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Estimating sustainable output growth in emerging market economies

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Abstract

In the spirit of Borio et al. (2014) we present a model that incorporates information contained in diverse variables when estimating sustainable output growth. For this purpose, we specify a state-space model representing a multivariate HP-filter that links cyclical fluctuation of GDP with several indicators of macroeconomic imbalance. We obtain the parameterization of the model by estimating it over a cross-section of emerging market economies. We show that trend output growth rates estimated using this model are more stable than those obtained with a univariate version of the filter and thus are more consistent with the notion of sustainable output.

Keywords: output gap, financial cycle, macroeconomic imbalances, emerging markets
JEL classification: E32, E44, C33.

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1 Introduction

The concept of potential growth and output gap plays a key role in the formulation and implementation of macroeconomic policies. Monetary, fiscal and macroprudential policies take into account these estimates in order to adapt the policy stance so as to reduce possible macroeconomic imbalances and dampen aggregate fluctuations. The relevance and usefulness of these concepts depends on how accurately the potential growth estimate reflects the sustainable path of economic development and the output gap and serves to summarize the imbalances of the economy.

In this regard, estimation of potential output growth in emerging markets has recently been a challenging task. Estimates obtained with conventional univariate statistical filters (e.g. Hodrick-Prescott (HP) filter) generally failed to detect imbalances prior to the onset of the crisis in late 2008. Moreover, these filters were not always helpful in decomposing the post-crisis slowdown in output growth into its cyclical and trend components. In these circumstances it seems appropriate to rely on additional macroeconomic indicators for the diagnostics of the state of the business cycle. It is generally accepted that inflationary pressure builds up when output is above potential and subsides when output falls below potential. As such, inflation in particular is viewed as a key symptom of unsustainability. However, to simply equate potential output to non-inflationary output is too restrictive. The same applies to another conventional theory that links fluctuations in unemployment and output gap (Okun’s Law). Recent history has demonstrated that other imbalances, notably in the financial sector and in asset markets, can emerge even when inflation and unemployment remain stable. Research has shown that these financial factors may contain important information relevant to the cyclical component of output. The aim of this paper is to incorporate information contained in financial-imbalance indicators into the estimation of sustainable output growth in emerging market economies.

Our work is related to the recent literature on the link between business cycles and financial cycles (Alessi and Detken (2011); Claesens et al. (2011); Schularick and Taylor (2011)). We concentrate here on developments in emerging markets, which means that data limitations will effectively restrict our analysis to the latest boom/bust episode. This closely links our work with the literature on the main factors explaining output fluctuations during the crisis of 2008 (Frankel and Saravelos (2010); Lane and Milesi-Ferretti (2010); Cecchetti et al. (2011); Feldkircher (2012)). Our main contribution to these strands of research is that we follow Alberola et al. (2013), Borio et al. (2013) and Borio et al. (2014) in employing an empirical model that enables us to decompose output fluctuations into cycle and trend components based on empirical relationships with various measures of imbalances. The resulting indicators may be interpreted, in economic sense, as metrics of sustainable (i.e. not associated with the buildup of imbalances) output and output gap.

The paper is structured as follows. Section 2 discusses the set-up of the model. Section 3 presents the dataset, and Section 4 reports the empirical results. Section 5 discusses the output gap estimates for the cross-section of emerging markets in general and provides more detailed results for Russia. Section 6 concludes.

2 Model set-up

We follow Borio et al. (2013) and Borio et al. (2014) and employ a multivariate Hodrick-Prescott (MVHP) filter in state-space form[1]:

$$\Delta y^*_{it} = \Delta y^*_{it-1} + \varepsilon_{it} \quad (1)$$

$$y_{it} - y^*_{it} = \gamma' x_{it-s} + \zeta_{it} \quad (2)$$

$$\varepsilon_{it} \sim N(0, \sigma^2_1) \quad (3)$$

$$\zeta_{it} \sim N(0, \sigma^2_2) \quad (4)$$

$$\sigma^2_2 / \sigma^2_1 = 1600 \quad (5)$$

where y_{it} is log of real GDP and y^*_{it} is its unobserved trend component. The residuals of state equation (1) and signal equation (2) are assumed to be a normally and independently distributed error with mean zero and variance σ^2_1 and σ^2_2. The so-called signal-to-noise ratio (σ^2_2 / σ^2_1) determines the relative variability of the estimated potential output series.

[1] Unlike Borio et al. (2013) and Borio et al. (2014) we do not use a dynamic version of HP-filter, which involves the addition of a lagged output gap term to the right hand side of (2). Unrestricted estimation of this term's coefficient yields a value close to unity, which is economically implausible. Arguably this may be due to insufficient variability of output gap for the relatively short time sample in emerging markets. Also, as shown in Borio et al. (2014), when using dynamic HP-filter smoothing parameter λ should be recalibrated for each specific case in order to make the results comparable with the static version. That would seriously complicate our analysis, which is based on pooled estimation.

We set this ratio at 1600, which corresponds to the smoothing parameter λ=1600 in a conventional univariate HP-filter. x_{it} represents indicators of imbalances with lag order[2] s.

Instead of relying on country-specific analysis we conduct a pooled estimation for the cross-section of emerging market economies. We believe that this may be appropriate given that (due to data limitations) in each individual case we are effectively limited to the analysis of only the last wave of large output fluctuations (i.e. before and after 2008). Technically this means that we specify a state-space model consisting of blocks comprising equations (1) and (2) attributed to individual countries in the cross-section. We thus allow for country-specific trend GDP (y^*_{it}) but assume common coefficients that link its developments with imbalance indicators (γ). We use a Kalman filter to obtain the maximum likelihood estimates of these parameters and the unobserved trend GDP.

3 Data

We follow the literature (most notably Alessi and Detken (2011) and Frankel and Saravelos (2010)) in our choice of imbalances indicators, using those that have produced robust results under a variety of specifications of the model[3]. We use the credit/GDP (C_t) and broad money/GDP (M_t) ratios, as well as stock market capitalization (S_t) (all in logs) as proxies for financial imbalances. We also use the share of gross fixed capital formation in GDP (INV_t). These are combined with traditional indicators of imbalances: annual CPI growth (π_t) and unemployment rate (U_t). All the data are standardized and seasonally adjusted and de-trended by means of the HP-filter (λ=100000)[4].

Our main data source is the IMF IFS database, except for gross capital formation shares and stock market capitalization data, which are from the World Bank WDI database.

[2] We tested s from 0 to 4 and found that it most cases s=1 yields the best results.

[3] We tested a broad range of indicators before making this selection. Most notably, indicators of external imbalances (trade balance, external debt, real effective exchange rate), although not included in the final model, worked well in other specifications. Also, admittedly, the availability of financial indicators for emerging markets is severely limited, making their compilation for the whole cross-section quite difficult. We therefore were unable to test some indicators that could potentially be useful (e.g. housing prices).

[4] This transformation is different from that of Borio et al. (2014), who use de-meaned growth rates. Such a transformation seems less applicable to emerging markets for which sample means are often not associated with equilibrium values (e.g. CPI mean growth in the case of gradual disinflation). Admittedly, de-trending the data exacerbates the end-point problem and thus worsens the real-time performance of the model. We have experimented with de-trending the imbalances variables jointly with GDP but, while the model becomes computationally heavier, the results are not significantly different.

We used quarterly data, and where only annual data were available we interpolated using cubic splines.

We were able to compile these indicators for a cross-section of 28 emerging market economies (Table 1). The model was estimated over an (unbalanced) time sample from 2000Q1 to 2012Q4. All available data were used for preliminary de-trending of imbalances indicators.

Table 1 Countries in the cross-section

Argentina	Czech Republic	Korea	Poland
Armenia	Ecuador	Latvia	Romania
Brazil	Estonia	Lithuania	Russia
Bulgaria	Georgia	Macedonia	Slovakia
Chile	Hungary	Malaysia	Slovenia
China	Indonesia	Mexico	Thailand
Croatia	Kazakhstan	Peru	Ukraine

4 Empirical results

We begin by estimating the bivariate versions of the model which include the imbalances indicators individually and then proceed by including all the indicators jointly (Table 2). With the exception[5] of the broad money/GDP variable, all variables have the expected signs and high statistical significance when included in the model together with inflation and unemployment. These results generally confirm the idea that developments in financial variables were associated with cyclical fluctuations of output and importantly can provide information about the state of the business cycle beyond that contained in conventional indicators (i.e. inflation and unemployment).

[5] For the models presented in Tables 2-4 we removed variables with “wrong” signs.

Table 2 Estimates of parameters γ (test statistics in parenthesis)

π_t	U_{t-1}	INV_{t-1}	S_{t-1}	C_{t-1}	M_{t-1}
0.08 (20.5)	-	-	-	-	-
-	–0.19 (–41.6)	-	-	-	-
-	-	0.14 (41.4)	-	-	-
-	-	-	0.16 (51.3)	-	-
-	-	-	-	0.08 (4.9)	-
-	-	-	-	-	0.01 (2.5)
0.03 (5.1)	–0.11 (–11.2)	0.08 (7.7)	0.16 (26.4)	0.05 (3.2)	-

We consider the resulting parameterization to provide a benchmark model even though arguably one may reasonably use a homogeneous cross-section that includes only relevantly similar economies (e.g. from one region). The caveat here is that it is also desirable to have a dataset that is balanced as regards the presence of boom/bust occurrences. For example, if our dataset only included European countries (most of which experienced dramatic output fluctuations) we would be unable to test the performance of the model in a more tranquil environment. Nevertheless, in order to check the robustness of the results, we also report the estimates obtained for the sub-samples. First, we split our cross-section into regional groups: Asia, Central and East Europe (CEE), former Soviet Union (FSU) and Latin America. As might be expected, the estimates (Table 3) were most ambiguous (only inflation and stock prices variables had significant coefficients with correct sign) for the Asian sub-group, where the boom/bust episode was less pronounced than in the other regions. On the contrary, all parameters were significant for European countries and, most notably, the credit variable's coefficient was much larger than in the benchmark model. The results obtained for the Latin American region are similar to the benchmark model, albeit the credit and inflation variables have low statistical significance.

Table 3 Estimates of parameters γ over regional sub-samples (test statistics in parenthesis)

Sub-sample	π_t	U_{t-1}	INV_{t-1}	S_{t-1}	C_{t-1}
Asia	0.02 (2.6)	–0.01 (–1.0)	-	0.07 (10.8)	-
CEE	0.04 (2.9)	–0.06 (–1.9)	0.08 (3.4)	0.2 (13.3)	0.19 (4.2)
FSU	0.04 (3.1)	–0.26 (–10.2)	0.07 (2.9)	0.17 (8.0)	0.13 (2.6)
Latin America	0.01 (0.3)	–0.09 (–3.9)	0.06 (2.8)	0.16 (11.3)	0.03 (1.4)

Asia: China, Indonesia, Korea, Malaysia, Thailand. **CEE**: Bulgaria, Croatia, Czech Republic, Hungary, Macedonia, Slovakia, Slovenia, Poland, Romania. **FSU:** Armenia, Estonia, Kazakhstan, Georgia, Latvia, Lithuania, Russia, Ukraine. **Latin America:** Argentina, Brazil, Chile, Ecuador, Mexico, Peru.

Another possibility is that the relevance of financial variables may vary depending on the size of the financial sector. We proxy financial depth by the credit/GDP ratio (averaged over 2000Q1–2012Q4) and divide our cross-section into quartiles: the first group containing the countries with the lowest credit/GDP ratios and the last group those with the highest. We find no distinct pattern in the results (Table 4). For example the credit variable performs best in the first and last quartiles, while the stock prices variable is highly significant over all sub-samples. We conclude that the relevance of financial indicators for cyclical output fluctuations variables is not conditioned by the size of the financial sector (at least as measured by credit/GDP ratio).

Table 4 Estimates of parameters γ over sub-samples by financial sector size (test statistics in parenthesis)

Sub-sample	π_t	U_{t-1}	INV_{t-1}	S_{t-1}	C_{t-1}
1st quartile	-	–0.14 (–6.7)	0.09 (2.9)	0.14 (3.5)	0.06 (2.1)
2nd quartile	0.05 (3.2)	–0.12 (–3.5)	0.06 (2.4)	0.18 (9.2)	-
3rd quartile	0.04 (2.9)	–0.1 (–3.7)	0.11 (4.3)	0.22 (11.4)	0.04 (1.2)
4th quartile	0.04 (3.3)	–0.09 (–3.7)	0.07 (3.0)	0.12 (11.1)	0.04 (1.6)

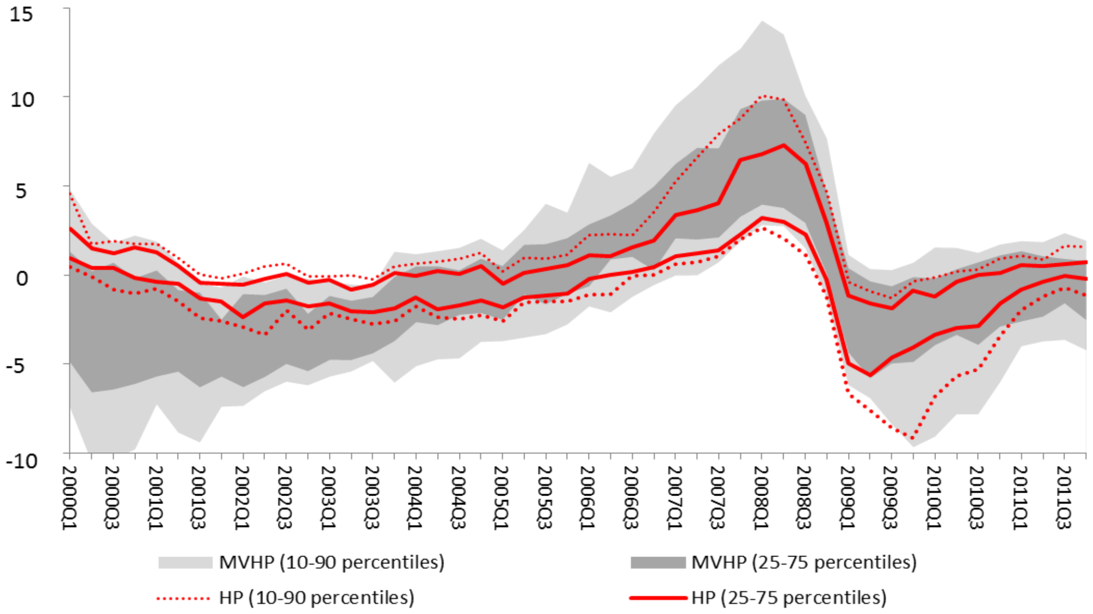
1st quartile: Argentina, Armenia, Ecuador, Georgia, Mexico, Peru, Romania. **2nd quartile**: Indonesia, Kazakhstan, Macedonia, Poland, Russia, Slovenia, Ukraine. **3rd quartile:** Brazil, Bulgaria, Croatia, Czech Republic, Hungary, Lithuania. **4th quartile:** China, Estonia, Korea, Latvia, Malaysia, Slovakia, Thailand.

5 Output gap estimates

5.1 General results

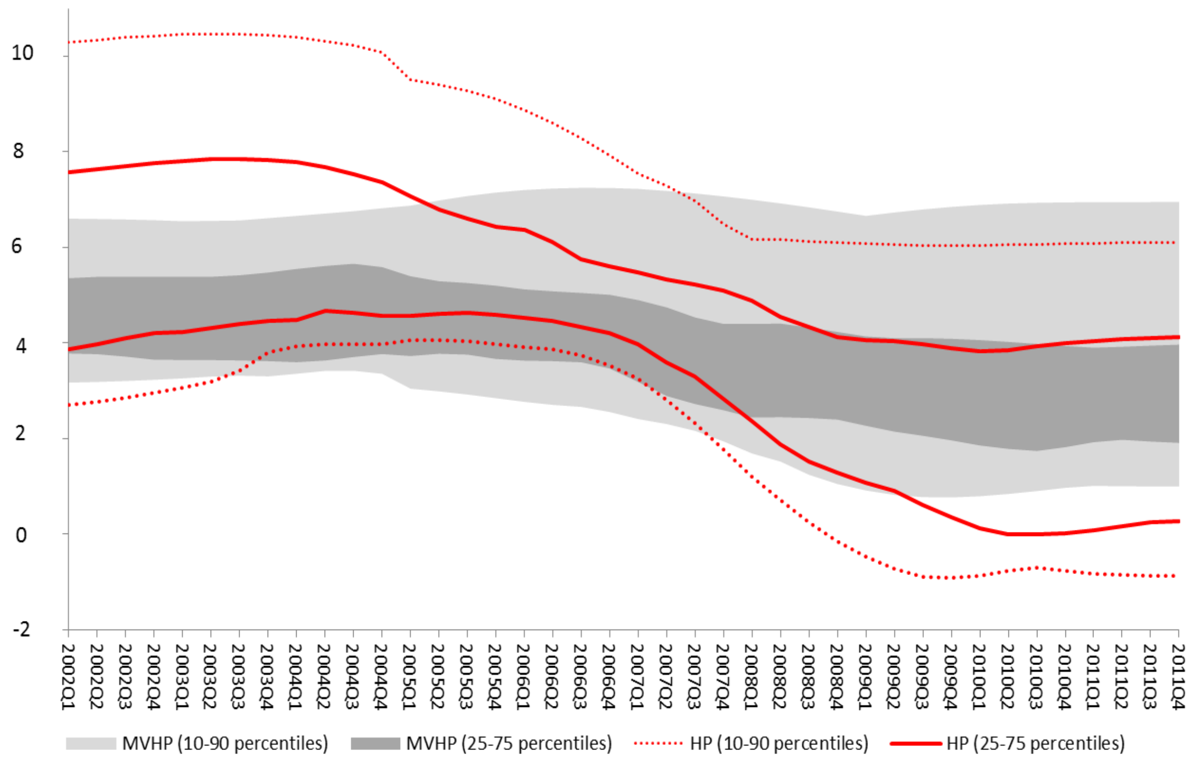
Using the benchmark parameterization reported in Table 2, we compute the trend and cycle components of GDP for all the countries in our cross-section. We can then compare the ranges of estimates of output gaps obtained with univariate and multivariate versions of the HP-filter (Figure 1). Several distinct differences may be identified as between two ranges. Prior to 2006, the standard versions of output gap were fluctuating close to zero, while the MVHP versions were mostly negative. At their peak in late 2007 the MVHP versions of output gaps are higher and after the crisis lower than standard HP versions. The variability and magnitude of fluctuations of MVHP versions are generally larger.

Figure 1 Ranges of output gap estimates (%)



The underlying reason for the difference between the two sets of estimates can be illustrated by plotting the growth rates of trend GDP (Figure 2). The growth rate estimates based on the univariate HP filter display notable variability, decreasing by about 4 p.p. in the second part of the time sample as compared to the pre-crisis level. This may of course be a true reflection of the severe damage that was dealt by the crisis to the potential economic growth. But more likely, given the relatively short time sample and magnitude of output fluctuation during the crisis, the unvariate filter "overfits" the data by introducing excessive variability into the trend and weakens its interpretation as the sustainable level of output. As regards the MVHP version, a part of the actual GDP fluctuations is explained by imbalance indicators ensuring a more stable trend GDP growth.

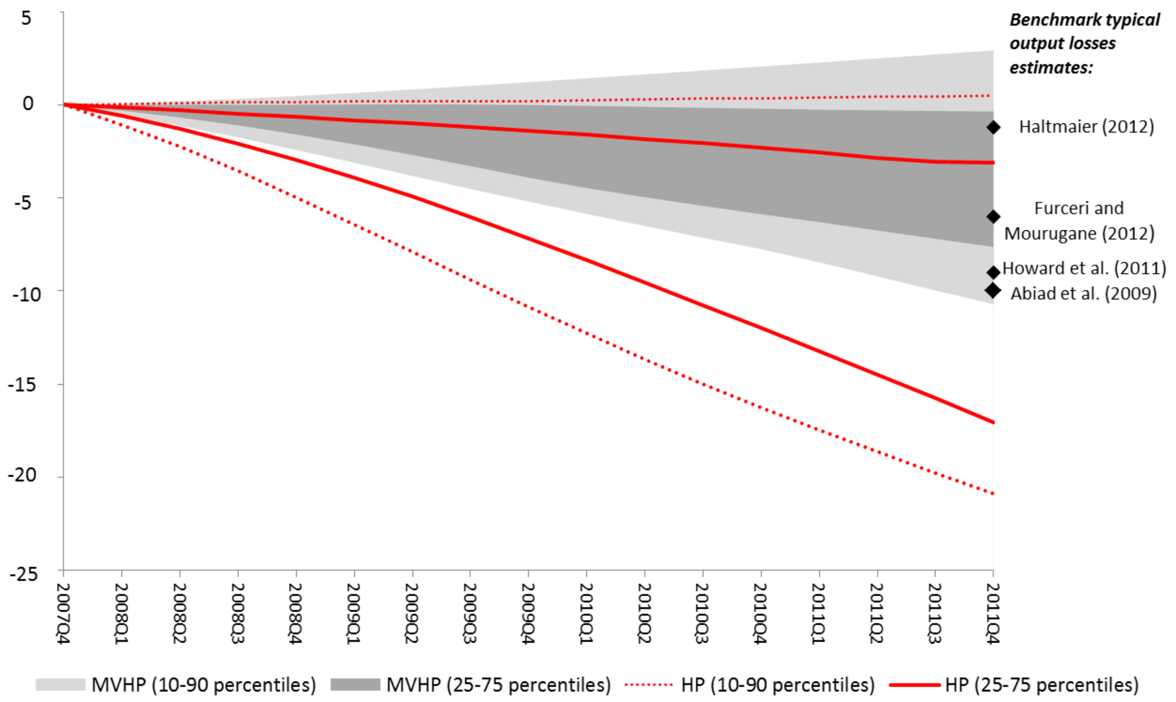
Figure 2 Ranges of trend GDP growth (y-o-y, %)



We also apply the concept of cumulated potential GDP losses to illustrate the difference between the two versions of the filter. To this end, for the period starting with 2008, we estimate the difference between actual trend GDP and the extrapolated[6] trend values. Interestingly, we may compare our results with estimates of typical output losses over previous recessions reported by existing studies[7]: Abiad et al. (2009), Furceri and Mourougane (2012), Haltmaier (2012) and Howard et al. (2011). The results obtained with MVHP-filters are generally in line with these estimates while standard HP-filters indicate that the output losses after recent crisis were notably larger than on average in the historical cases.

[6] For extrapolation, we use the average growth rate of trend GDP in 2005-2007.
[7] We report the resultant values of output evolution after banking crises estimated in Abiad et al. (2009) and output as a percentage of pre-crisis trend after deep and long recessions in emerging economies reported in Howard et al. (2011), estimated impact of severe financial crisis reported in Furceri and Mourougane (2012), average cumulative level change of potential output in emerging markets after stand-alone recessions reported in Haltmaier (2012).

Figure 3 Ranges of cumulative output losses estimates (% of pre-crisis trend)



5.2 Country-specific results: the case of Russia

We expand on our findings by providing more detailed results from our model's application to GDP fluctuations in Russia. Similarly to the general results for the whole cross-section, the MVHP output gap estimate is wider at its peak and narrower after the crisis compared to the HP version (Figure 4). This implies that the annual growth trend decreased from about 5% to 3% after the crisis (from 6% to 2 % in case of univariate filtering) (Figure 5).

Figure 4 Output gap estimates for Russia (%)

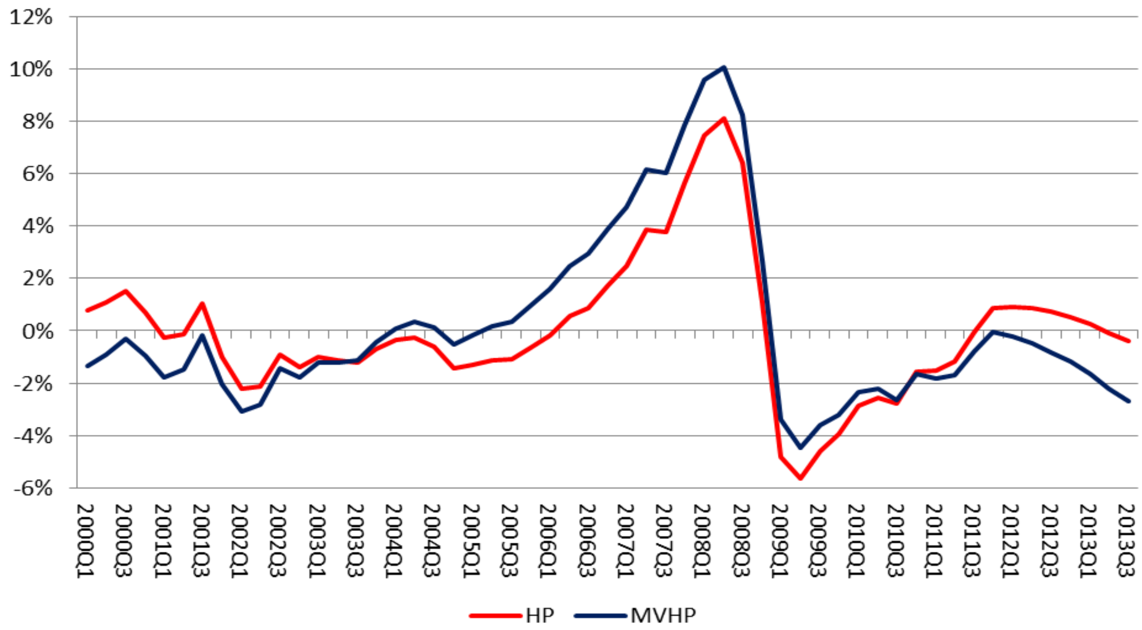
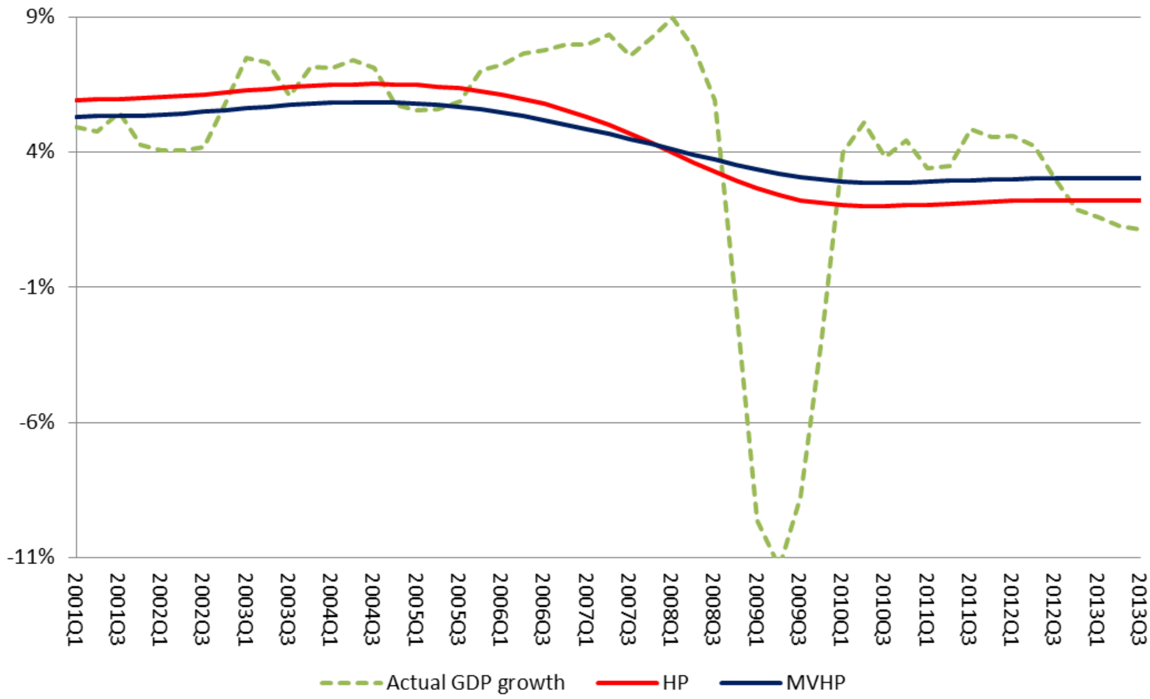
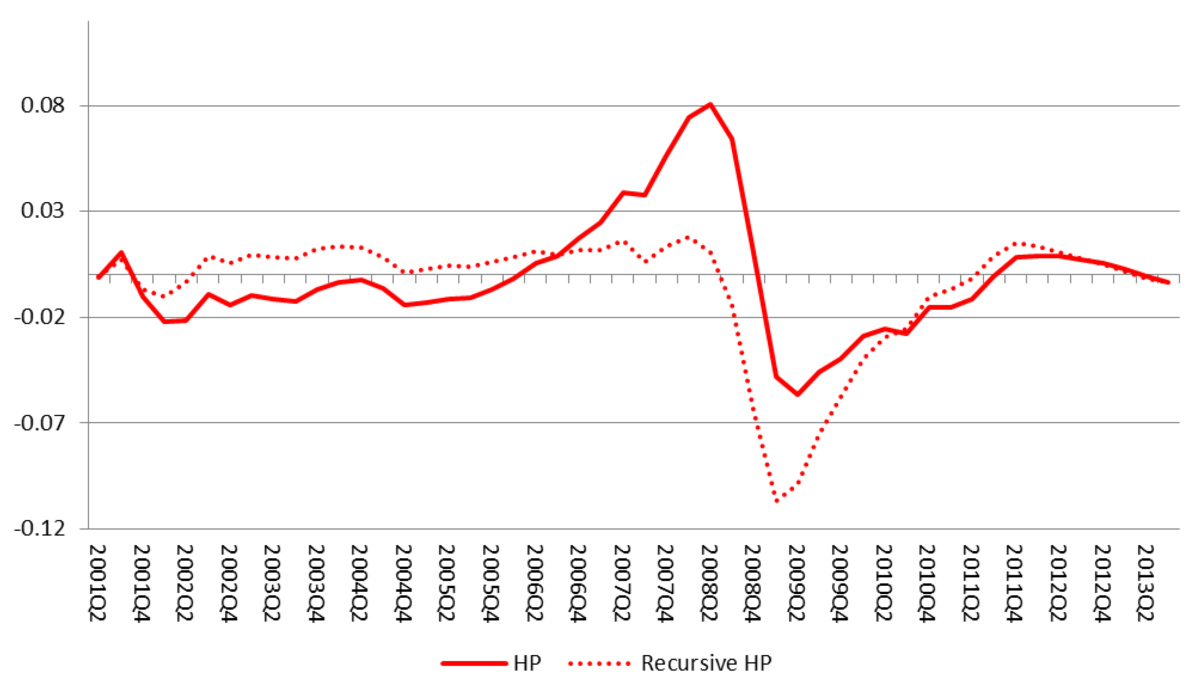


Figure 5 Actual and trend GDP growth estimates for Russia (y-o-y, %)



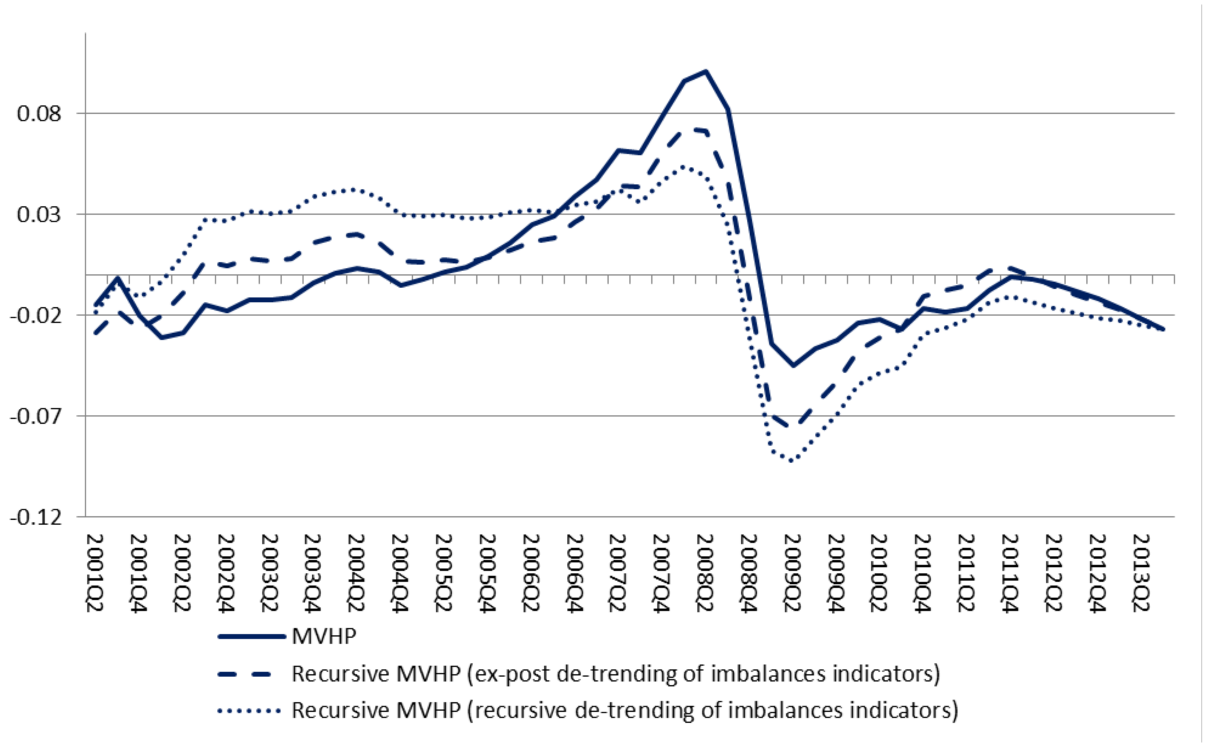
The recursive estimates (Figure 6) show that application of the univariate HP filter to the Russian GDP was not sufficiently informative. Multivariate filters may potentially improve the real time performance of the analysis. We conduct quasi[8] recursive estimates using the MVHP version of the filter (Figure 7). These estimates are much more stable over time. The caveat is that this is no longer the case when imbalances indicators are also de-trended recursively. Apparently the model is quite sensitive to the end-point problem that arises at the preliminary step.

Figure 6 Recursive HP-filter output gap estimates for Russia (%)



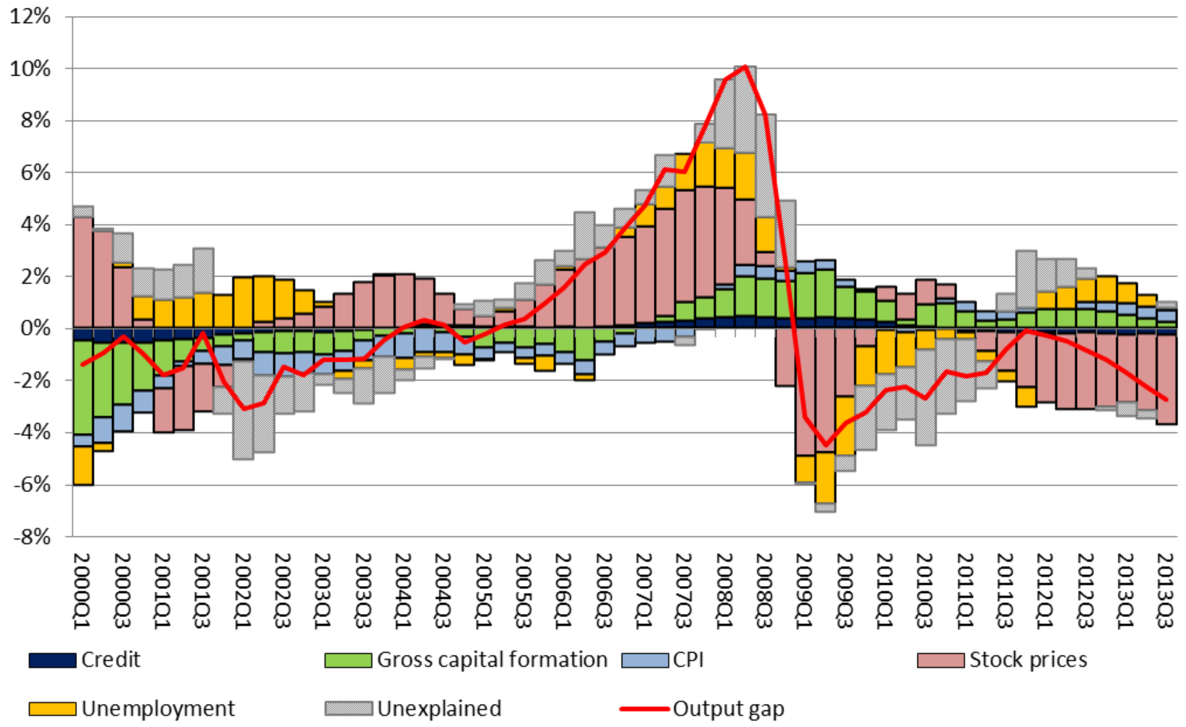
[8] We assume that parameterization γ is known and does not conduct recursive estimates for the pooled data-set. We are not able to fully replicate the real-time analysis because in our sample most of the information on boom/bust occurrence comes in one batch.

Figure 7 Recursive MVHP-filter output gap estimates for Russia (%)



Finally, we may examine the contributions from different indicators to the explained part of output gap (i.e. $\gamma' x_{it-s}$) (Figure 8). The results show that prior to the crisis all imbalance variables unanimously indicated that the GDP was above the sustainable level. For the post-crisis period, the results are ambiguous. Stock price developments is the most important indicator for explaining output gap fluctuations, followed by gross capital formation and unemployment. Credit developments and CPI inflation do not play an important role (at least under this parameterization). Admittedly, our model is purely empirical and does not have structural interpretation. It is therefore impossible, based on our results, to say that stock market developments as such were the underlying factor behind output gap formation in Russia. Instead we may argue that stock prices could be regarded as a good summary indicator for financial conditions in the economy (perhaps serving as proxy indicator for e.g. asset price developments, capital inflows, risk perception) and that, based on the observed asset price boom on the Russian stock market, one can analyse the deviation of output growth from sustainable path.

Figure 8 Contributions of individual imbalance indicators to explaining the output gap in Russia (%)



6 Conclusions

During the recent financial crisis, doubts have been expressed as to the relevance and usefulness of conventional approaches to output gap estimates. Thinking of potential output only as non-inflationary output or output not associated with reduced unemployment rate had proved to be too restrictive. Recent history has demonstrated that other imbalances, notably in the financial sector and in asset markets, can emerge while inflation and unemployment remain stable. In our paper we present a model that helps to incorporate the information contained in financial indicators into the estimation of sustainable output growth in emerging market economies.

We specify a state-space model representing a multivariate HP-filter that links cyclical fluctuation of GDP with several indicators of macroeconomic imbalances. The latter include financial variables as well as conventional CPI inflation and unemployment rate. We obtain the parameterization of the model by estimating it jointly for a cross-section of emerging market economies. The results indicate that imbalance indicators are statistically significant in explaining the output gap fluctuations (in particular in case of European countries), meaning that they contain information beyond that contained in inflation and unemployment variables. A stock price indicator seems to perform especially well. As the model has no structural interpretation this does not mean that stock market developments as such were the main factor behind the output gap fluctuations. Nevertheless, one might well claim that a rise in stock prices is an important symptom that could help to distinguish between trend and cyclical output growth acceleration.

The output gaps obtained on the basis of the estimated model differ substantially from those calculated with univariate version of HP-filter. Most notably, trend output growth rates are more stable and therefore more consistent with the notion of sustainable output. Cumulative output losses after the recession in 2008, estimated on the basis of a multivariate filter are (unlike those estimated with a univariate version) are comparable with typical episodes reported in the literature. Employing the multivariate filter may help to improve the real-time robustness of the model, although our approach is still quite sensitive to the end-point problem associated with transformation of imbalance variables.

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