WP/11/79

IMF Working Paper

Mongolia: Measuring the Output Gap

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INTERNATIONAL MONETARY FUND

 WP/11/79

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Asia and Pacific Department

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Authorized for distribution by Nigel Chalk

April 2011

Abstract

This paper compares the output gap estimates for Mongolia based on a number of different methods. Special attention is paid to the substantial role of mining in the Mongolian economy. We find that a Blanchard and Quah-type joint model of output and inflation provides a more robust estimate of the output gap for Mongolia than the traditional statistical decompositions.

JEL Classification Numbers: E32; C22; C32

Keywords: Mongolia, Output Gap, Nonmineral GDP, Blanchard-Quah Decomposition

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[1] We thank Steven Barnett, Fred Joutz, and Leandro Medina for valuable comments and Janice Lee for research assistance. All remaining errors are ours.

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I. INTRODUCTION

The Mongolian economy has been growing at an average 6 percent during the last 10 years. However, growth has also fluctuated sharply from 1 percent in 2000 to 10 percent in 2007 and to -1.6 percent in 2009. In the early 1990s Mongolia transitioned from a centrally planned to a market economy which brought about structural changes that can partly explain the strong but volatile growth pattern. Exceptional events such as the severe winters (Dzud) that occasionally happen in Mongolia's harsh climate, for example in the winters of 2000–01 and 2009–10, and the sharp increase in copper prices in 2006–07 followed by a collapse in late 2008 help explain some of the "boom-bust" cycles. However, these shocks only affect the Mongolian economy as strongly because they hit a barely diversified economy in which agriculture (mostly livestock) and mining (mostly copper) account each for around 20 percent of GDP (see Figure 1), and because fiscal and monetary policy tend to be procyclical.

Making the economy more resilient to external shocks is challenging. It takes time to diversify the economy, hence, leaving policymakers with the task to ensure macroeconomic stability in the near future. To pursue more countercyclical macroeconomic policies, policymakers need to assess the current state of the economy. The output gap is a key concept in assessing the economic situation and designing appropriate macroeconomic policies. Defined as the difference between potential and actual output, a positive output gap indicates that aggregate demand exceeds aggregate supply leading to inflationary pressures while a negative output gap is associated with recession and disinflation. When the output gap is closed, the economy is operating at potential, that is, the maximum output level that is consistent with low and stable inflation. Measuring the output gap is not straightforward as it cannot be directly observed and has to be inferred from other macroeconomic aggregates. Furthermore, concerns over data quality and availability complicate the task (further discussion below).

The Bank of Mongolia recently changed from using an output gap measure based on a statistical filter applied to real GDP alone (based on the Hodrick-Prescott, 1997, filter) to an output gap measure based on a joint model of real GDP and inflation using a Blanchard and Quah (1989)-type decomposition. The purpose of the present study is to compare different output gap measures and assess their suitability for policymaking. To the best of our knowledge, no research has previously been published on output gap measures for Mongolia. As for any economy, a good output gap measure should have good end-point properties and be stable, that is, it should adequately characterize the current state of the economy and the assessment should not change substantially as new data becomes available. In addition, Mongolia differs from most other economies in the importance of mineral production in the economy (see Figure 1). Variations in mineral production are outside policymakers' control and are best thought of as structural changes that affect potential GDP. Therefore, we will measure the output gap both for overall GDP and nonmineral GDP, that is, excluding mineral GDP. As movements in mineral GDP should appropriately be captured in the trend and not the cyclical component, a good output gap measure should yield similar results for both GDP measures and we will use this as an additional criterion in evaluating output gap measures for Mongolia.[2]

We compare three commonly used statistical output gap measures: linear detrending; the Hodrick-Prescott (1997) filter with different smoothing parameters; and an asymmetric frequency filter, the Christiano Fitzgerald (2003) filter; with an economic measure: a bivariate Blanchard-Quah decomposition using long-run economic restrictions based on the relationship between inflation and real GDP for Mongolia.[3]

After describing the data, we present the different output gap measures in Sections III and IV for overall GDP, while in Section V we compare them with the same output gap measures applied to nonmineral GDP. In Section VI we analyze potential output for overall and nonmineral GDP derived from the Blanchard-Quah decomposition which seems the most suitable output gap measure for policymakers in Mongolia. Section VII concludes.

II. Data

Our analysis uses quarterly real GDP for 1998Q1 until 2010Q3. The sample is very short compared to the length of time series normally used but it is the longest available time series for Mongolia. It is likely to cover only around three to four business cycles, making the use of more sophisticated methods infeasible. The Mongolian economy is highly seasonal; furthermore, there are concerns that the measurement of quarterly GDP (collecting quarterly data on a year-to-date basis and hence accumulating all data revisions in the last quarter of the year) further distorts the data.[4] Therefore, it is very important to seasonally adjust quarterly GDP. We use the X12-Arima procedure in Eviews (U. S. Census Bureau). Panels 3 through 6 of Figure 1 present the seasonally unadjusted and adjusted data for real GDP and nonmineral real GDP. As illustrated in the first panel of Figure 1, mining plays an important role in the Mongolian economy. However, as mining in Mongolia is very capital- but not labor-intensive and the minerals extracted are almost exclusively exported, the impact on aggregate domestic demand is quite limited. Therefore, we are interested in the differences in the output gaps found by the various measures when applied to total GDP versus nonmineral GDP. A proper output gap measure should be similar for the two data series since the output gap should exclude structural movements. We begin the analysis focusing on total real GDP

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[2] The importance of measuring separately the output gap for the natural resource and nonnatural resource sectors for commodity exporters is discussed, for example, in Villafuerte, Lopez-Murphy, and Ossowski (2010) and Magud and Medina (2011). Villafuerte et al. use the nonresource output gap to assess the cyclicality in fiscal policy in nonrenewable resource exporters in Latin America and the Caribbean. Magud and Medina analyze the differences in potential output in the natural-resource (mining, agriculture, and fishing) and nonnatural-resource sectors in Chile and the nonlinear contributions to potential growth of the sectors.

[3] For low-income countries and emerging market economies the empirical and policy-oriented literature commonly resort to either the Hodrick-Prescott filter, for example, Ochirkhuu (2010) for Papua New Guinea; or a battery of output gap measures, for example, Medina (2010) for Peru; Magud and Medina (2011) for Chile, Faal (2005) for Mexico, and El-Ganainy and Weber (2010) for Armenia.

[4] The National Statistical Office in Mongolia is in the process of revising and improving quarterly GDP measures.

and then in Section V we compare the results from the different filters for total versus nonmineral real GDP.

III. UNIVARIATE OUTPUT GAP MEASURES

A. Linear Trend

As a first statistical method to measure the output gap, we estimate the output gap as the deviations of the series from a simple linear trend. We also check for structural breaks by applying the Quandt-Andrews unknown breakpoint test to the mean of real GDP but we are unable to reject the null hypothesis that there are no breakpoints within the trimmed data (using 5 percent or 15 percent trimming). Therefore we do not include any structural breaks in our trends.[5] The estimated output gap is presented in the first panel of Figure 2. Based on this method, the output gap appears to be positive at the beginning and ending of the sample and negative over most of the 2001–06 period.

B. Hodrick and Prescott (HP) Filter

The Hodrick and Prescott (1997) filter is probably the most commonly used method to decompose a GDP series into trend and cycle. This filter is a two-sided smoothing method that minimizes both the fluctuations of the cycle and the trend, conditional on a smoothing parameter, lambda. The parameter lambda determines to what extent variability in the trend as compared to the cycle is allowed for; the higher the lambda, the smoother the trend. For quarterly data, the standard value for lambda is 1600 and has been calibrated for U.S. GDP data. However, this might not be an appropriate parameter value for developing countries where the trend might be much less smooth (and therefore require a smaller lambda, see discussion in Canova, 1998). Following Canova (1998), we use different lambdas (ad hoc choice of 8, 40, and 1600) to see how sensitive the measured output gap is.[6] The second panel of Figure 2 shows the output gap estimates derived.

For the first part of the sample, up through 2006, the estimates do not appear very sensitive to our choice of lambda. For the later part of the sample, however, there are some substantial differences. During the recent boom period, the estimated output gap is much smaller when using a lower smoothing parameter. One reason for this difference could be that the boom in 2007–08 was not a pure business cycle phenomenon but also a structural change in the economy. If this is the case, then a lower smoothing parameter for Mongolia than the traditional 1600 would indeed be appropriate. The differences are particularly apparent at the end of the sample, where lambda even determines the sign of the output gap: after the crisis in 2009, the output gap closes when taking a lower lambda but remains negative with a

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[5] Similar results were found with structural break tests applied to nonmineral real GDP.

[6] The HP filter is equivalent to the smoothed trend from an unobserved components model with a stochastic trend component and a random irregular term. The signal-to-noise ratio, that is, the ratio of the variance of the trend shock over the variance of the irregular shock, is equal to the inverse of the HP smoothing constant (Harvey and Trimbur, 2008). This means that a smaller lambda is associated with a higher signal-to-noise ratio.

lambda of 1600. The remainder of this analysis will use the HP filter with a smoothing parameter of 40 which appears more appropriate for a developing country.

As is well known, the HP filter has end-point problems as it is a two-sided filter and the assessment might change substantially when new data are added. Panel 3 of Figure 2 illustrates the sensitivity of the output gap measure to new data: for example, using real time data, the boom in 2008 was not detected. This makes the HP filter a problematic output gap measure as it might fail to correctly measure the current state of the economy relative to potential and hence lead to inappropriate policy decisions.

The seasonally adjusted quarterly GDP series is very volatile, hence, it might be an option to take a four-quarter moving average and then apply the HP filter. This approach suggests that there is a much smaller (and by construction less volatile) output gap than when we apply the HP filter directly to the seasonally adjusted real GDP data (panel 4 in Figure 2).

The advantage of the HP filter is that it is an easy method and widely used. The downsides are the end-sample bias which calls into question its suitability for forward-looking policy decisions and the sensitivity to the choice of the smoothing parameter.

C. Christiano Fitzgerald Frequency Filter

Band pass filters are designed to eliminate high and low frequency movements in the data using a two-sided symmetric moving average. A two sided symmetric filter is not appropriate for policy analysis, which is mainly focused on assessing the current state of the economy (except if sufficiently good forecasts of GDP are available that can be included). Christiano and Fitzgerald (2003) construct a filter that is nonstationary, asymmetric, and depends on the time series properties of the underlying data. The idea is that the ideal band pass filter decomposes a time series into different frequency components through a linear transformation of the data that leaves the components for a specified frequency band intact and eliminates all other components. The ideal filter requires an infinite data set and hence an approximation is needed. Christiano and Fitzgerald construct an approximation to the ideal band pass filter which is optimal when the underlying raw data follow a random walk. Panel 5 of Figure 2 depicts the resulting output gap and also shows that new observations lead to backward revisions but that these are limited (i.e., less than with the HP filter). The recent boom-bust cycle in 2007–10 does appear to have a larger amplitude than the preceding cycles based on later data. This output gap measure is appealing because it suggests a smaller number of cycles than the HP filter and this appears economically more plausible.

D. Comparison of Statistical Filters

The most striking difference between the output gaps measured by the different filters is that very few periods are consistently assessed as positive or negative (panel 6 in Figure 2). Only the boom-bust cycle in 2007–09 and a negative gap in late 2005–early 2006 were jointly identified. While the current state of the economy is assessed as a positive output gap by the HP filter, the linear trend and the Christiano-Fitzgerald filter show a closing, but still negative output gap. As the statistical filters do not present a robust output gap measure, additional economic information may help in identifying the appropriate output gap. We turn to this in the next section.

IV. MULTIVARIATE OUTPUT GAP MEASURE: THE BLANCHARD-QUAH DECOMPOSITION

A. The Blanchard-Quah (BQ) Output Gap

The statistical filters previously discussed rely exclusively on the information provided in a single series to identify the output gap. Blanchard and Quah (1989) go a step further and exploit long-run economic relationships with other macroeconomic variables to identify separate (supply and demand) shocks. They define the output gap as the accumulation of demand shocks. More specifically, in their model of the United States they use the unemployment rate in addition to real GDP to identify the underlying shocks. For identification, they assume that the two types of disturbances are uncorrelated and neither has a long-run effect on unemployment. Furthermore, they assume that one type of shock has a long-run effect on output (supply shock) while the other type of shock does not (demand shock).

For Mongolia, we use the inflation rate as an additional macroeconomic variable instead of the unemployment rate, the reason being that unemployment data are not very informative due to high informal (un)employment and underemployment. Unit root tests (Augmented Dickey Fuller test and Kwiatkowski, Phillips, Schmidt, and Shin test) confirm that the log of seasonally-adjusted real GDP is integrated of order 1 while the inflation rate is stationary. The inflation data are presented in the first panel of Figure 3.

We estimate a structural VAR on the first difference of the log of seasonally-adjusted real GDP and the quarter-on-quarter seasonally adjusted headline inflation rate imposing Blanchard and Quah's long-run restriction for identification.[7] The lag length selection criteria suggest using four lags. The output gap series is then constructed as reflecting only the effect of demand disturbances using the recovered structural demand shocks and the (noncumulative) Impulse Response Function. The derivation of the output gap requires setting a starting point at which the gap is closed. Following the Bank of Mongolia, we choose to set the output gap equal to zero in the first quarter of 2000.[8]

The second panel of Figure 3 presents our estimates of the BQ output gap for Mongolia. According to these estimates, the output gap was negative for most of the sample with a large boom in 2008 followed by a bust and then a smaller boom at the beginning of 2010 again followed by a bust. Demand shocks may be playing a larger role near the end of the sample for a number of reasons. One possibility is that the global boom-bust transmitted to Mongolia and brought an unusually outsized demand shock to the country. In the absence of further large global demand shocks, we would expect that in the future the output gap would look more like the historical one with only a small role for demand shocks. An alternative explanation could be that Mongolia's economy is maturing so that there are fewer structural shocks but more room for demand shocks, as is common among more developed economies.

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[7] Administered prices account for some 20 percent of the CPI basket and it would be more appropriate to use a market-determined inflation measure excluding administered prices. However, this data are not available for the whole sample period and the cost of further reducing the already short sample seemed too high.

[8] This assumption affects the absolute level of the output gap, but not its relative movements.

B. Comparing the Multivariate to the Univariate Output Gap Measures

In terms of smoothness and number of cycles the BQ gap appears most similar to the Christiano-Fitzgerald filter (panel 3 in Figure 3). The BQ gap estimate suggests that there was little cyclical movement in the early part of the sample where the statistical filters disagreed on the number and timing of turning points. All estimates find a boom in 2008 and a bust in 2009.

Further insight is needed to clearly select the best measure for the output gap. In the case of Mongolia, there is reason to believe that a proper measure of the output gap should be similar whether derived from total or from only nonmineral GDP. In particular, variations in the output from mineral mining will in general not be due to domestic demand and therefore should not be part of the output gap. Thus, in the next section we apply both the statistical filters and the BQ approach to nonmineral GDP.

V. NONMINERAL GDP

Mineral output and value added in mining do not depend on demand conditions and do not move with the business cycle. For example the volume of copper exported (and mined) has remained unchanged throughout the last boom-bust cycle. Variations in mineral production are better thought of as structural changes that affect potential GDP as it is structural changes like the exploitation of a new mine or the reduction of reserves in an existing mine that drive mineral GDP. Furthermore, mining in Mongolia is very capital intensive (mostly foreign capital) and employment is quite limited hence playing a minor role for aggregate domestic demand. Therefore, we will measure the output gap both for overall GDP and nonmineral GDP, that is, excluding mineral GDP. As movements in mineral GDP should appropriately be captured in the trend and not the cyclical component, a good output gap measure should yield similar results for both GDP measures and we will use this criterion to choose a robust output gap measure for Mongolia.

Indeed, the output gap derived with the HP filter, the Christiano-Fitzgerald filter, a linear trend and the Blanchard-Quah decomposition is broadly the same for nonmineral and overall GDP (see figure 4). A few differences are that the Christiano-Fitzgerald filter has some differences in the sign of the output gap between 2002 and 2004, the linear trend produces a slightly smoother output gap measure for nonmineral than for overall GDP and for the BQ decomposition the transition from positive to negative output gap for nonmineral GDP once slightly lagged behind. Overall, however, it appears that the BQ decomposition has the smallest difference between the two measures both in terms of magnitude and in terms of missed turning points. Therefore, including the additional economic information in the inflation measure seems to improve upon the simple univariate filters. Thus, we use the BQ decomposition as our preferred measure of the output gap.

VI. Potential GDP

Based on the BQ output gap, we next construct a corresponding measure of potential output. We report here the log of potential output which we define as follows:

$$\ln(\text{potential GDP}) = \ln(\text{actual GDP}) - (\ln(\text{gap}/100) + 1).$$

Based on our estimates, presented in Figure 5, we can see that the potential output for Mongolia is almost as volatile as the GDP series itself. This is a common finding for developing countries. For example, Aguiar and Gopinath (2007) find that shocks to trend growth are the primary source of fluctuations in emerging economies rather than transitory fluctuations around a stable trend.[9] This appears to be particularly true in the early part of the sample where the BQ decomposition identifies the fluctuations in both mineral and nonmineral real GDP as arising from movements in potential output. In the later part of the sample, potential output appears smoother with actual output deviating substantially from potential with a boom around 2008 and a bust around 2009. The smoothness of potential output begins sooner for nonmineral GDP than for overall GDP, but their overall pattern is similar.

The increased smoothness in potential output over time could be explained by large structural changes as the Mongolian economy developed and fewer structural shocks as the economy matures. Alternatively, it could be that there were simply fewer structural shocks either globally or locally during the last few years and more structural shocks may return in the future.[10] Large mining projects, such as the Oyu Tolgoi and Tavan Tolgoi mines, expected to come on stream in the next couple of years make further large structural changes likely.

VII. Conclusion

In this paper we construct output gap estimates for Mongolia based on a number of different methods. In particular, we compare the estimates from univariate statistical filters to a Blanchard and Quah-type model which includes the additional economic information provided in inflation data from Mongolia. We find that the Blanchard and Quah-type joint model of output and inflation provides a more robust estimate of the output gap for Mongolia than the traditional statistical decompositions. In particular, the results are similar whether we apply the approach to overall real GDP or nonmineral real GDP. This is important for a country like Mongolia where a large sector of the economy, here mining, is not subject to traditional demand pressures and is almost entirely for export purposes. The additional economic information provided through the inflation data helps better identify demand versus supply shocks and therefore is a substantial improvement over univariate statistical filters as a policy-relevant output gap measure.

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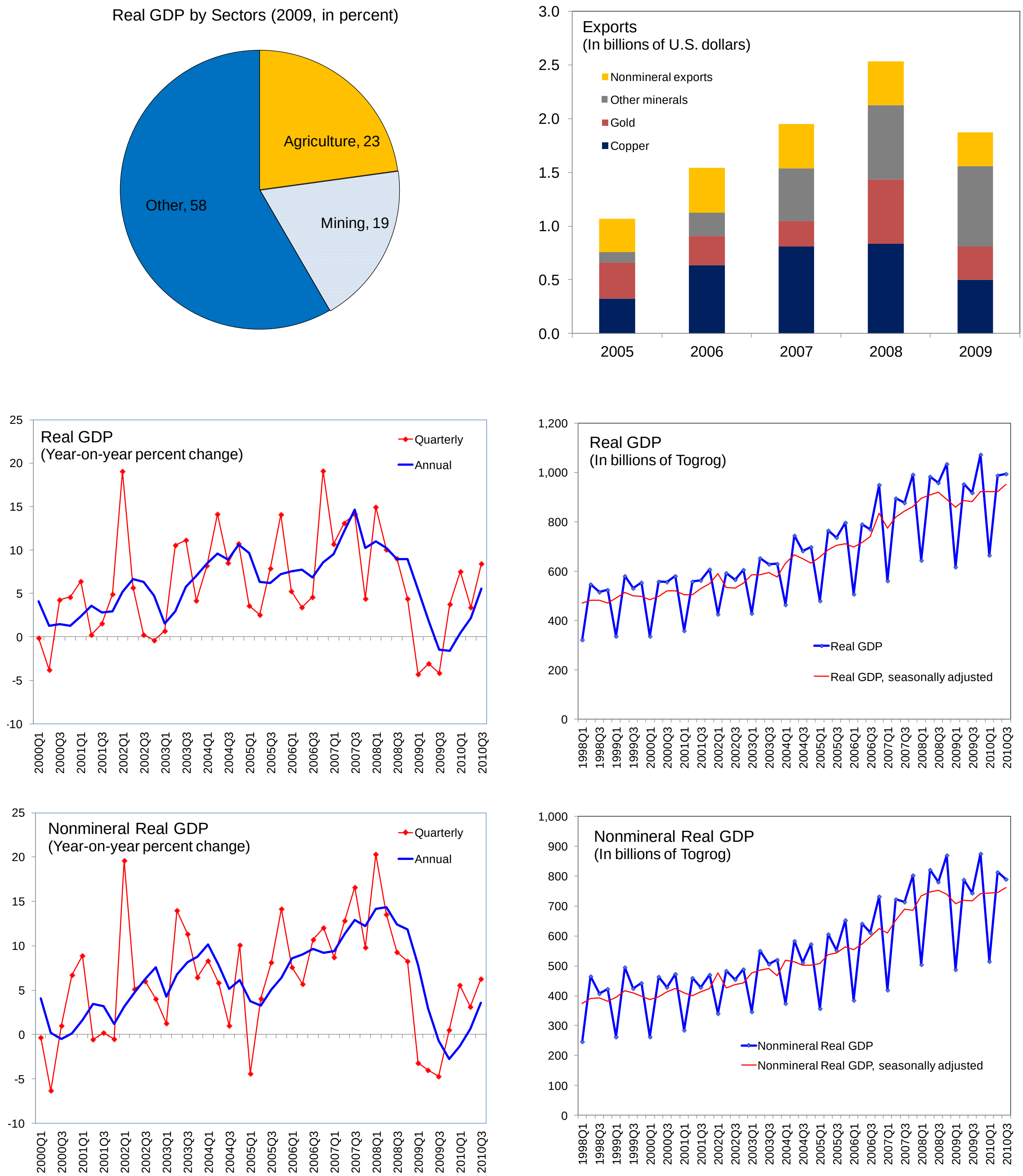
[9] Similarly, Becker and Mauro (2006) find specifically that "output drops" caused by real shocks are more common for developing countries.

[10] One way to explore this further would be to allow for time variation in the relationships among the parameters, similar to the approach of Kara et al. (2007). Our sample, however, is too short for such an approach.

We also estimate potential output based on our preferred output gap measure and find that potential output for Mongolia has become smoother over our sample suggesting a reduction in structural shocks. The output gap estimate suggests, however, that there was a large boom around 2008 followed by a bust in 2009. In the earlier part of the sample, there appears to be little cyclical movement for Mongolia.

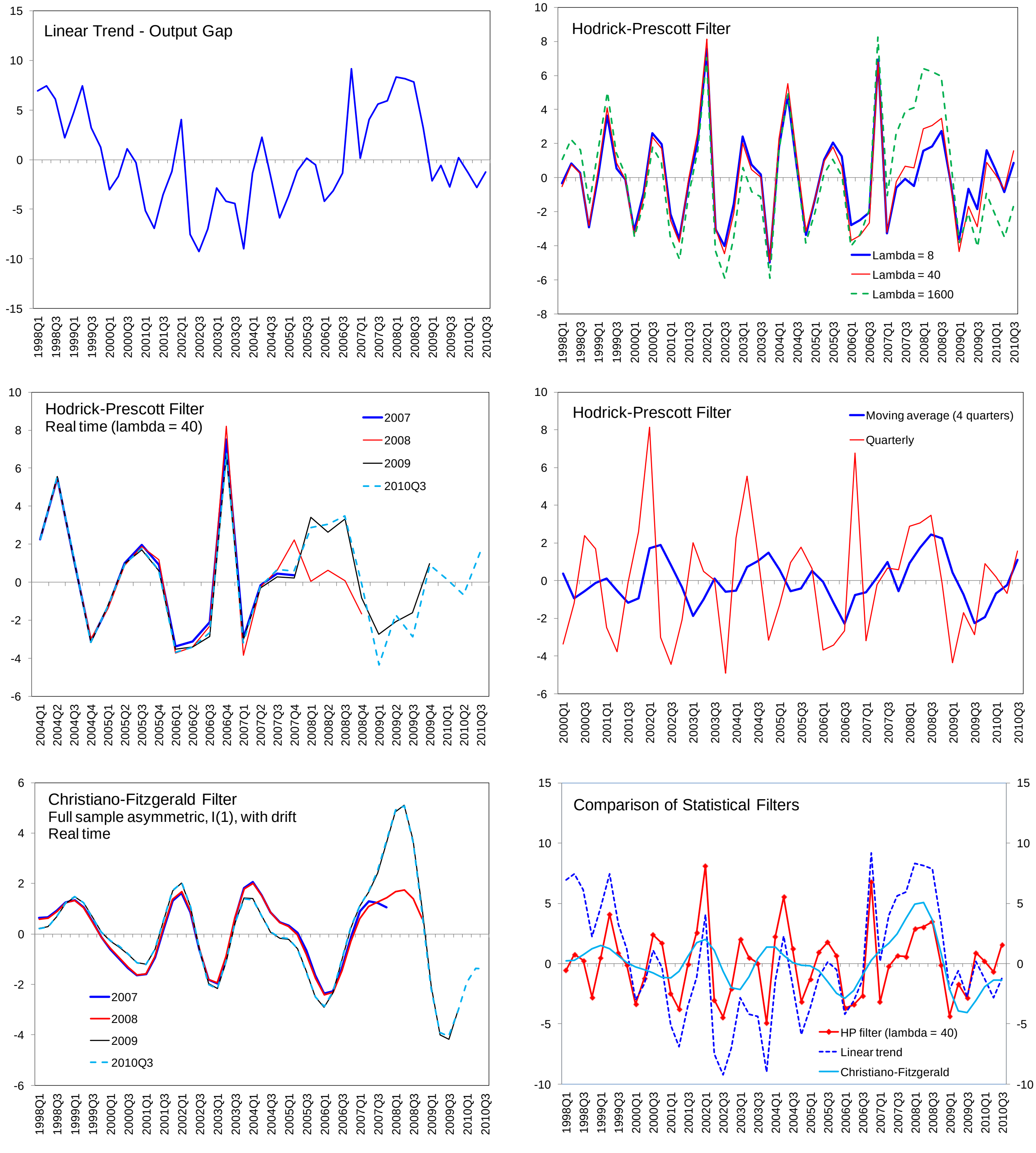
Our approach could easily be extended to other countries. In particular, the idea of comparing output gap estimates from overall GDP versus output gap estimates from a GDP measure that excludes sectors that economic theory suggests do not experience demand shocks should be helpful in identifying a robust output gap measure.

Figure 1. GDP and Exports



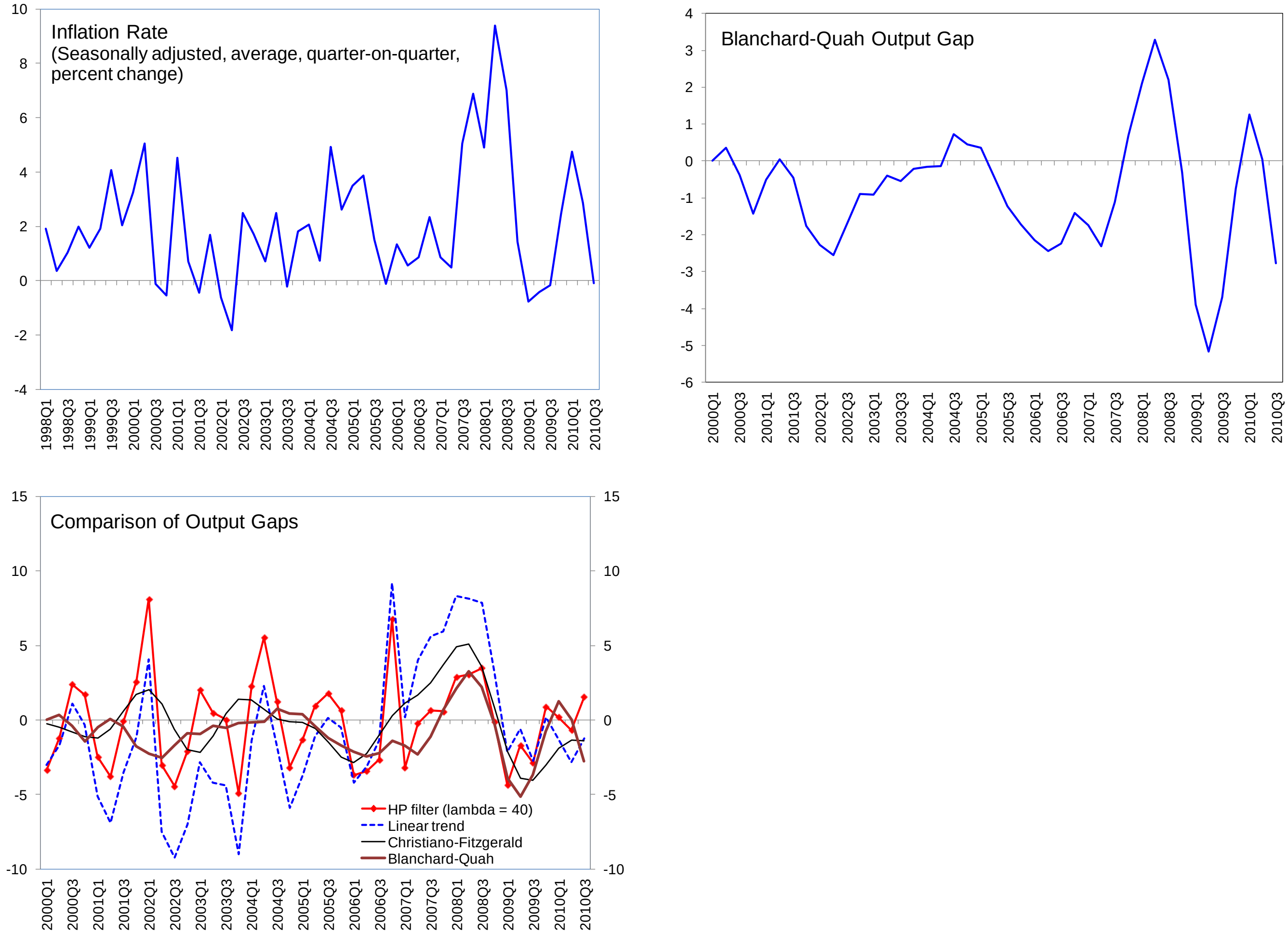
Sources: Mongolian authorities; and IMF staff estimates.

Figure 2. Univariate Output Gap Measures



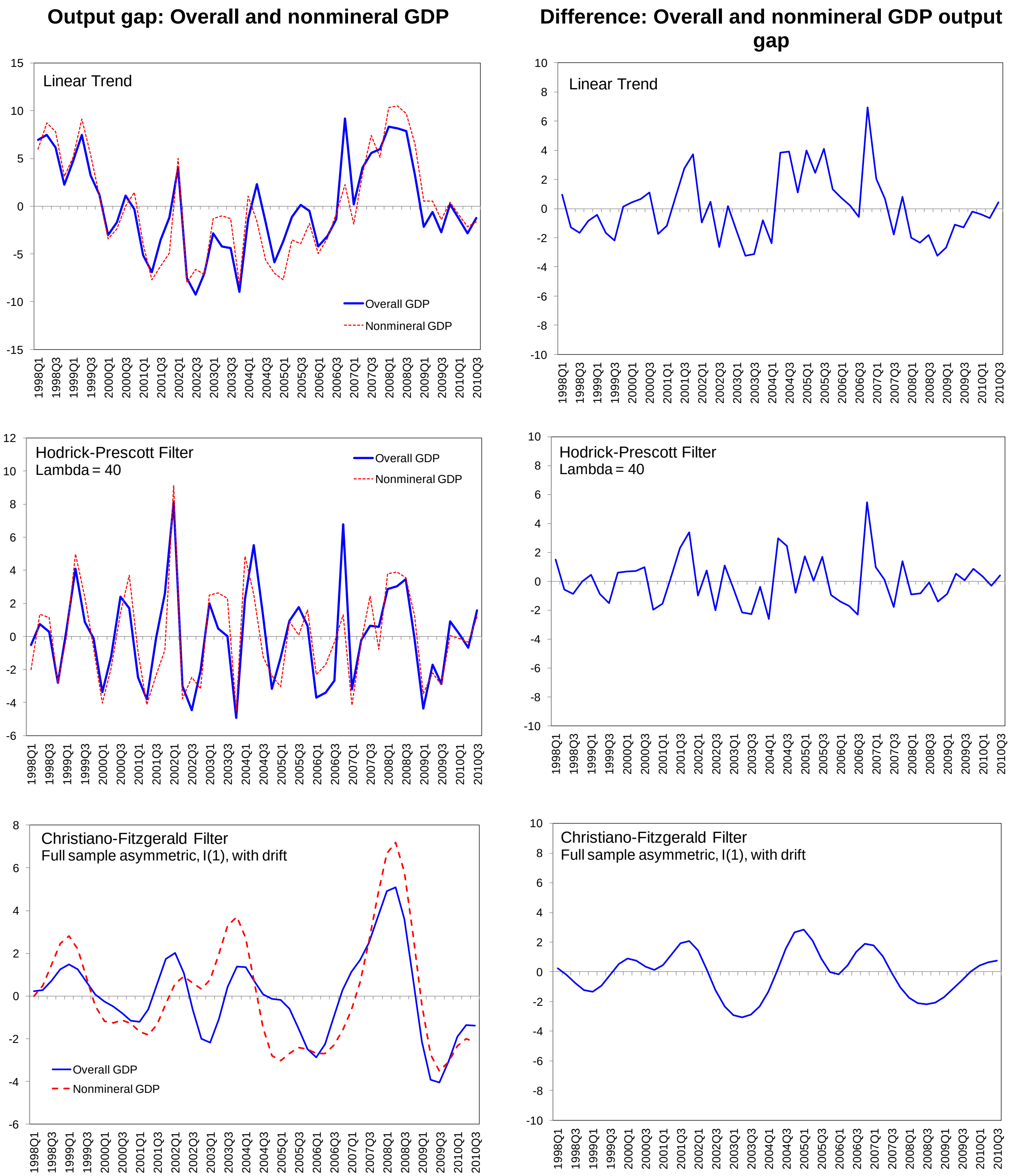
Sources: Mongolian authorities; and IMF staff estimates.

Figure 3. Blanchard-Quah Decomposition



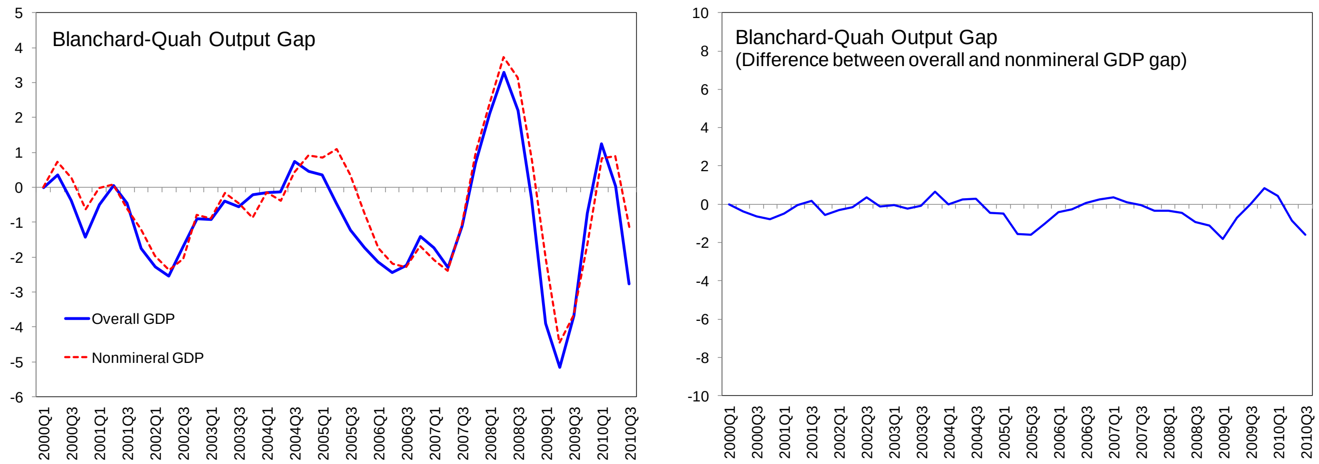
Sources: Mongolian authorities; and IMF staff estimates.

Figure 4a. Overall and Nonmineral Output Gap Measures



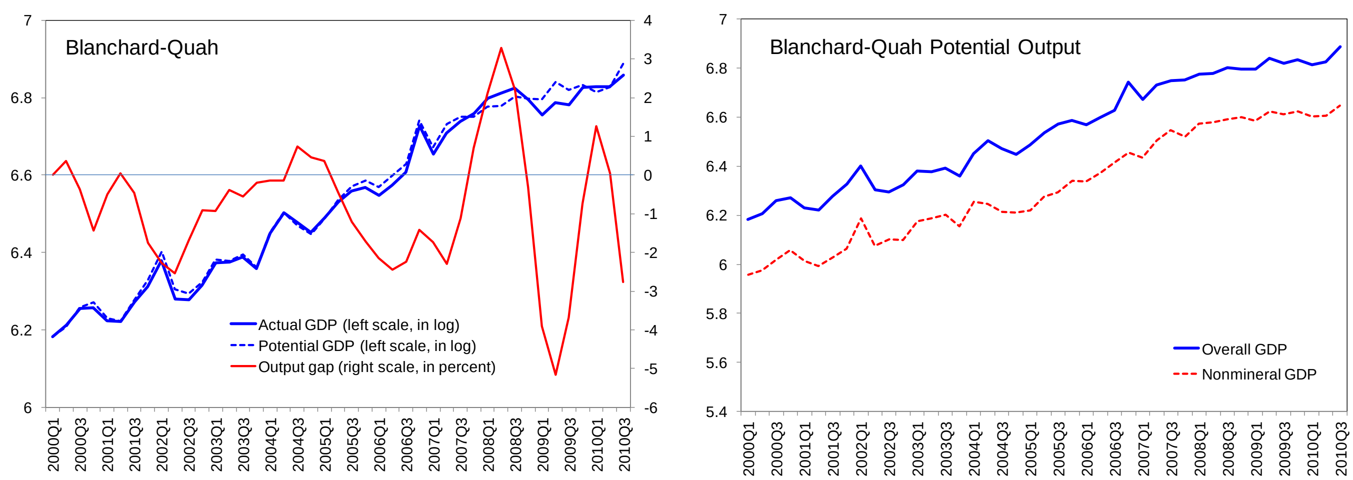
Sources: Mongolian authorities; and IMF staff estimates.

Figure 4b. Overall and Nonmineral Output Gap Measures (cont.)



Sources: Mongolian authorities; and IMF staff estimates.

Figure 5. Potential Output



Sources: Mongolian authorities; and IMF staff estimates.

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