advocate the development of model-based trends that incorporate a wider range of variables and economic fundamentals to complement the BIS gap (Claessens et al., 2012; Galati et al., 2016; Lang & Welz, 2017; Rünstler & Vlekke, 2018; Schüller et al., 2015). In this vein, our findings reiterate the importance of considering a broader set of relevant credit indicators either in the context of estimating structural trends or simply as input for decision-making purposes. It is important to bear in mind, however, that model-based estimates and other complex indicators come with their own caveats and estimation problems. Policy makers should be aware that there is no one-size-fits-all approach. The focus should rather be on building narratives based on indicators that provide an all-

encompassing picture of risks in the system to guide their decisions.

5 Conclusion

Despite its broad acceptance as a reliable measure of excess credit, a growing body of literature has focused on highlighting two important caveats of the credit-to-GDP gap. The first, the normalisation critique relates to the approach adopted to normalise credit. The second, the HP filter critique relates to the use of the HP filter to estimate the gap's trend component. In this paper, we assess the reliability of the Swiss credit-to-GDP gap by focusing on the relevance of these two critiques for the Swiss case.

Our findings show that despite its drawbacks, the BIS gap is a reliable measure of excess credit in Switzerland and should remain an integral part of the macroprudential decision-making framework. Alternatives do not provide clear advantages, rather they are considerably more complex to estimate and come with their own set of pitfalls. It is important, however, that policy makers complement the BIS gap's signal with narratives based on a broader set of additional credit metrics to ensure an all-encompassing risk assessment.



An analysis of the normalisation critique shows that the BIS gap is more sensitive to the direct impact of GDP variability than the modified BIS gap. This is true from both point-in-time (i.e. impact of GDP revisions on past gap signals) and over-the-time (i.e. impact of GDP variability on the gap's real-time signal over time) perspectives. However, through its approach to smooth GDP, the modified BIS gap is subject to the end-point problem and is therefore revised whenever new information becomes available, affecting its past values. Taking this additional effect into account, the total impact of movements in GDP on past gap signals can be greater for the modified BIS gap than for the BIS gap. Moreover, our assessment of gap signals over time suggests that the modified BIS gap's signal consistently lags that of the BIS gap in the build-up phase of the cycle, indicating inferior early warning properties. It therefore seems that a trade-off between signal stability over time and the early warning properties of the indicator exists. For policy-making purposes, authorities may place more weight on early warning properties to ensure that

action is taken early enough and that banks have enough time to build up additional buffers of capital. As such, based on our assessment of the normalisation critique, we find no compelling evidence for a need to deviate from the BIS gap as a reliable excess credit measure.

An analysis of the HP filter critique suggests that (i) while the start-point problem can have significant implications for the BIS gap's signal, its current signal is no longer affected by structural developments in the credit market that occurred around 1990 in Switzerland. (ii) Strategies applied by other jurisdictions to reduce differences between real-time and ex-post gap estimates add complexity without providing a clear advantage for Switzerland. (iii) The extent to which the HP filter incorporates part of the current long-lasting boom phase in Switzerland in its trend estimates is comparable to that observed for the other filtering approaches assessed in this paper. Moreover, currently, risks in the Swiss credit market appear to be driven mainly by quality issues, which are out of the realm of the BIS gap. This emphasises the need

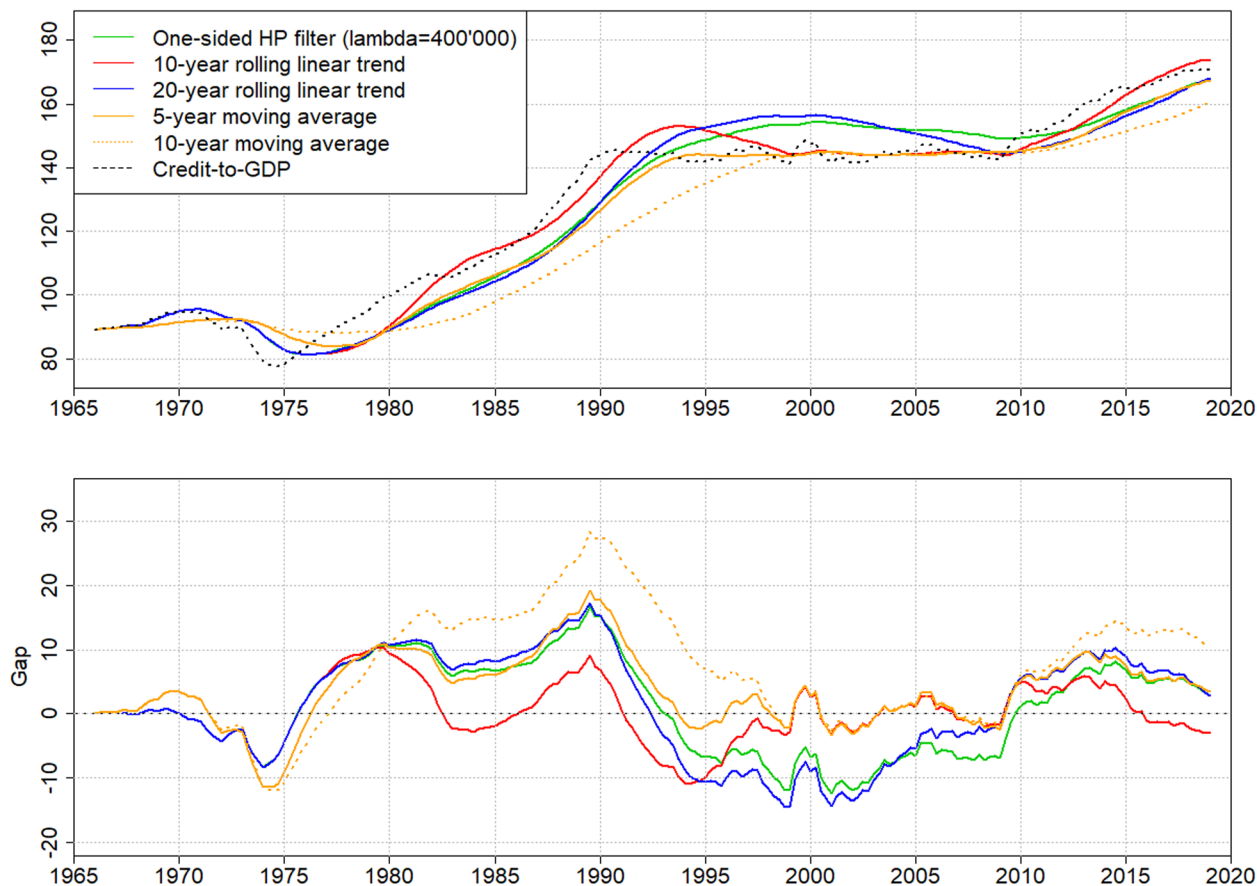


Fig. 13 Alternative trends (upper panel) and gap estimates (lower panel). Note: 10- and 20-year rolling linear trends are obtained by running linear regressions applied over 10- and 20-year rolling windows. The 5- and 10-year moving averages are simple moving average values with 5- and 10-year rolling windows. Only the last points are reported to obtain real-time series

for policy makers to complement the BIS gap with other credit indicators to ensure a comprehensive assessment of whether developments in the credit market are sustainable or a source of aggregate vulnerability.

Abbreviations

BIS: Bank for International Settlements; BCBS: Basel Committee for Banking Supervision; HP filter: Hodrick-Prescott filter; SFBC: Swiss Federal Banking Commission; SNB: Swiss National Bank

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Authors' contributions

TJ, RN, and SR contributed equally to the analysis, interpretation, and writing of the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The data that support the findings of this study are available from the Swiss National Bank but restrictions apply to the availability of these data, as some are not publicly available. Data are however available from the authors upon reasonable request and with permission of the Swiss National Bank.

Declaration

Competing interests

The authors declare that they have no competing interests.

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