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The Usefulness of Output Gaps for Policy Analysis

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ABSTRACT/RÉSUMÉ

The Usefulness of Output Gaps for Policy Analysis

Measures of the gap between actual and potential activity are used frequently as indicators of the economic cycle and play a vital role in the conduct of monetary and fiscal policy. Given that output and unemployment gap estimates are often subject to considerable revision over time, this paper investigates the uncertainty surrounding projections and early outturn estimates of such gaps and evaluates their usefulness for policy making in real time. Current-year projections and initial outturn estimates of the gaps both appear to provide a reasonably good picture of the business cycle over the period studied, but one-year-ahead projections perform rather poorly. Projections made at cyclical turning points are subject to greater revision than those made at other times. Revisions to output gaps appear to stem primarily from revisions to actual rather than potential GDP. Empirical results show that output gaps remain a significant influence on inflation, but their influence is now weaker than in the past, and the usefulness of output gap estimates for real-time inflation projections is limited. Revisions to real-time output gaps also generate revisions to real-time estimates of the fiscal stance, although typically these are relatively moderate. Despite the uncertainty attached to gap estimates, they remain useful for policymakers, helping to situate current economic developments.

JEL classification: E31; E32; E52; E62
Keywords: output gap; inflation forecasting; cyclically-adjusted budget balance; uncertainty

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L'utilité de l'écart de production pour l'analyse de politique macroéconomique

Les estimations de l'écart entre l'activité courante et potentielle sont fréquemment utilisées comme indicateurs du cycle économique et jouent un rôle crucial dans la conduite des politiques monétaire et budgétaire. Étant donné, qu'au fil du temps les estimations des écarts de croissance et de chômage sont souvent révisées, ce papier évalue l'incertitude qui entoure les prévisions ainsi que les premières estimations de ces écarts pour l'année écoulée et analyse leur utilité pour les décisions de politique économique en temps réel. Les prévisions pour l'année en cours et les premières estimations pour l'année écoulée des écarts donnent une image assez représentative du cycle sur la période étudiée tandis que les prévisions à un an sont plutôt médiocres. Les prévisions qui sont faites lors d'un retournement de cycle sont sujettes á de plus fortes révisions que celles réalisées á d'autres périodes. Les révisions des écarts de production viennent d'abord des révisions du PIB courant plutôt que du potentiel. Les résultats empiriques montrent que les écarts de production continuent d'influer sur l'inflation même si leur effet est moindre que par le passé et que ' utilité des estimations des écarts de production pour les prévisions de l'inflation en cours est limitée. Les révisions des écarts de production courants génèrent aussi des révisions des estimations de la situation fiscale courante, même si ceux-ci sont relativement modérés. Malgré l'incertitude liée aux estimations des écarts de croissance, ces dernières demeurent utiles pour les décideurs politiques dans la mesure où elles les aident à évaluer la situation économique courante.

Classification JEL : E31 ; E32 ; E52 ; E62
Mots clés : écart de production ; prévision d'inflation ; solde budgétaire ajusté du cycle ; incertitude

TABLE OF CONTENTS

Figures

THE USEFULNESS OF OUTPUT GAPS FOR POLICY ANALYSIS

by

Isabell Koske and Nigel Pain[1]

1. Introduction and summary

1. Measures of demand/supply imbalances in particular markets, or the economy as a whole, are frequently used as indicators of the economic cycle. For instance, the level and direction of movement of output gaps and unemployment gaps are seen as providing indications about prospective inflationary pressures in product and labour markets, giving them a role to play in the conduct of monetary policy. Equally, estimates of the cyclical position of the economy are a key input into calculations of cyclically-adjusted budget balances. This paper considers the use made of various concepts and measures of output gaps in macroeconomic policy analysis and discusses their reliability and the ways in which the associated uncertainty can be taken into account in the conduct of macroeconomic policy.

2. A basic difficulty with any measure of the business cycle is that potential activity is unobservable and, as such, measures of the gap between actual and potential activity are ill-defined and often subject to considerable revision over time. This in itself does not imply that gap concepts, or equally estimates of potential output, are without value. Such concepts can still contain information of use to policymakers, even if they are measured with error. Uncertainty about the size and movement of gaps is only one component of the overall uncertainty faced by policymakers. Projections and initial outturns of output growth are also subject to error, and survey data have associated sampling errors.

3. This paper makes use of a number of different estimates of demand-supply imbalances within the economy and a new real-time data set constructed from historical issues of the OECD *Economic Outlook* (EO) to assess the information available from current and one-year-ahead projections of output and unemployment gaps, and also the reliability of the initial outturn estimates for the previous year.[2] The usefulness of the EO gaps is then compared with alternative real-time filter-based estimates of output and unemployment gaps and survey data on capacity utilisation, the latter being less prone to revision. The paper reviews the desirable features that such estimates should have to be of use to policymakers, and analyses the extent to which each of the measures of the cyclical position of the economy satisfies these criteria. It then explores the implications of revisions to output and unemployment gap estimates for projections of inflation and the cyclically-adjusted budget balance (CABB).

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1. The authors are members of Country Studies V Division and Country Studies IV Division of the Economics Department of the OECD. They are grateful to Pete Richardson, Jorgen Elmeskov, Jean-Luc Schneider and other colleagues in the Economics Department for helpful comments and suggestions and to Diane Scott for assistance in preparing the document.

2. Unless specified otherwise, the following terminology is used throughout the paper to describe real-time estimates: For the level of the gap in year *t*, the one-year-ahead projection is the projection of year *t* made in year *t*-1, the current-year projection is the projection of year *t* made in year *t,* the initial outturn estimate is the estimate of year *t* made in year *t*+1 and the final outturn estimate is the estimate of year *t* made in year *t*+4.

4. The output and unemployment gap estimates published by the OECD and other international organisations such as the European Commission, are constructed using estimates of potential output and the structural rate of unemployment (the NAIRU). Potential output is derived using a production function method and the NAIRU is obtained from a multivariate model of price inflation, in which structural unemployment is treated as an unobserved component to be estimated (Box 1). Many other approaches are possible. The alternative economy-wide gap estimates considered in this paper are derived using a standard univariate Hodrick-Prescott (HP) filter through both *ex-post* and real-time data on GDP and the unemployment rate.

5. Examining the properties of the real-time estimates of output and unemployment gaps, the following main findings emerge from the analysis:

- The different measures of output and unemployment gaps for each economy are strongly positively correlated, with the exception of survey-based measures of capacity utilisation. This suggests that survey data might contain information that is not reflected in the gap estimates.
- Current-year projections and initial outturn estimates of the economy-wide output and unemployment gaps are strongly correlated with the final outturn estimates. This suggests that, within the sample period considered, early estimates do contain useful information, even if they are prone to revision.
- Current-year projections and initial outturn estimates of economy-wide output and unemployment gaps are both good predictors of the sign and direction of movement of the respective gaps for that year in the final outturn estimates. However, a significant bias is present in the projections and initial outturn estimates for some countries. On average, the current-year projections of the output gap are around 1 percentage point away from the final estimates. Amongst the G7 economies, initial output gap estimates have been consistently revised up to be less negative over time in Japan, Germany and Italy. France is the economy with the smallest revisions to real-time estimates over the past decade.
- One-year-ahead projections of the output and unemployment gaps are found to contain less useful information, performing poorly on all metrics considered. This is similar to the findings for GDP growth projections by Vogel (2007).
- The revisions made to projections and initial outturn estimates of the output gap are markedly larger in those years in which a cyclical turning point occurs.
- Differences between initial and final outturn estimates of the output gap for a particular year are attributable primarily to revisions in actual rather than potential GDP in two-thirds of the countries considered, and almost all of the G7 economies. This suggests that much of the uncertainty about the size of the output gap simply reflects the uncertainty of the actual GDP data and projections.
- The real-time univariate filter gap measures and survey data on capacity utilisation are poor predictors of the revisions made to the initial outturn estimates of the output gap published in the *Economic Outlook*. However, in some countries, they are better predictors of the revisions made to the current-year and one-year-ahead projections of gaps.

6. Concepts of the output and unemployment gaps are used at the OECD and elsewhere to gauge potential inflationary pressures and to derive cyclically-adjusted estimates of the level and change in the budget balance. The usefulness of different gap measures for assessing inflationary pressures is explored in the paper by estimating price inflation equations for the G7 economies and assessing their forecast performance using real-time and *ex-post* data. For the cyclically-adjusted budget balance, estimates are made of the accuracy of real-time projections and the extent to which the revisions made to output gap

estimates can help to account for revisions in the cyclically-adjusted balance. The following main findings emerge from these analyses:

- All the measures of gaps considered are found to have a significant relationship with inflation in the G7 economies. The output and unemployment gaps have stronger explanatory power than the simple HP-filter-based gaps and capacity utilisation, but the differences are small.
- There is clear evidence of a structural break from the mid-1990s onwards, with a decline in the responsiveness of inflation to each particular measure of the domestic business cycle after that point. In contrast, the sensitivity of domestic price inflation to foreign prices has risen over time. These changes imply that inflation projections will have become less sensitive to revisions in estimates of domestic gaps.
- There is evidence that several components of the production-function-based output gap influence inflation. Focusing solely on the unemployment gap as the measure of demand pressure is rejected by the data. Using *ex-post* data, models with the economy-wide output gap are found to have smaller forecast errors than models with the unemployment gap. Using real-time data the differences are smaller, suggesting that while other components of the output gap may contain useful information they are difficult to forecast accurately.
- The usefulness of business cycle measures for inflation forecasting appears to be limited in recent years, in part reflecting the greater flatness of the Phillips curve in most countries. Although there are a number of cases in which forecasting performance is improved by taking into account information about the cyclical position of the economy, the gains in forecast accuracy are typically small.[3]
- The signs of the current year real-time projections of the level and change in the cyclically-adjusted budget balance, and also those of the initial outturn estimates, are identical to those of subsequent revised estimates in more than four-fifths of the cases examined. The initial outturn estimates are also unbiased and efficient predictors of subsequent estimates of the level and change in the cyclically-adjusted balance.
- Revisions made to current-year projections of the output gap are one source of the revisions made to current-year projections of the cyclically-adjusted primary balance (CAPB). On average across the G7 economies, revisions to the level of the output gap account for revisions of 0.4 percentage points in the CAPB to GDP ratio. The mean absolute revision to the change in the gap is associated with an absolute revision of 0.3 percentage points to the change in the CAPB to GDP ratio.

7. The quantitative implications of output gap uncertainty for inflation and for estimates of the cyclically-adjusted budget balance can be explored using the historical revisions to the gaps to obtain a range of possible outcomes around any central gap estimate. Overall, calculations of this form suggest that the likely revisions to estimates of inflation and the cyclically-adjusted budget balance are comparatively small. But revisions to gap estimates can be important, especially if they are unusually large, such as around cyclical turning points, or when inflation and the cyclically-adjusted budget balance are on the threshold of either meeting or missing particular target levels.

8. In general, the increased flatness of the Phillips curve can be expected to raise uncertainty about the precise level of the output (unemployment) gap, and also potential output (the NAIRU) if the gap is

3. This need not imply that business cycle measures are not useful. The sample period is characterised by low and stable inflation. It might well be that business cycle measures are more useful during more volatile times.

derived from such a framework. This raises questions as to whether it is useful for policymakers to continue to focus on measures of gaps and, if so, how best to incorporate the uncertainty of the estimates into policy decisions. The findings in the paper suggest that:

- Output gap outturn estimates remain useful for policymakers. They help to situate current economic developments and contain information that can help to account for current fluctuations in inflation or the fiscal position.
- Explicit account of uncertainty should be taken in the policy framework. This can be done in a variety of ways, including analysis of a range of possible scenarios about the state (and structure) of the economy, or attempts to quantify formally a range for inflation and the cyclically-adjusted budget balance based on the calibrated uncertainty thought to be attached to gap estimates and other data, or through adjusting initial data/outturn estimates for likely revisions.
- The net impact of uncertainty about gaps on policy decisions is unclear. Such uncertainty could attenuate policy responses, with less weight being given to movements in gaps in policy decisions, or it could augment them, if allowing for uncertainty reveals a possibility of a particular undesirable outcome occurring. In the context of a flatter Phillips curve, changes in projected output gaps might generate firmer monetary policy action because of the difficulties of returning inflation to target once it has risen or fallen.
- At times of observed or expected structural changes in the economy, such as those resulting from globalisation, policymakers may need to give more weight to survey measures of resource utilisation and the behaviour of target variables, such as whether price inflation is accelerating or declining, rather than demand pressures as reflected in estimated gaps.

9. Ultimately, a considerable role for judgement remains in policymaking, with a need for a broad approach that examines many other indicators in addition to output and unemployment gaps. Other alternative variables include monetary aggregates, long and short-term interest rates, business confidence indicators, capacity utilisation and job vacancies.

10. The remainder of the paper is structured as follows. Section 2 provides a short overview of the use of business cycle measures for monetary and fiscal policy and discusses a number of desirable features that such measures should have to be of use to policymakers. Section 3 then examines the extent to which some of the most commonly used approaches to estimating the cyclical position of the economy display these properties. The impact of output and unemployment gap uncertainty on inflation forecasting and the calculation of the cyclically-adjusted budget balance is addressed in section 4 and the resulting implications for policymaking are discussed in section 5.

2. The use of business cycle measures in macroeconomic policy analysis

11. Indicators of the cyclical position of the economy play an important role in monetary and fiscal policy analysis and surveillance.[4] This section briefly reviews the use of such indicators and sets out a number of desirable characteristics that a measure of the cycle should ideally have in order to be a useful tool for policymakers.

4. Although the focus of this paper is on the use of business cycle indicators for monetary and fiscal policy analysis, applications of the indicators are more wide-ranging. For example, the indicators are important for the conduct of labour market policy given that unemployment which is identified as being structural may require a different policy response from unemployment which reflects cyclical variations in economic activity.

Box 1. **Measures of the business cycle**

The cyclical position of the economy can be defined as the difference between actual activity and the level of potential activity that can be sustained without generating inflationary pressures in the economy. A basic difficulty with this definition is that potential activity is unobservable and, as such, measures of the gap between actual and potential activity are ill-defined. Various alternative concepts of the relevant reference value exist, the most common ones being potential output, the structural rate of unemployment (as given by the NAIRU) and full capacity. Each of these concepts has particular problems in measurement and interpretation and the choice of the appropriate concept will depend on the use to be made of it.

Whilst the unemployment gap, defined for the purposes of this paper as the difference between the NAIRU and the actual unemployment rate, is a rather narrow concept, focusing solely on supply/demand imbalances in the labour market, the output gap, given by the difference between actual and potential output, is a more broad-based approach, depicting demand/supply in the economy as a whole. Economy-wide estimates of the output gap are of use for constructing structural measures of total expenditure or taxation, whereas estimates of imbalances in particular markets may be of greater relevance if making cyclical adjustments to detailed items of government expenditure or taxation. For example, the unemployment gap may be important for adjusting expenditure on current transfers to households. Equally, in modelling the cyclical behaviour of components of final expenditure, especially fixed investment, it might be more relevant to look at measures of spare capacity rather than the economy-wide output gap.

As potential output and the NAIRU are unobservable, the choice of the empirical approach used to estimate them is a critical issue. The large number of different methods that have been used broadly fall into one of two categories -- ones that rely exclusively on information about GDP and the unemployment rate to derive potential output or the NAIRU (univariate approaches) and ones that seek to incorporate additional information from other variables (multivariate structural approaches).

Univariate approaches determine the cyclical position of the economy on purely statistical grounds, decomposing real GDP or the unemployment rate into permanent and transitory components. Examples include linear and non-linear de-trending methods, the Hodrick-Prescott (HP) filter, the Baxter-King band-pass filter and the Beveridge-Nelson decomposition. Multivariate approaches put more structure behind the derivation of potential output or the NAIRU by taking into account their relationships with other macroeconomic or labour market variables. Examples include the multivariate HP filter, multivariate unobserved component models, the production function approach and structural VAR models.[1]

The purpose of this paper is not to provide a detailed overview of all the possible approaches to estimating output or unemployment gaps. The analytical work focuses only on the methods used at the OECD (and many other international organisations) to estimate the output and the unemployment gaps and compares these to the results from using a simple univariate HP filter to estimate each and survey information on capacity utilisation. At the OECD, a production function approach is used to derive estimates of potential output and an unobserved components model based on a Phillips curve equation is used to estimate the NAIRU. The output gap is then defined as the difference between actual and potential output, expressed as a share of potential output, and the unemployment gap is given by the difference between the NAIRU and the unemployment rate. The following paragraphs briefly describe the different approaches to measuring these concepts and present a short discussion of their respective merits and drawbacks.[2]

The HP filter approach to deriving potential output and the NAIRU

The HP filter is a simple smoothing procedure that derives the trend of a series by minimizing a combination of the gap between the actual value of a series and the value of its trend and the rate of change of the trend. The smoothness of the trend is determined by the smoothing parameter λ which specifies the relative weight of the two components of the objective function. In this study the filter is applied to real GDP to obtain potential output and to the unemployment rate to obtain the NAIRU. The main advantage of the procedure lies in its simplicity. It is fairly straightforward to perform, requiring only data on real GDP and the unemployment rate. However, the procedure suffers from several shortcomings. Most importantly, the results hinge crucially on the choice of the smoothing parameter λ. In the present study the smoothing parameter is set equal to 1600 for quarterly data and equal to 6.25 for annual data, as suggested by Ravn and Uhlig (2002).[3] A second difficulty with the procedure stems from its high end-sample bias (Mise *et al*., 2005). To help mitigate this problem, projections are included alongside all available historical data in the calculation of the trend component in the analytical work.

An unobserved components model of the NAIRU

The calculation of the NAIRU uses a multivariate unobserved components model that treats the NAIRU as an unobservable variable within a (price inflation) Phillips curve framework. The NAIRU is identified based on its time series properties, which are frequently specified as a random walk or a random walk with drift.[5] The parameters of the Phillips curve equation as well as the time series of the unobserved component -- the NAIRU -- are then estimated using a Kalman filter technique. This approach means that estimates of the NAIRU, and hence the unemployment gap, are consistent with the behaviour of inflation. A major drawback of the procedure is that the estimates are sensitive to the specification of the Phillips curve equation and also to the assumptions about the time series properties of the NAIRU. Thus, to some extent, the approach is open to the same type of criticism made about univariate approaches.

The production function method to deriving potential output

The production function approach uses a theoretically consistent approach to derive potential output, relating potential output to the level of available factor inputs and production technology. The approach has been adopted by the OECD and the European Commission, among others. In its simplest form, the approach rests on a two-factor Cobb-Douglas production function with capital and labour inputs, subject to labour-augmenting technical progress. Potential output is determined as the level of output that results when all factors of production and total factor productivity are at their potential levels. In the framework used at the OECD, estimation of potential output amounts to removing the cyclical components from labour, capital and total factor productivity, with labour inputs being decomposed into labour force participation, the employment rate and hours worked (Beffy *et al*., 2006). The trend unemployment rate (the NAIRU) makes use of the results of the unobserved components framework described above; the remaining components of the output gap are de-trended using an HP filter.

An advantage of the production function method is that it derives potential output using economic theory rather than just its statistical properties. As such, the method can help to identify structural changes in the economy and highlight how the different factor inputs and technical progress contribute to potential output. However, it is more complex than univariate techniques, requiring assumptions about the functional form of the production technology and necessitating a wide range of data inputs. In particular, robust estimates of capital inputs (capital services) are difficult to obtain for many countries. Moreover, given that trend participation, trend hours worked and trend productivity are derived using HP filters, the criticisms raised above also apply to aspects of the production function approach.

Survey data of capacity utilisation

Survey data of capacity utilisation provide an alternative means of measuring the cyclical position of the economy. Such data are available for a large set of countries.[8] For many countries, the data are rarely revised, although there can be occasional revisions due to normalisation of the series, or amendments in seasonal adjustment factors and sectoral weights. Nonetheless, data revisions are typically small, especially compared to non-survey based indicators. However, survey measures have separate problems. For instance, the responses to survey questions might be subject to a bias. Companies' perceptions about the normal rate of capacity utilisation may vary with the economic cycle and over time (HM Treasury, 1999). Moreover, it is not clear what firms regard as full capacity; it could be the maximum output that could be produced with current inputs, or the output that could be produced with each input at its historical peak. Aggregating across firms, the concept of capacity utilisation differs from that of the economy-wide output gap. Spare resources can remain in the economy even if each firm reports that they are operating at full capacity using their existing resources. The available data for capacity utilisation may also relate to a subset of industries only, rather than the full economy.

1. Univariate and multivariate methods need not be mutually exclusive - some of the multivariate methods use filtered series and inputs for estimation.
2. For a discussion of a broader range of business cycle indicators see Cerra and Saxena (2000), Claus *et al*. (2000) and Cotis *et al.* (2005).
3. For annual data, the value of the smoothing parameter is alternatively set equal to 100, which is the most commonly used value. Whenever this leads to markedly different results, this is explicitly stated in the text.
4. Further details on the Phillips-curve framework used by the OECD to calculate time-varying NAIRUs can be found in Richardson *et al*. (2000).
5. Other less frequently used indicators include business and consumer confidence indices, and indicators of the recruitment difficulties of firms.
6. The data are obtained from the OECD's Main Economic Indicators database. For most countries the data supplied by member countries are entirely based on management surveys, though for some they are partly based on estimates of physical units of capacity or on trends through peaks in production. The latter will be subject to revision over time, although this is not considered in this paper.

12. The use of business cycle indicators in monetary policy decisions reflects the judgement that demand-supply imbalances in particular markets, or the economy as a whole, provide indications about prospective inflationary pressures in product and labour markets.[5] Information about the future path of

5. See Mishkin (2007) for a discussion of the importance of estimates of potential output and the output gap for US monetary policy.

potential output and the NAIRU is thus essential to evaluate whether the current stance of monetary policy is consistent with price stability.

13. Although such a short-run trade off between inflation and the output or unemployment gap (the short-run Phillips curve) appears to exist, the relationship is not simple. The inflation rate depends on numerous other factors such as inflation expectations or import price inflation. Moreover, the relationship between inflation and the output or unemployment gap might be nonlinear or asymmetric in the sense that positive demand shocks have larger absolute effects on inflation than negative ones. This would for example be the case if prices or wages exhibit downward stickiness. In the presence of such asymmetries monetary policy may react more promptly to signs of inflationary pressures given that bringing inflation back to target could be very costly in terms of lost output.

Box 2. **The derivation of the cyclically-adjusted budget balance**

The cyclically-adjusted budget balance is the underlying fiscal position when cyclical or automatic movements are removed. The procedure used by the OECD to calculate the cyclically adjusted budget balance consists of adjusting personal income taxes, corporate income taxes, indirect taxes and social security contributions for movements in the output gap and unemployment related expenditures for movements in the unemployment gap:[1]

$$CABB_t^* = T_t^H \cdot \left[\alpha_H \cdot (GAP_t)^{\varepsilon H} + (1-\alpha_H)\cdot(GAP_{t-1})^{\varepsilon H}\right] + T_t^B \cdot \left[\alpha_B \cdot (GAP_t)^{\varepsilon B} + (1-\alpha_B)\cdot(GAP_{t-1})^{\varepsilon B}\right] + T_t^{ind} \cdot (GAP_t)^{\varepsilon ind} + SCC_t \cdot (GAP_t)^{\varepsilon SSC} - G_t \cdot (UGAP_t)^{\varepsilon G} + X_t\,,$$

where *CABB* is the cyclically-adjusted budget balance, T^H are personal income taxes, T^B are corporate income taxes, T^{ind} are indirect taxes, *SSC* are social security contributions, *G* are total current disbursements excluding interest payments, *X* are other types of revenues and expenditures that are assumed to be independent of the business cycle, *GAP* is the output gap, *UGAP* is the unemployment gap and *t* is the time index. For personal income taxes and corporate income taxes it is assumed that they react to variations in activity levels with some delay, so that part of the adjustment occurs in the current year with the remainder occurring in the subsequent year.[2] The respective weights as well as the elasticities are reported in Girouard and André (2005).

A slightly different concept also used in this paper is the cyclically adjusted primary balance *CAPB*, which is equal to the *CABB* plus net interest payments *NINT*:

$$CAPB_t^* = CABB_t^* + NINT_t = T_t^H \cdot \left[\alpha_H \cdot (GAP_t)^{\varepsilon H} + (1-\alpha_H)\cdot(GAP_{t-1})^{\varepsilon H}\right] + T_t^B \cdot \left[\alpha_B \cdot (GAP_t)^{\varepsilon B} + (1-\alpha_B)\cdot(GAP_{t-1})^{\varepsilon B}\right] + T_t^{ind} \cdot (GAP_t)^{\varepsilon ind} + SCC_t \cdot (GAP_t)^{\varepsilon SSC} - G_t \cdot (UGAP_t)^{\varepsilon G} + NINT_t + X_t\,.$$

As net interest payments are not cyclically adjusted, the elasticity of the CAPB with respect to the output and unemployment gaps is identical to the elasticity of the CABB with respect to the two gaps.

The adjustment procedure has a number of shortcomings that should be kept in mind when interpreting the level of the cyclically adjusted budget balance (see also Box 1 in Girouard and André, 2005). First, it does not adjust the budget balance for compositional effects; the composition of the tax base might in practice vary over the economic cycle along with variations in the composition of GDP.[3] The budget balance might also be adjusted for the effects of movements in asset prices (Girouard and Price, 2004), budgetary one-offs (Koen and Van den Noord, 2005) and terms-of-trade effects (Turner, 2006). Finally, the method captures the effect of the cycle in a linear way; as such, it is unable to pick up nonlinear aspects of a downturn or upturn. Chalk (2002) points out that such nonlinearities could potentially matter for the cyclical adjustment of corporate income taxes.

1. A detailed description of procedure is provided in Girouard and André (2005).
2. Possible reasons include time lags in tax collection and rules for allowing tax losses to be carried forward.
3. For a discussion of this issue, see Braconier and Holden (1999), Bouthevillain *et al*. (2001) and Braconier and Forsfält (2004).

14. Indicators of the cyclical position of the economy are also important in the assessment of the sustainability of fiscal policy and the current fiscal stance, with actual budget positions being corrected for the impact of cyclical influences in order to gauge the underlying fiscal position (an overview of the approach adopted by the OECD to cyclically adjust government budget balances is provided in Box 2). Otherwise, purely cyclical changes in the budget might falsely be treated as structural, potentially leading to serious policy mistakes. The level of the cyclically-adjusted budget balance, and hence the level of the output/unemployment gap matters when evaluating fiscal sustainability; the change in the CABB, and hence the change in the gaps, is central to estimates of the current fiscal stance. In many OECD countries cyclically-adjusted budget balances are also an integral part in the formulation and assessment of budget rules.[6]

15. While the concepts of potential output and the NAIRU appear to be useful in principle, they suffer from the difficulty that they are unobservable, making measures of the output and unemployment gap ill-defined and sensitive to the choice of estimation technique and available data set. Nonetheless, a number of desirable features can be identified that measures of the output and unemployment gap should have to be of use to policymakers.[7]

16. Ideally, estimates of the business cycle should be available on a timely basis and subject to minimal revision so that early outturn estimates provide a reliable picture of the "true" state of the economy. If a central bank believes that the output or unemployment gap is positive when it is in fact negative, a consequent monetary policy tightening will tend to amplify the business cycle and intensify the downward pressure on inflation. As changes in the stance of monetary policy affect the aggregate economy only with a certain time lag, policymakers do not only require reliable estimates about the past or current state of the economy but also about its future evolution. This makes the accuracy of the projections of a business cycle indicator an important criterion for its usefulness. In this respect, it might also be beneficial if a particular method of estimating potential output or the NAIRU provides information directly about the precision of the estimates and hence the uncertainty attached to those estimates.

17. For monetary policy, the output gap needs to have a well-defined and stable relationship with inflation; for fiscal policy, the output gap concept should provide a basis to adjust budget items for short-term cyclical fluctuations in expenditure and taxation. A likely requirement for this objective is that the underlying estimates of potential output or full capacity be non-cyclical or, at a minimum, less variable than actual output. In addition the gap between actual and potential activity and actual and structural unemployment, respectively, should be roughly symmetric, at least during periods in which inflation is broadly stable and other influences on inflation remain unchanged. This requirement need not prevent the gap from being persistently negative or positive over periods during which inflation is either falling or rising persistently.

18. An additional consideration is the transparency of a particular measure of the cyclical position. While purely statistical approaches, such as the HP filter, are more transparent in one sense because they incorporate only a limited amount of information and can be readily replicated, they ignore potentially important information that may matter for policy decisions, such as changes in the quantity and quality of available production factors or the underlying production technology. In principle, the production function approach enables these shortcomings to be overcome by determining potential output based on potential factor inputs and potential factor productivity. As such, changes in potential output can be traced back to

6. For example, cyclically-adjusted budget balances are a central element of the preventive arm of the EU's Stability and Growth Pact.

7. A review of the desirable features that output gap estimates should have and an associated evaluation of various approaches to estimating the output gap is provided by Cotis *et al*. (2005).

changes in the quantity of available factor inputs or the potential rate of technical progress, facilitating interpretation and communication.

3. Empirical evaluation of alternative measures of the business cycle

19. As outlined in section 2, estimates of the cyclical position should ideally have a number of particular features if they are to be of use to policymakers. This section considers the extent to which these criteria are satisfied by the measures of the output and unemployment gap discussed in Box 1. The analysis makes use of two different data sets. The first comprises quarterly data for the period 1980 to 2006, taken from the spring 2007 versions of the *Economic Outlook* and the *Main Economic Indicators* databases.[8] This *ex-post* data set is used to examine the statistical properties of the business cycle indicators (section 3.1) and their relationship with inflation (section 3.5).

20. The second data set is a real-time data set constructed from spring versions of the *Economic Outlook* published between 1995 and 2007.[9] The data set is annual and covers the years 1995 to 2006 for the two output gap measures and 2001 to 2006 for the two unemployment gap measures.[10] Real time estimates of capacity utilization are generated by using the latest available data from the *OECD Main Economic Indicators* database and assuming that data are available up to the first quarter of the year of interest, with data for the remaining quarters extrapolated using a fourth-order autoregressive model. This second data set is used to examine the sequence of different projections and estimates of the cyclical position of the economy at a particular point in time (sections 3.2 to 3.4). The real-time data set is also used to evaluate the usefulness of business cycle indicators for inflation forecasting (section 3.6) and to investigate the information content of projections and early outturn estimates of the cyclically adjusted budget balance (section 3.7). Unless specified otherwise, the empirical exercises are carried out for 21 OECD economies.[11]

21. For the gap in any given year *t*, four different assessments are considered: the first is made in year *t*-1, the second in year *t*, the third in year *t*+1 and the final one in year *t*+4, which is taken to be the point at which the final outturn estimate is made.[12]

22. The analytical work below with real-time data takes the production-function-based output gap estimate made in year *t*+4 as the benchmark estimate of the output gap in year *t*, and focuses on what best

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8. It would be possible to undertake related exercises on the series available from other international organisations, although this is not considered in the present paper.

9. Autumn issues of the *Economic Outlook* are discarded. The accuracy of spring and autumn data and projections are inherently different (Vogel, 2007) and combining them would potentially distort the results.

10. For the two unemployment gap measures, the sample starts in 2001 as this was the first year that NAIRU estimates were published in the *Economic Outlook*. Although real time estimates of the HP-filter based unemployment gap can be constructed for a longer period, only estimates for 2001 and after are considered to make the results comparable to the published real-time Kalman-filter based unemployment gaps.

11. The countries considered are Australia, Austria Canada, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. Estimates for the euro area are also given in places.

12. The choice of *t*+4 as the time of the final estimate reflects the comparatively small sample period used and the high correlation between estimates in this year and later years (not shown here). Other recent studies have also taken the estimate at *t*+4 as the final outturn (see, for example, Mora and Norgueria Martins, 2007). In a few instances, the available data are not sufficient to use the estimate at *t*+4 as the final outturn, and so the estimate made at *t*+2 is used instead.

predicts this final outturn estimate. Similarly, the equivalent Kalman-filter-based estimate of the unemployment gap is taken to be the benchmark estimate of the unemployment gap in year *t*. These assumptions are used to avoid potentially misleading comparisons of the size and pattern of the revisions made to each separate real-time gap measure. The structural gap estimates are also the most economically meaningful estimates, in the sense that such estimates take a wider range of economic information into account.

23. *A priori*, it is likely that the revisions to the HP-filter estimates of the gap will be smaller than those made to the structural estimates of the gap. The HP filter implicitly assumes that the output gap is white noise. Furthermore, being a two-sided filter, estimates of trend output give a lot of weight to end-of-sample observations, which are more prone to revision. Such revisions will automatically generate similar revisions to trend output at the sample end point. In contrast, some elements of the production function, such as the Kalman-filter-based estimates of the NAIRU, are much less sensitive to end-of-sample data revisions. Thus, revisions to actual GDP need not be accompanied, at least in the short-term, by revisions to potential output; instead they will be reflected in changes in the output gap. Greater persistence in output gaps can result from this approach.

3.1 Statistical properties of the business cycle measures

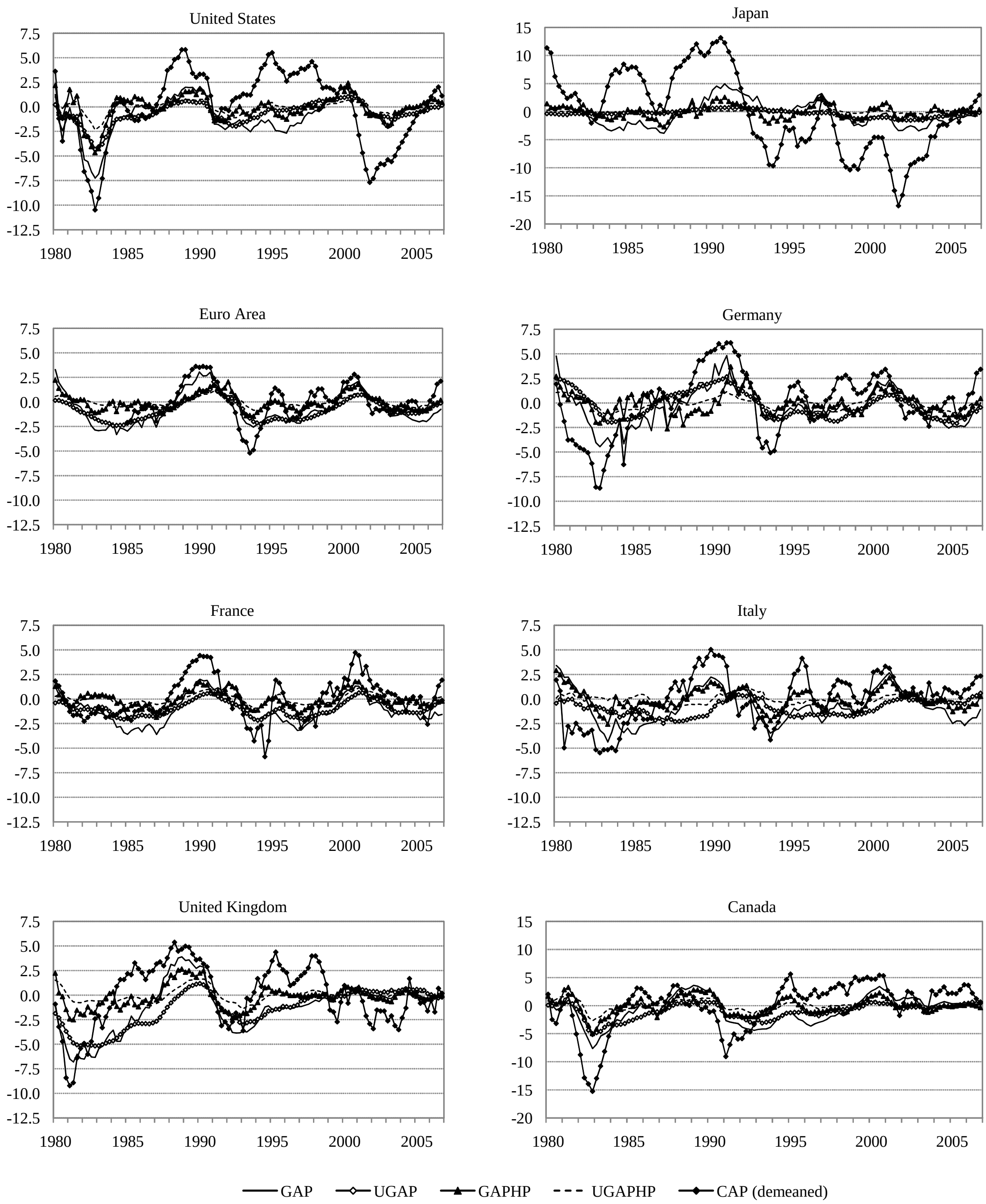
24. To get a first impression of the business cycle indicators, their statistical properties are examined using the *ex-post* data set. As shown in Figure 1 and Tables 1 and 2, all five business cycle measures (the published output and unemployment gaps,[13] plus HP filter estimates of these gaps and survey data on capacity utilisation) show a strong co-movement over time for France and the euro area indicating that for these countries/regions the choice of a specific measure of the cycle might be of limited importance, at least *ex post*. For the remaining countries, one or several of the pair-wise correlations are smaller, especially those that involve capacity utilisation, with Italy being an extreme case with negative correlation coefficients. An implication is that the capacity utilisation data contain different information from that contained in the other measures, perhaps reflecting differences in its sectoral coverage.[14]

[Table 1. Correlation between business cycle indicators]

13. The unemployment gap used in the analysis is measured as the difference between the NAIRU and the actual unemployment rate, so that a negative unemployment gap is equivalent to a negative output gap.

14. Chagny and Döpke (2001) calculate correlations between 9 different measures of the business cycle in the euro area over the period 1985 to 2002. The correlations between the HP-filter based output gap, the production-function based output gap published by the OECD and survey data on capacity utilisation are similar in size to those reported in Table 1. However, the correlations with some of the other business cycle measures considered in their study are lower.

Figure 1. **Business cycles in the G7 economies and the euro area**



Note: The scaling is different for Japan and Canada.

25. A related exercise shows that the separate components of the production function gap -- the total factor productivity gap, the hours worked gap, the labour force participation gap, and the unemployment gap -- are also weakly correlated in many cases, indicating that the components of the output gap vary in different ways (see Figure 2 and Table 2). This suggests that the relevant components provide different insights about the cyclical position of the economy and that it could be beneficial for policymakers to take into account information from several or even all of the components.

[Table 2. Correlation between output gap components]

26. Looking at the cyclical behaviour of the business cycle indicators, the *ex-post* gaps derived from the HP filter are associated with less persistent and less pronounced gaps than those derived from the production function approach or, in the case of unemployment, the Kalman filter (see Table 3). Periods during which output is constantly above (below) potential, and periods in which unemployment is below (above) the natural rate last 9 and 10 quarters (16 and 22) years respectively when calculated with the production function approach or the Kalman filter, compared with 5 and 8 quarters (7 and 9 quarters) when calculated with the HP filter.[15] The maximum (minimum) level that the gap reaches during such a period is about twice as high (low) for the two HP-filter-based measures than for the two structural approaches.

27. The two HP-filter-based measures are approximately symmetric by construction,[16] with average duration and magnitudes being reasonably close for phases of positive and negative gaps (see Table 3). In contrast, the duration of contractions and expansions often differs for the production-function and Kalman-filter-based estimates of gaps. On average, these gaps are negative over the period 1980 to 2006, suggesting either that the economic performance of the 21 economies considered was on average below potential during this period,[17] or that potential output was persistently over-estimated.

[Table 3. Descriptive statistics]

28. The two measures of the NAIRU are less volatile than the actual unemployment rate and the two measures of potential output are less volatile than real GDP, implying that the procedures have reduced the cyclical fluctuations in the original data (see Table 4).[18] The variability of the implied output and unemployment gaps declines over time, reflecting in part the comparative stability of output growth over recent years (Table 5).

[Table 4. Variability of actual and potential activity/unemployment]
[Table 5. Variability of business cycle indicators]

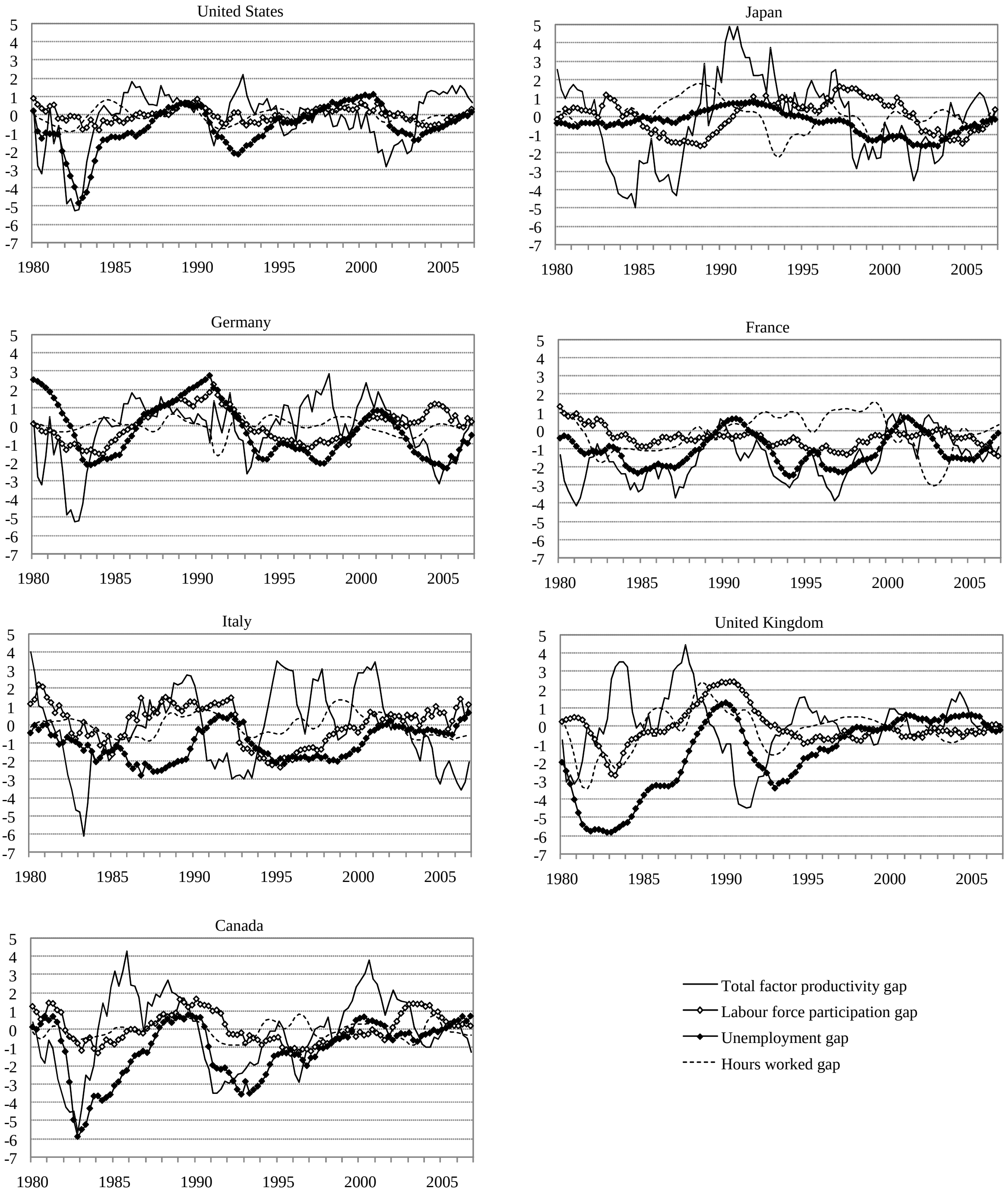
15. Chagny and Döpke (2001) and Claus *et al*. (2000) also find that statistical measures such as the HP filter imply shorter cycles than structural measures such as the production function approach. Dupasquier *et al*. (1997) conclude for the United States that only structural VAR approaches generate output gaps whose length is consistent with traditional views on business cycle length.

16. The HP-filter based gaps are not exactly equal to zero over the sample period as historic and future data were considered in the construction of the HP filter to mitigate the endpoint problem.

17. This period saw a marked decline in the average rate of consumer price inflation in the OECD economies. The extent to which this is reflected in a prolonged negative unemployment gap when using the Kalman filter approach to estimate a Phillips curve model will depend on the behaviour of the other factors included in the Phillips curve specification, such as import prices and import penetration.

18. For actual and potential output, the differences in variability are small for the level terms as the series exhibit a stochastic time trend that dominates their standard deviations.

Figure 2. **Components of the production-function-based output gap, 1980-2006**



3.2 Revisions to initial outturn estimates of gaps

29. Since the data used to estimate the business cycle are subject to revisions over time, once additional information becomes available to statistical agencies, initial estimates of the cycle provide only imperfect information about the underlying state of the economy. This section looks at the information content of initial real-time outturn estimates of the output and unemployment gaps for a particular year by comparing them to estimates made four years after the year of interest (three years after the initial estimate), making use of the real-time data set from successive spring issues of the OECD *Economic Outlook*.[19,20]

30. Initial outturn estimates of the output and unemployment gap in a particular year are generally highly correlated with subsequent estimates for that year.[21] Notable exceptions are Germany, Japan, Italy, the United Kingdom, Australia and New Zealand. In these economies the correlations are not significantly different from zero for at least one of the gap measures, implying that the initial gap estimates do not provide a reliable picture of the final assessment of the economy's cyclical position.[22]

31. Despite the high bi-variate correlations, the revisions made to the initial outturn estimates are not random. Scatter plots of the initial and final outturn estimates for the G7 countries illustrate that revisions often have a considerable bias (Figure 3). This can be tested statistically by regressing the final outturn estimate at time t+4 on a constant and the initial outturn estimate at time t+1:

$$X_{i,t|t+4} = \alpha_i + \beta_i X_{i,t|t+1} + \varepsilon_{i,t} \quad (1)$$

where X represents the particular business cycle measure considered. Equation (1) is estimated jointly as a system of equations (consisting of 21 equations, one for each country). The hypothesis that the initial outturn estimate at time t+1 is an efficient and unbiased predictor of the final outturn estimate at time t+4 (which implies that all the constants α_i are equal to zero and all slope coefficients β_i are equal to unity) is jointly rejected across all 21 economies for each gap measure (Table 6). Looking at the results for individual countries, there are only six in which there is no significant statistical evidence of inefficiencies in the initial outturn estimates of either the output gap or the unemployment gap.[23]

[Table 6. Test for efficiency and unbiasedness of initial data releases]

19. The lack of any substantial revisions need not mean that the measure provides an exact picture of the cyclical position of the economy as both the initial and the final estimate might be inaccurate.

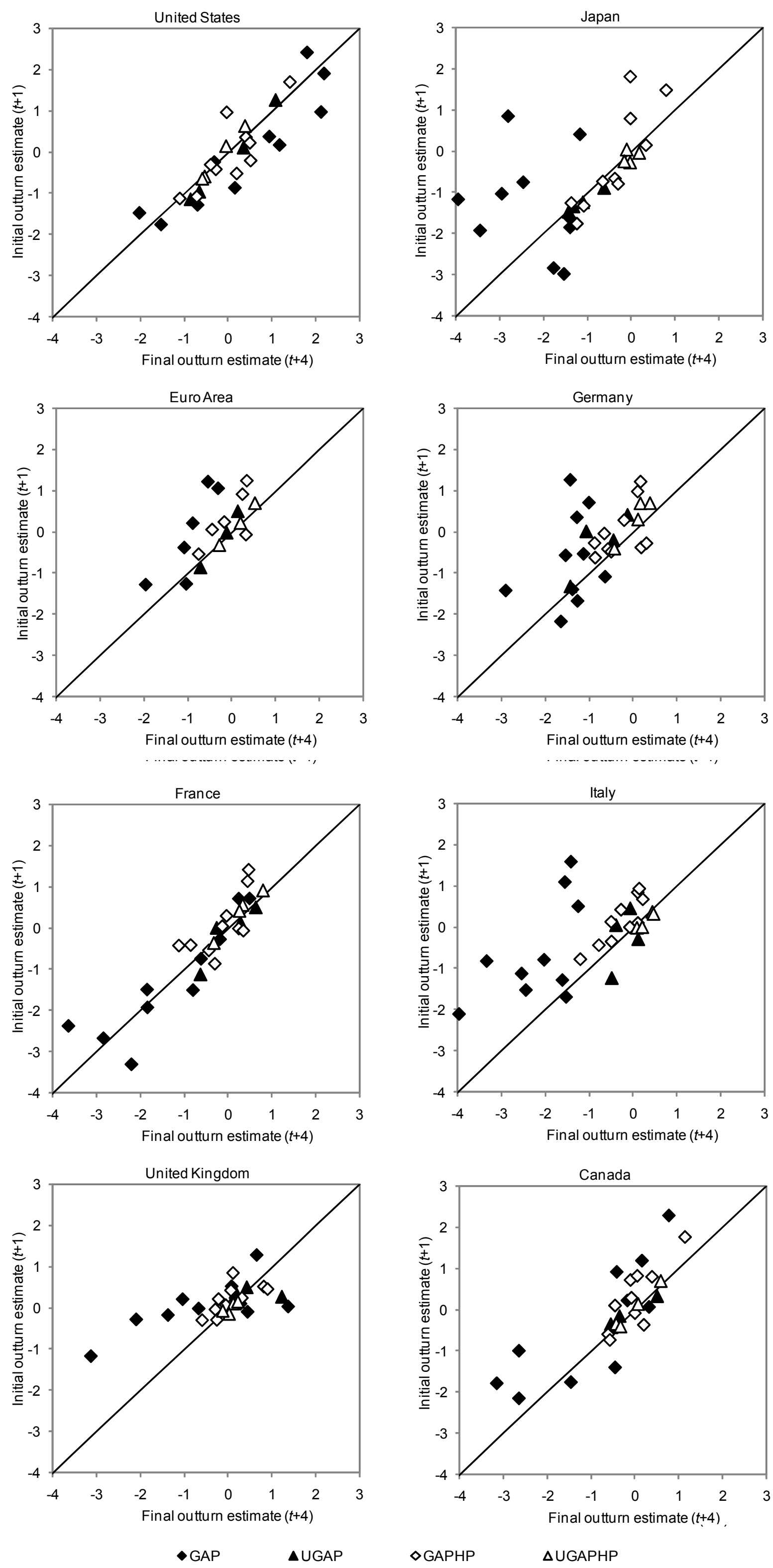
20. Revisions to the production-function based output gap are related to revisions to the Kalman-filter based unemployment gap as the latter is a component of the former.

21. Correlation coefficients may understate the relative importance of revisions as they do not account for differences in the mean of the series considered.

22. Bernhardsen *et al*. (2005) show for the Norwegian economy that the correlation between real-time and final estimates of the output gap is close to 0.9 for the production function approach but close to zero for the HP filter.

23. The six countries are Germany, France, Ireland, Spain, Sweden and Switzerland.

Figure 3. **Initial vs. final outturns of business cycle estimates**



32. The initial outturn estimates of the two HP-filter-based business cycle measures appear to be unbiased and efficient for a larger number of countries than the initial outturn estimates of the other two approaches. This is not surprising given the different features of the HP-filter and structural estimates. Revisions to the HP-filter estimate of trend output are, at least in the short term, more likely to be sensitive to changes in actual GDP than are structural estimates of potential output. Thus revisions to GDP are more likely to result in revisions to the output (and unemployment) gap when the structural approach is used.

33. Despite the observed inefficiencies, the initial outturn estimates of the level of the output or unemployment gap are good predictors of the sign of the gap (see Table 7). In 80% of the available observations the sign of the initial outturn estimate of the production-function-based output gap in a particular year is the same as the revised estimate of that year made three years later.[24] This suggests that real-time business cycle measures are better seen as indicators of the general cyclical position of the economy (above/below potential) rather than of the precise magnitude of the gap.

[Table 7. Sign of initial and final gap estimates]

34. The output gaps derived from the production function approach are, on occasion, subject to sizable and persistent revisions over time.[25] While the magnitude of consecutive revisions (the revisions that take place from one year to the next) tends to decline gradually over time, annual revisions exceeding ½ percentage point are not unusual even several years after the initial estimate is published (see Figure 4). Revisions over time to the Kalman-filter-based unemployment gap are smaller than those to the output gap, but also display a high degree of persistence (Table 8).

[Table 8. Revision with respect to initial outturn estimate at *t*+1]

35. Revisions to data for actual GDP appear to be a more important source of output gap revisions than revisions to potential GDP in most countries. This can be seen by decomposing revisions to the change in the output gap as:

$$\Delta \ln\left(\frac{GAP_{t|t+4}}{100}+1\right)-\Delta \ln\left(\frac{GAP_{t|t+1}}{100}+1\right)=\left(\Delta \ln GDPV_{t|t+4}-\Delta \ln GDPV_{t|t+1}\right)$$
$$-\left(\Delta \ln GDPVTR_{t|t+4}-\Delta \ln GDPVTR_{t|t+1}\right) \qquad (2)$$

where *GAP* is the output gap, *GDPV* is actual GDP, *GDPVTR* is potential GDP and the index $i|j$ denotes the level of the respective variable at time i as published at time j.[26] Thus, $\Delta\ln GAP_{t|t+1}$ is the change in the output gap between t–1 and t, as published at time t+1. In just under two-thirds of the economies considered the (absolute) revisions to actual GDP growth are larger on average than revisions to potential

24. This result differs from Orphanides and van Norden (2002) and Bernharsen *et al*. (2004) who find for the US and Norwegian economies that the sign of real-time output gap estimates is the same as that of the final estimates in only 50- 60% of all observations.

25. Orphanides and van Norden (2002) and Bernhardsen *et al*. (2005) also conclude that revisions are large and persistent. Cunningham and Jeffery (2007) note a similar feature in estimates of GDP growth in the United Kingdom.

26. The analysis focuses on the change in the output gap rather than the level to avoid problems related to changes in the base year of real GDP.

Figure 4. **Range of revisions with respect to previous period's estimate**

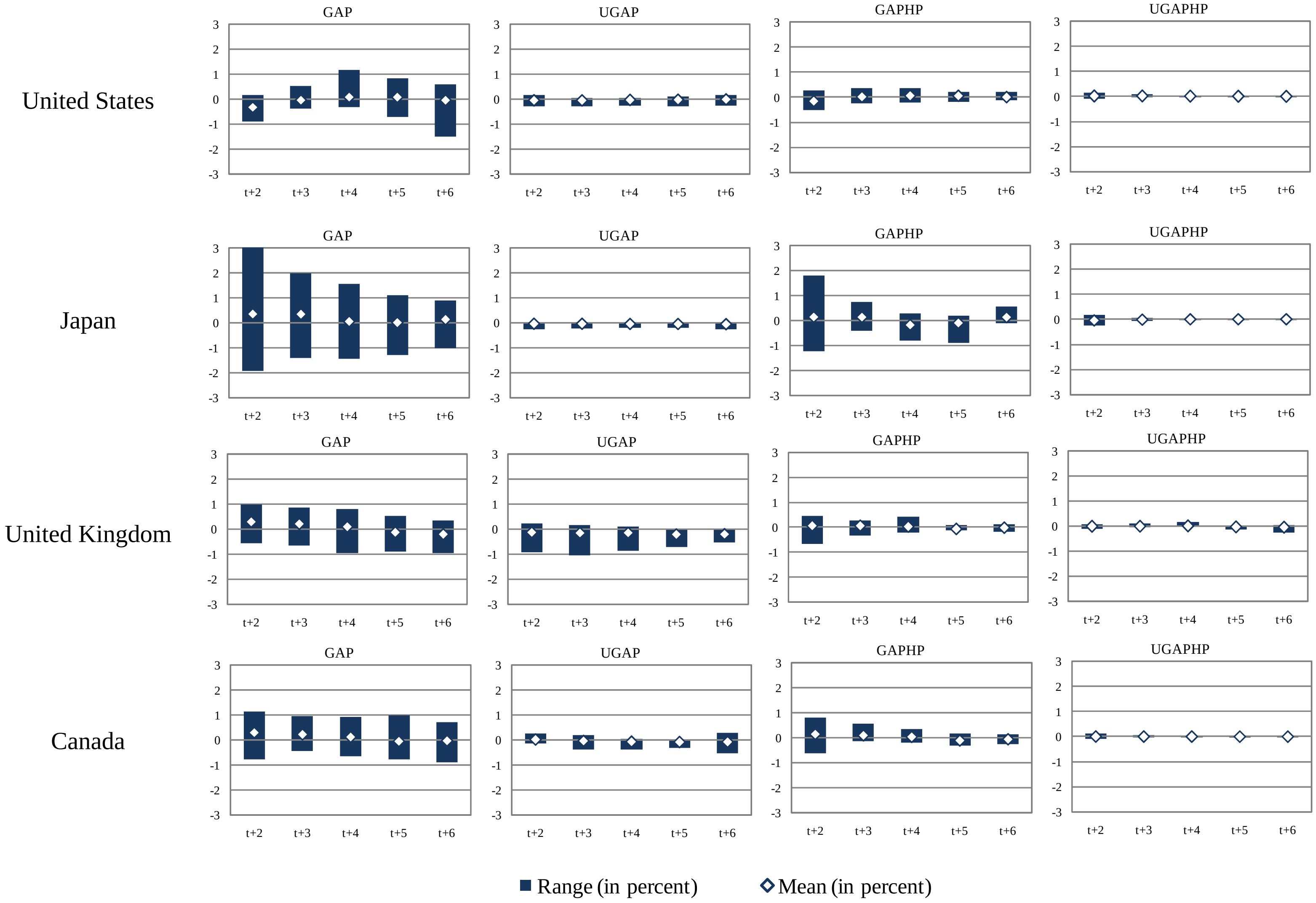
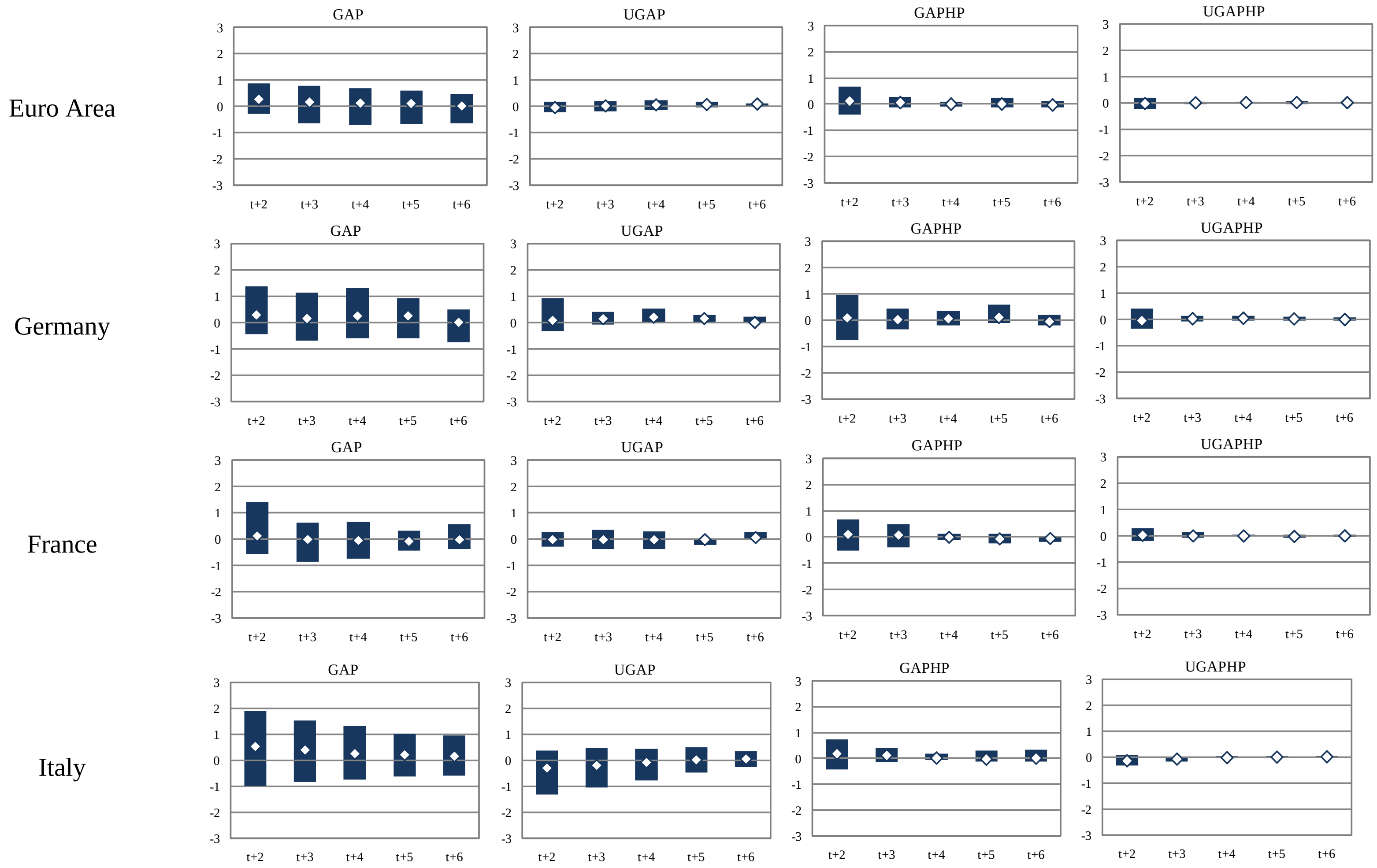


Figure 4. **Range of revisions with respect to previous period's estimate** (cont'd)



Notes: The first bar is associated with the first revision (one year after the first publication in year *t*+1), the next bar reflects the second revision (the difference between the values published one year and two years following the first publication), and so on.

GDP growth (see Table 9 and Figure 5). In the remaining countries, revisions to the change in the output gap are largely attributable to revisions in potential GDP growth. Interestingly, all G7 economies apart from Italy belong to the first group, indicating that potential output revisions tend to be smaller relative to data revisions in the largest economies. The largest average revisions over time to the change in the output gap are for Ireland and Japan. For both economies, the revisions are primarily attributable to revisions in output growth.

[Table 9. Mean absolute revision between *t*+1 and *t*+4]

36. The probability of an upward or downward revision to the initial outturn estimate of the output gap is related to the sign of the initial estimate (see Table 10). If the initial estimate of the gap is negative, there is a probability of about two-thirds that the output gap will be revised upwards in the future (*i.e.* become less negative). This finding is mainly driven by a few countries for which the data initially pointed to a negative output gap for all years between 1995 and 2006 but were later revised upwards.[27] Positive initial outturn estimates are more likely to be followed by downward rather than upward revisions in the case of the HP filter whilst upward and downward revisions are about equally likely for the production function approach.[28] For the unemployment gap, there is no strong evidence that the sign of the revision is related to the sign of the initial outturn.

[Table 10. Sign of initial gap estimate and direction of gap revision]

37. Across countries, there is little empirical evidence that initial outturn estimates of the HP-filter-based output gap contain information that could help predict future revisions to the production-function-based output gap.[29] This is established by estimating each of the following two equations jointly across the G7 economies:

$$GAP_{i,t|t+4} = \alpha_i + \beta_i \, GAPHP_{i,t|t+1} + \gamma_i \, GAP_{i,t|t+1} + \varepsilon_{i,t} \quad (3)$$

$$GAP_{i,t|t+4} - GAP_{i,t|t+1} = \alpha_i + \beta_i \, (GAPHP_{i,t|t+1} - GAP_{i,t|t+1}) + \varepsilon_{i,t} \quad (4)$$

The first of these equations can be used to test whether the initial outturn estimate of the HP filter contains valuable information about the final outturn estimate of the production function approach, given the information contained in the initial outturn estimate of the production function approach. The second equation can be used to test whether the difference between the initial outturn estimates of the two approaches can help to predict the revisions to the production-function-based output gap.[30]

27. These countries are Japan, Germany, Italy, Belgium and Switzerland.

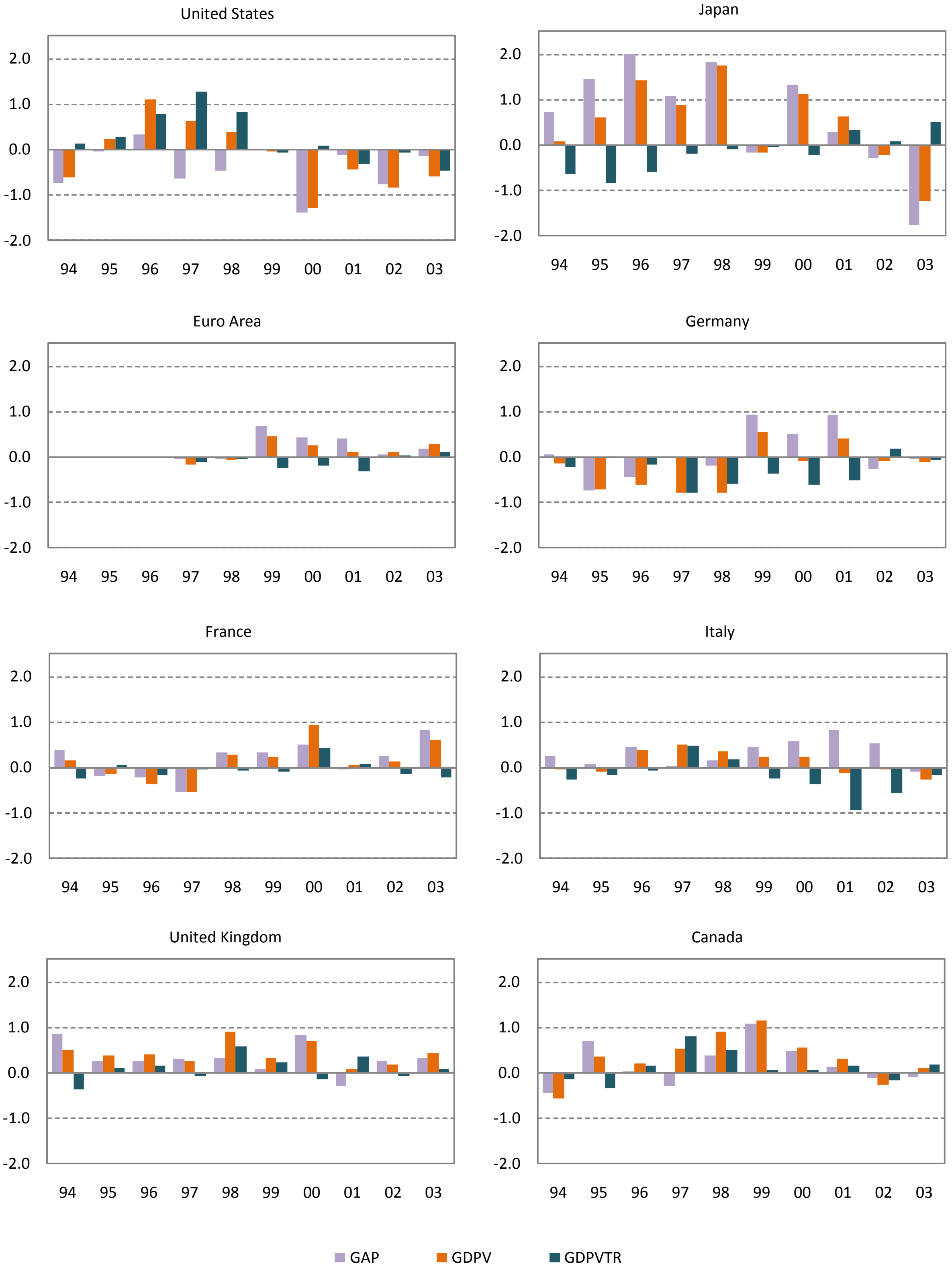
28. When the smoothing parameter γ of the HP filter is set equal to 100 instead of 6.25, the probability of upward and downward revisions appears to be unrelated to the sign of the initial data outturn.

29. The analysis is restricted to the G7 economies for reasons of simplicity.

30. Equation (4) implies that the final outturn of the production function approach is a weighted average of the initial outturns of the production function approach and the HP-filter approach. It thus corresponds to equation (3) with $\beta_i + \gamma_i = 1$ for all *i*. Given that equation (4) imposes a restriction on the data that is not imposed by equation (3) the results might differ across the equations. The analysis is restricted to the G7 economies for reasons of simplicity.

Figure 5. **Decomposition of revisions to changes in the production-function-based output gap**

Percentage points



38. For most countries, the slope coefficient β is not significantly different from zero in either equation [see columns (a) and (b) in Table 11], suggesting that the initial outturn estimate of the HP-filter-based output gap does not systematically contain information that could be used to help predict revisions to the initial outturn estimate of the production-function-based gap. The two notable exceptions are Japan, where the slope coefficient is significant in both equations and the United Kingdom, where the slope coefficient is significant in equation (4).[31]

39. There is also little statistical evidence that initial outturn estimates of capacity utilisation (*CAP*) contain information that could help predict future revisions to the production-function-based output gap. When estimating each of the equations

$$GAP_{i,t|t+4} = \alpha_i + \beta_i\, CAP_{i,t|t+1} + \gamma_i\, GAP_{i,t|t+1} + \varepsilon_{i,t} \quad (5)$$

$$GAP_{i,t|t+4} - GAP_{i,t|t+1} = \alpha_i + \beta_i\, (CAP_{i,t|t+1} - GAP_{i,t|t+1}) + \varepsilon_{i,t} \quad (6)$$

$$GAP_{i,t|t+4} - GAP_{i,t|t+1} = \alpha_i + \beta_i\, (CAP_{i,t|t+1} - GAP_{i,t|t+1}) + \gamma_i\, (GAPHP_{i,t|t+1} - GAP_{i,t|t+1}) + \varepsilon_{i,t} \quad (7)$$

jointly across the G7 economies the slope coefficient β is generally not significantly different from zero [columns (c) to (e) in Table 11]. Japan is again a notable exception, with the slope coefficient being significant in all three specifications.[32] The coefficient γ on the difference between the production-function-based estimate and HP-filter-based estimate in equation (7) is again significant for the United Kingdom and Japan, confirming the results obtained with specification (4).[33]

[Table 11. Predicting the production-function-based output gap and the Kalman-filter-based unemployment gap]

40. The estimates of equation (7) reported in Table 11 provide one means of judging the weights that would be used if the information in the three cyclical variables was combined to form a single estimate of the cycle. However, these estimates are not especially efficient, given that they are made for each country over a short sample period. Additional tests on the results reported in Table 11 suggested that it is valid to impose common slope parameters across countries, giving an aggregate panel specification of the form:

$$GAP_{i,t|t+4} = \alpha_i + \beta\, GAP_{i,t|t+1} + \gamma\, GAPHP_{i,t|t+1} + \delta\, CAP_{i,t|t+1} + \varepsilon_{i,t}. \quad (8)$$

This specification is estimated jointly across the G7 economies, allowing for a separate error variance in all economies. Subsequent tests showed that it was permissible to also drop the country-specific intercepts and to constrain the slope coefficients to sum to unity.[34]

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31. While the point estimate of the slope coefficient in equation (4) is equal to 0.7 for the United Kingdom, the point estimate is above unity for Japan.

32. This is consistent with Kamada (2005), who finds that the TANKAN survey contains information that can be used to forecast the final output gap estimate for Japan given the real-time output gap. Note, however, that the coefficient on capacity utilisation is only marginally significant once the HP-filter estimate is added to the equation [specification (7)].

33. Although the point estimates of the coefficient are above unity for both countries, the standard errors are large so that the hypothesis that the coefficients are smaller than unity cannot be rejected for either country.

34. The *p*-value of the corresponding Wald-test is 0.09 for the specification with fixed effects and 0.92 for the specification without fixed effects.

41. The results of various specifications are summarised in Table 12.The final outturn estimate of the production-function-based output gap is found to be significantly related to the initial outturn estimates of the two gap measures, with the coefficient of the HP-filter-based gap being equal to about 0.55 and the coefficient of the production-function-based gap being equal to about 0.45. The coefficient on capacity utilisation is not significantly different from zero, and dropping the variable does not affect the coefficients on the other two measures. The finding of a significant role for the HP filter is likely to stem from the significant effects found for the United Kingdom and Japan (Table 11).

[Table 12. Relationship between business cycle indicators, pooled regression results]

42. A similar analysis of the unemployment gap indicates that the HP-filter-based gap also contains information about revisions to the outturn estimates of the Kalman-filter-based gap in a number of countries [columns (f) and (g) in Table 11]. Although these results are sensitive to the choice of the smoothing parameter of the HP filter and to the choice of the "final" outturn estimates, taken together they point to some inefficiencies in the gap outturn estimates published in the *Economic Outlook*.[35,36]

3.3 Revisions to gap projections

43. In the previous section, the precision of the initial gap outturn estimates was investigated by looking at the subsequent revisions to them. The remainder of this section examines the accuracy of current-year and one-year-ahead projections of the four measures of the output and the unemployment gap.

44. The current-year projections of the output and unemployment gap (projections for year *t* made in year *t*) published in the *Economic Outlook* appear to be reasonably good predictors of the initial and final outturn estimates (Figures 6 and 7). The projections are generally highly correlated with the outturn estimates (see Table 13) and the sign of the gap, as well as its direction of change, is predicated correctly on average (see Tables 14 and 15).[37]

[Table 13. Correlation between gap projections and outturn estimates]
[Table 14. Sign of projected gap vs. outturn estimate]
[Table 15. Projected vs. actual change of the output/unemployment gap]

35. Given the small sample size in the case of the unemployment gap, the analysis is also conducted using the outturn at time $t+2$ as the final value.

36. When setting the parameter equal to 100 instead of 6.25, the HP-filter-based estimates are found to contain some useful information for the United Kingdom, Italy and Japan. The sensitivity of the results might reflect the small sample size.

37. The table reports a binomial test measuring the association between the projected sign of the gap (its projected direction of change) and the sign (direction of change) of the outturn estimate by comparing the observed frequencies in a two-by-two contingency table to the frequencies that would be expected to occur if there were no association between the projections and the outturn estimates (see Siegel and Castellan, 1988, chapter 9 for details).

Figure 6. **1-year-ahead and current-year output gap projections (production function approach)**

Per cent

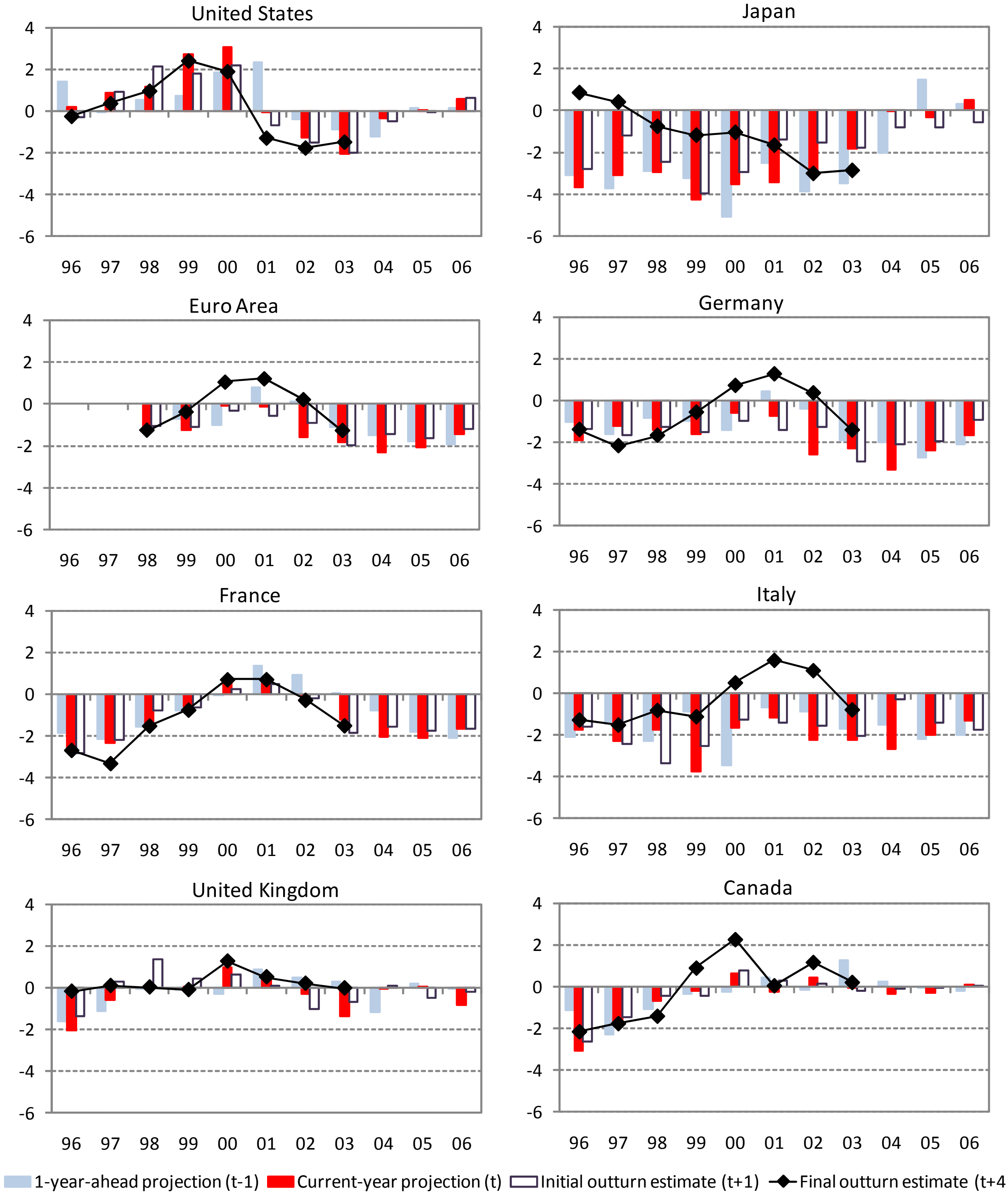
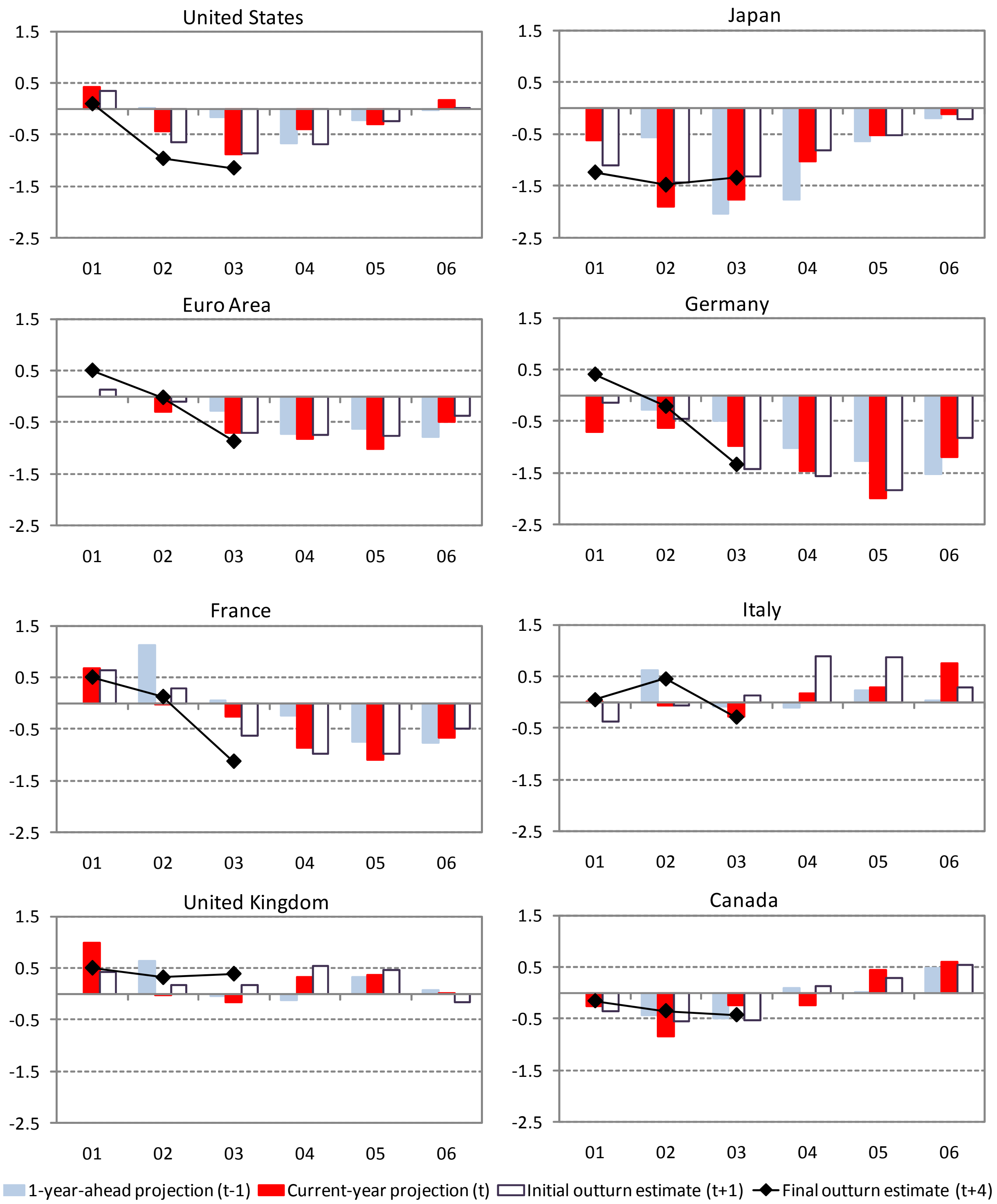


Figure 7. **1-year-ahead and current-year unemployment gap projections (Kalman filter)**

Per cent



45. As the correlation coefficients do not reflect any differences in the means of the series considered, they might understate the disparity between the projections and the released data. That revisions are indeed quite sizable in many countries can be seen from looking at the average absolute difference and the maximum absolute difference between projections and actual outturn estimates (Table 16). On average across countries, the mean absolute revision between years *t* and *t*+4 is equal to 1.2 percentage points for the production-function-based output gap and 0.4 percentage points for the Kalman-filter-based unemployment gap. The maximum absolute revision is considerably higher for the output gap (2.3 percentage points on average across countries), but only marginally higher for the unemployment gap (0.6 percentage points), indicating that the dispersion of the estimates over time is much smaller for the latter measure.

[Table 16. Size of revisions to output gap and unemployment gap projections]

46. The current-year projections of the production-function-based output and the Kalman-filter-based unemployment gap are statistically biased for many countries. This is demonstrated by estimating a number of equations that relate the respective outturn estimates in years *t*+1 and *t*+4 on a constant and either the current-year or the one-year-ahead projection.[38] These equations have a similar form to equation (1). The hypothesis that the current-year projections are unbiased and efficient predictors of the outturn estimates is collectively rejected for the 21 economies though there are several countries for which the projections perform reasonably well (see Tables 17 and 18). The hypothesis of efficiency cannot be rejected for about half of the countries for the production-function-based output gap and for about two-thirds of the countries for the Kalman-filter-based unemployment gap. The hypothesis of efficiency cannot be rejected for the set of 21 countries in the case of the HP-filter-based output gap.

[Table 17. Test for efficiency and unbiasedness of output gap projections]
[Table 18. Test for efficiency and unbiasedness of unemployment gap projections]

47. The probabilities of upward (downward) revisions to the current-year and the one-year-ahead predictions of the production-function-based output gap appear to be related to the sign of the initial projection (see Tables 19 and 20). If the gap is projected to be negative, there is a probability of over two-thirds that the projection will be revised upwards in the future (meaning that the gap becomes less negative), which is consistent with the results obtained for the revisions made between *t*+1 and *t*+4. Similar results are obtained for the current-year projections of the other gap measures, with negative gaps often being revised upwards over time.

[Table 19. Sign of current-year projection and direction of revision]
[Table 20. Sign of 1-year-ahead projection and direction of revision]

48. For all four business cycle measures there is no strong evidence that the revision of the projection in a given period (with respect to the initial outturn estimate in year *t*+1) is related to the revision of the projection in the previous period. When estimating a system of equations relating the revision of the projection in a given period to a constant and the revision of the projection in the previous period, the slope coefficients are in general not significantly different from zero (Table 21). Thus, if the gap is overestimated in a certain year, this does not affect the likelihood that the gap is also overestimated in the subsequent year. Moreover, the revisions to the current-year and the one-year-ahead projections are in general not

38. For the two unemployment gap measures no results are reported for regressions involving data released at time *t*+4 as the number of observations is not sufficient for such regressions.

correlated across countries, as shown in Table 22.[39] A notable exception is the revisions of France and Germany, which have a significant positive correlation. This suggests that there is a common factor that might help to account for the revisions made in these economies.

[Table 21. Autocorrelation of revisions]
[Table 22. Cross-country correlation of revisions]

49. To evaluate whether the current-year projections of the HP-filter and capacity utilisation contain valuable information that could help predict future revisions to, respectively, the production-function-based output gap and the Kalman-filter-based unemployment gap several equations are estimated that are similar to equations (3) to (8). The results are summarized in Tables 23, 24 and 25. In general, the current-year projections of the HP-filter-based output gap and the capacity utilisation rate do not appear to help predict the final outturn estimate of the production-function-based output gap.[40] However, for France, Italy and the United Kingdom there is statistically significant evidence that the difference between the HP-filter-based and the production-function-based current-year projections is significantly correlated with the revisions made over time to the current-year projection of the production-function-based output gap. The estimation results imply that a deviation between the two projections is associated with a revision that brings the production-function-based estimate closer to the HP-filter-based estimate over time. For the unemployment gap, there is some evidence that the HP-filter-based projection contains significant information about revisions to the initial outturn estimate of the Kalman-filter-based gap in France, Italy, the United Kingdom, and Canada.

[Table 23. Predicting the final outturn estimates of the production-function-based output gap]
[Table 24. Predicting the initial outturn estimates of the production-function-based output gap and the Kalman-filter-based unemployment gap]
[Table 25. Relationship between business cycle indicators, pooled regression results]

50. In contrast to the current-year projections, the one-year-ahead projections (projections for year *t* made in year *t*-1) appear to be rather poor predictors of the initial and final outturn estimates. The correlations between the projections and the outturn estimates are often very low and not significantly different from zero. Moreover, both the sign and the direction of change of the gap are wrongly predicted in many cases. Performance in this case appears similar to that reported for one-year-ahead GDP growth projections in Vogel (2007).[41]

3.4 Gap projections and estimates at cyclical turning points

51. Large forecast errors often occur around cyclical turning points. So it is of interest to see whether projections and early outturn estimates of the output gap for the years around cyclical turning points are subject to greater revisions than at other times. The sample used in the preceding analyses was split in two, with one sub-sample consisting of the years with cyclical troughs or peaks and the other sub-sample consisting of the remaining years.[42] A comparison was then made of the directional accuracy of projections

39. For reasons of clarity Table 22 shows cross-country correlations for the G7 economies only. The results are similar for the remaining countries with the prediction errors generally being uncorrelated across countries.

40. The analysis of the information content of the HP-filter-based measures and the capacity utilisation rate is again restricted to the G7 economies.

41. Vogel (2007) shows that the GDP growth forecasts published in the spring-issue of the *Economic Outlook* are useful for predicting GDP growth in the current year but are uninformative about GDP growth in the subsequent year.

42. The cyclical peaks and troughs were identified using the production-function-based output gaps published in the spring-2007 issue of the *Economic Outlook*.

of the change in the output gap in the year of the peak/trough (year *t*) and the subsequent year (year *t*+1), as compared to that shown in the final outturn estimates. A projection is regarded as correct when the signs of the changes in the output gap in year *t* and year *t*+1 are both correctly identified.[43] This analysis was initially undertaken using the current-year projections (projections for year *t* and year *t*+1 made in year *t*) and then repeated using the initial outturn estimates (estimates of year *t* and projections for year *t*+1 made in year *t*+1).

52. The numbers of correct and incorrect decisions about the occurrence of a cyclical turning point in year *t* are reported in Table 26.[44] It is clear that in the year of the turning point (year *t*) the turning point is generally not detected, with the projection being correct only one-fifth of the time. But in the year after the trough or peak, the turning point is identified correctly in just under three-fifths of the cases considered. The balance of correct/incorrect decisions is similar for those years that are not cyclical turning points, suggesting that projections of the direction of change in the output gap are not that much more difficult to make at turning points than at other times.

[Table 26. Identifying cyclical turning points]

53. However, the level of the output gap is clearly more difficult to predict for those years in which a turning point is currently thought to have occurred. The average absolute revisions to the one-year-ahead and current-year projections of gaps, and also to the initial outturn estimates of gaps, are markedly larger in years with a turning point (Table 27).

[Table 27. Mean absolute revision of output gap estimates

3.5 The relationship between the business cycle and inflation

54. The link between inflation and measures of economic slack has weakened over time in most OECD economies (see Figure 8).[45] The flattening of the short-run Phillips curve can in part be attributed to the impact of globalisation (Pain *et al*., 2006). Greater competition from abroad limits firms' scope to raise prices when demand rises. Moreover, enhanced capital and labour mobility may reduce the sensitivity of wages and prices to domestic demand and supply imbalances, with workers being reluctant to push for higher wages when the domestic labour market tightens for fear of losing their jobs to foreign workers. However, in most countries the Phillips curve began to flatten before the pace of globalisation accelerated in the mid-1990s, suggesting that other forces have been at work as well. For example, improvements in the credibility of monetary policy, leading to better-anchored inflation expectations, have also contributed to the changing trade-off between inflation and activity.[46]

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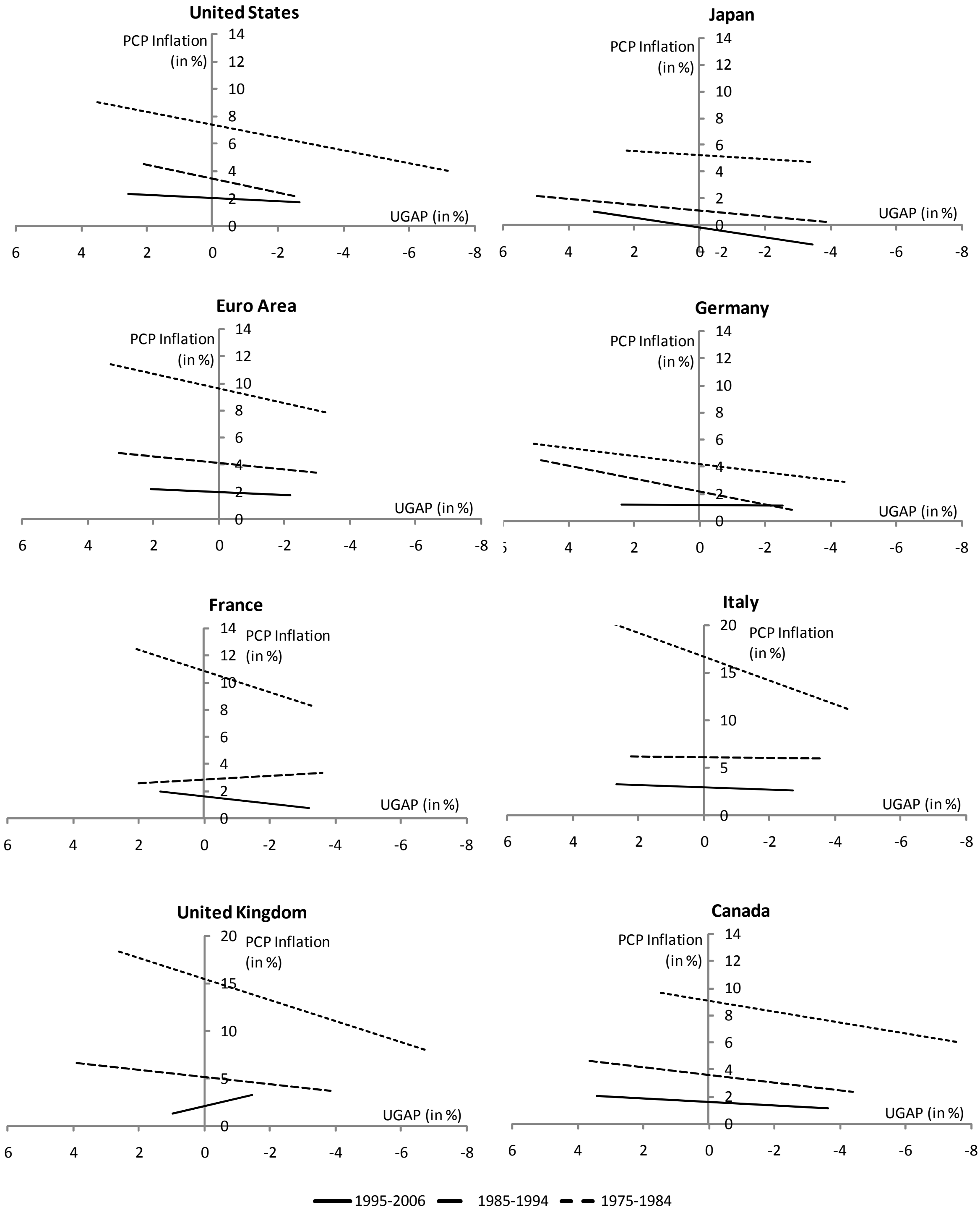
43. For any year *t* characterised by a cyclical trough (peak), a correct projection would be that the change in the gap in year *t* is negative (positive) and the change in the gap in year *t*+1 is positive (negative). In contrast, the two terms would have the same signs if no turning point occurs in year *t*.

44. The significance of the difference in the probability of correct and incorrect decisions is assessed using a binomial test (Siegel and Castellan, 1988).

45. See, for example, Pain *et al*. (2006), IMF (2006), Borio and Filardo (2007), and Mody and Ohnsorge (2007).

46. IMF (2006) show for the G7 economies and Australia that globalisation is the key factor behind the decline in the sensitivity of prices to domestic economic slack observed over the past two decades. Ihrig *et al*. (2007) by contrast do not find any evidence that the decline in the sensitivity of inflation to the domestic output gap is due to globalisation related factors.

Figure 8. **Phillips curves, 1975 to 2006**



Note: The Phillips-curves are derived as linear trends through quarterly data of inflation and the unemployment gap.

55. The relationship between inflation and activity is further examined by estimating Phillips-curve equations for the G7 economies over the period 1980 to 2006. The equations use a variant of the widely used "triangle model" of Gordon (1998), relating the change in consumer price inflation (as measured using the consumers' expenditure deflator) to real import price inflation (goods and services), real commodity import price inflation (with measures of both import prices deflated by unit labour costs) and a measure of domestic economic slack:[47]

$$\Delta\pi_{it} = \alpha_i \pi_{i,t}^{5Y} - \alpha_i \pi_{i,t-1} + \sum_{j=1}^{3} \beta_{ji} \Delta\pi_{i,t-j} + \sum_{j=0}^{4} \gamma_{ji} MGS_{i,t-j}^{SH} \left(\pi_{i,t-j}^{MGS} - \pi_{i,t-j}^{ULC}\right) + \sum_{j=0}^{4} \delta_{ji} MNW_{i,t-j}^{SH} \left(\pi_{i,t-j}^{MNW} - \pi_{i,t-j}^{ULC}\right) + \theta_{ji} \Omega_{i,t-1} \quad (9)$$

where π is the change in the private consumption deflator,[48] π^{5Y} is the five-year backward moving average of the change in the private consumption deflator, MGS^{SH} is the import content of consumption,[49] π^{MGS} is import price inflation (goods and services), π^{ULC} is the change in unit labor costs, MNW^{SH} is the GDP share of commodity imports, π^{MNW} is commodity import price inflation, Ω is the cyclical position of the economy and the indices t and i denote time and country.

56. The five-year backward moving average of consumer price inflation is included in the equations as a proxy for inflation expectations.[50] Dynamic homogeneity is imposed on all equations, with the coefficients on π^{5Y} and π_{t-1} summing up to unity.[51] The coefficients on real import price inflation and real commodity import price inflation are interacted with the share of imports in domestic demand and the share of commodity imports in GDP, respectively.[52] This implies that the implicit effect of import prices rises over time in all countries due to increases in import penetration, consistent with the results in Pain *et al*. (2006).

57. The empirical work uses quarterly *ex-post* data over the period 1980-2006. The system of equations is estimated separately, using each of the five business cycle measures discussed in Box 1. A seemingly unrelated regression procedure (SUR) is used, allowing for the possibility of non-zero co-variances across the error terms in the separate country equations. Cross-country restrictions are imposed

47. Related specifications are used by Richardson *et al*. (2000) and Mourougane and Ibaragi (2004).

48. The private consumption deflator (PCP) is used as the indicator of domestic inflation because it provides a broader measure of inflation than many national consumer or retail price series, and is in principle more directly comparable across countries because it comes from the system of national accounts.

49. The import content of consumption is calculated as $M_{i,t}^{SH} = (M_{i,t} - \eta_i X_{i,t})/(M_{i,t} + Y_{i,t} - X_{i,t})$, where M denotes total imports, X denotes total exports, Y denotes domestic output and η is the share of imports used in the production of export goods. Estimates of η_i are taken from Pain *et al.* (2005, Table 7).

50. The underlying assumption is that expectations are purely backward looking. Although a survey-based measure of inflation expectations might be preferable, the required data are not available for all countries on a comparable basis.

51. As the imposition of dynamic homogeneity is strongly rejected by the data, the system of equations is also estimated without imposing the restriction. The estimation results remain broadly similar.

52. This may understate the impact of commodity prices in those countries that are significant commodity producers.

as the data permit.[53] Initial parameter stability tests revealed evidence of a significant structural break in the parameters in the Phillips-curve equations in the mid-1990s.[54] This coincides with a period in which there has been a marked increase in the extent of globalisation and a marked decline in the mean of consumer price inflation. To overcome this, all coefficients are interacted with a dummy variable *D* which is equal to unity from the first quarter of 1995 onwards:

$$\Delta\pi_{it} = (\alpha_i + \varphi_i D)\pi_{i,t}^{5Y} - (\alpha_i + \varphi_i D)\pi_{i,t-1} + \sum_{j=1}^{3}(\beta_{ji} + \rho_{ji} D)\Delta\pi_{i,t-j} + \sum_{j=0}^{4}(\gamma_{ji} + \psi_{ji} D)MGS_{i,t-j}^{SH}\left(\pi_{i,t-j}^{MGS} - \pi_{i,t-j}^{ULC}\right)$$

$$+ \sum_{j=0}^{4}(\delta_{ji} + \omega_{ji} D)MNW_{i,t-j}^{SH}\left(\pi_{i,t-j}^{MNW} - \pi_{i,t-j}^{ULC}\right) + (\theta_{ji} + \nu_{ji} D)\Omega_{i,t-1} \qquad (10)$$

58. In estimating this second model, coefficients are grouped across countries on the basis of the results obtained from the initial specification with a single set of coefficients over the full sample period. Initially, all parameters are interacted with the dummy variable. Insignificant coefficients on the interaction terms are subsequently dropped from the model, so that only those parameters that exhibit a significant break in the first quarter of 1995 are ultimately interacted with the dummy variable. The other coefficients are applicable over the whole sample period.

59. The results of the final restricted regressions are summarised in Tables 28 to 32, with a separate set of coefficients for each of the five business cycle measures. The upper parts of the tables contain the coefficients applicable for 1980-94 and the lower parts contain those that are applicable from 1995 onwards. The resulting estimates suggest that inflation expectations have become a more important influence on domestic inflation in most G7 economies, with the size of the coefficient on the backward moving average of consumer price inflation significantly larger after 1995 than before.[55]

[Table 28. Phillips curve estimates – GAP]
[Table 29. Phillips curve estimates – UGAP]
[Table 30. Phillips curve estimates – GAPHP]
[Table 31. Phillips curve estimates – UGAPHP]
[Table 32. Phillips curve estimates – CAP]

60. Real import price inflation is found to have a positive influence on consumer price inflation in all countries, as indicated by the positive sum of the coefficients on the current and lagged real import price terms. Although the estimated coefficients do not exhibit a structural break during the sample period, the models incorporate a globalisation-related rise in the impact of real import price inflation on domestic consumer price inflation by interacting real import price inflation with the import content of consumption. Real commodity import price inflation is found to have a significant influence on consumer price inflation in Canada, Germany, and the United States during the entire sample period and in France and the United Kingdom since 1995. The effect is notably larger for the United States than for the other countries.

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53. It should be noted that the groups that are formed are ones that are data acceptable, so they do not necessarily have a direct economic interpretation.

54. A dummy variable test is used, with each variable in the restricted system of equations being interacted with a dummy equal to unity from 1995Q1 and zero before. The parameters on the dummied terms are found to be jointly significant when included in the restricted system, indicating the presence of a structural break in at least one of coefficients in the original restricted model. A similar finding is reported by Pain *et al*. (2006).

55. In the models using the HP-filter-based output gap and the capacity utilisation rate, inflation expectations are not significant for Canada and the United States prior to 1995.

61. Each of the five business cycle measures is found to have a significant influence on consumer price inflation in all countries, with the impact on inflation being smaller after 1995 than before, confirming the observation made in Figure 8. On average across all G7 economies, a rise of 1 percentage point for four consecutive quarters in any of the domestic business cycle measures is estimated to raise inflation in the four quarters following the onset of the shock by about ¼ percentage point per annum less in the more recent period compared to the earlier period (see Table 33). For example, a 1 percentage point rise in the Kalman-filter-based unemployment gap raised inflation in the G7 economies by 0.6 percentage points per annum prior to 1995 compared to 0.4 percentage points thereafter. This decline in the short-run reaction of inflation to changes in domestic economic conditions is in line with the findings of other recent studies on this issue (Pain *et al*., 2006; IMF, 2006; Melick and Galati, 2006; Borio and Filardo, 2007; Ihrig *et al*., 2007).

[Table 33. Inflationary impact of a rise in the gap (deviation from baseline)]

62. As might be expected given the close correlation of the output and unemployment gaps and the smaller amplitude of variations in the latter measure, the estimation results show that consumer price inflation is more sensitive to the unemployment gap than to the output gap. The post-1995 coefficients imply that a 1 percentage point rise for four consecutive quarters in either of the two unemployment gap measures is estimated to raise inflation in the four quarters following the onset of the shock by about ¼ percentage point more on average across the G7 economies than an equal rise in either of the two output gap measures. The impact on inflation is even smaller for the capacity utilisation rate.

63. To assess the relative goodness of fit of the five models, they were also estimated using a full information maximum likelihood (FIML) approach. The log-likelihood values of the different models suggest that the specifications using either the production-function-based output gap or the Kalman-filter-based unemployment gap fit the data equally well and better than the models that use the other three business cycle measures.[56] When the production-function-based output gap and the capacity utilisation rate are included as explanatory variables in the same Phillips-curve equation, capacity utilisation is not found to provide any additional statistically significant information to that contained in the output gap. The output gap is highly significant in both sub-periods, but capacity utilisation is not significant in either of them.

64. As discussed in Beffy *et al.* (2006), the output gap calculated with the production function approach consists of four main components, the total factor productivity gap, the hours worked gap, the labour force participation gap, and the unemployment gap. To investigate the relationship between inflation and each of these components the Phillips-curve equations are also estimated replacing the single output gap measure with the four components:

56. This result might be expected, at least for the unemployment gap, since it is constructed directly using information on inflation (see, Richardson *et al*, 2000). The respective log likelihood values are 3475, 3473, 3457, 3448 and 3440 for the models including GAP, UGAP, GAPHP, UGAPHP and CAP. Note that survey data might still be the preferable measure of the business cycle given that the lack of any substantial revisions represents an important advantage in forward-looking analyses.

$$\Delta\pi_{it} = (\alpha_i + \varphi_i D)\pi_{i,t}^{5Y} - (\alpha_i + \varphi_i D)\pi_{i,t-1} + \sum_{j=1}^{3}(\beta_{ji} + \rho_{ji} D)\Delta\pi_{i,t-j} + \sum_{j=0}^{4}(\gamma_{ji} + \psi_{ji} D)MGS_{i,t-j}^{SH}(\pi_{i,t-j}^{MGS} - \pi_{i,t-j}^{ULC})$$
$$+ \sum_{j=0}^{4}(\delta_{ji} + \omega_{ji} D)MNW_{i,t-j}^{SH}(\pi_{i,t-j}^{MNW} - \pi_{i,t-j}^{ULC}) + (\kappa_{ji} + \vartheta_{ji} D)\ln\left(\frac{TFP_{i,t-1}}{TFPTR_{i,t-1}}\right) + (\eta_{ji} + \mu_{ji} D)\ln\left(\frac{LFPR_{i,t-1}}{LFPRTR_{i,t-1}}\right)$$
$$+ (\sigma_{ji} + \tau_{ji} D)\ln\left(\frac{HRS_{i,t-1}}{HRSTR_{i,t-1}}\right) + (\zeta_{ji} + \xi_{ji} D)\ln\left(\frac{1 - UNR_{i,t-1}/100}{1 - NAIRU_{i,t-1}/100}\right) \quad (11)$$

65. In estimating the model, the same restrictions were imposed on the coefficients as in the model including only the output gap. The coefficients on the four components were initially allowed to vary by country but were restricted subsequently to be equal across subsets of countries as the data permit. Given that the coefficient on the output gap was found to exhibit a structural break in 1995, the coefficients on the components were initially also interacted with the break dummy. Statistically insignificant dummy variables were subsequently dropped, so that only those parameters that exhibit a significant break in the first quarter of 1995 were ultimately interacted with the dummy variable.[57]

66. The resulting estimates show that the total factor productivity gap and the unemployment gap have both had a significant influence on consumer price inflation during the entire sample period (see Table 34). In the first sub-sample, from 1980 to 1994, the hours worked gap and the labour force participation gap are also found to have had a significant impact on consumer price inflation in a number of countries. This suggests that other components of the output gap contain valuable information about inflationary pressures over and above the information already contained in the unemployment gap.[58] While the sensitivity of inflation to the total factor productivity gap appears to have remained unchanged throughout the sample period, the sensitivity to the unemployment gap is smaller in the more recent period.[59]

[Table 34. Phillips curve estimates – GAP components]

3.6 The usefulness of business cycle measures for inflation forecasting

67. A number of recent papers have evaluated the usefulness of business cycle measures for predicting inflation (see Box 3). Those that conduct out-of-sample forecasts using *ex-post* information about the cyclical position of the economy have typically found that measures of the cycle do not in general improve the forecasting performance of simple benchmark models, such as an autoregressive model of inflation. For the United States, there is some evidence that the accuracy of inflation forecasts is improved by including measures of the business cycle in the forecasting equation, but for other countries, the gains in forecast accuracy, if any, are only marginal. If real-time data are used, the information contained in the output gap or unemployment gap has frequently been found to lead to a deterioration in forecast performance. A few studies have suggested that survey data might provide valuable information for predicting inflationary pressures, although the gains appear to be small and limited to certain periods of time.

57. A Wald test cannot reject the null hypothesis that the additional set of restrictions holds. The corresponding *p*-value is 0.19.

58. A Wald test strongly rejects the hypothesis that the total factor productivity gap, the hours worked gap and the labour force participation gap can be jointly dropped from the Phillips curve equations.

59. Despite this decline, the sensitivity of inflation to the unemployment gap remains significantly higher than the sensitivity to the total factor productivity gap. A Wald test strongly rejects the hypothesis that the coefficients on the two gaps are of equal magnitude in the second half of the sample (*p*-value=0.014).

Box 3. **The usefulness of business cycle measures for inflation forecasting**

There are many empirical studies of the usefulness of business cycle indicators for predicting inflationary pressures. Most use *ex-post* data in their forecasting analyses, with only a few assessing their performance using real-time data. The latter approach provides a better picture of their operational usefulness, given that most indicators are subject to substantial revisions over time.

Studies using ex-post data

Stock and Watson (1999) examine forecasts of US inflation using *ex-post* information on a large number of indicators of economic activity. They conclude that the forecasts produced by a traditional Phillips curve model are more accurate than those produced by simple benchmark models and also more accurate than those produced by models that are based on other macroeconomic variables, such as interest rates or the stock of money. The forecasts can however be improved upon if a measure of aggregate real activity is used in place of the unemployment rate. Similar results regarding the usefulness of *ex-post* business cycle data for forecasting inflation in the United States are obtained by Orphanides and van Norden (2005). Eleven out of the twelve output-gap-based forecasting models considered in their study are found to outperform significantly the autoregressive (AR) benchmark model.

Ross and Ubide (2001) find that business cycle measures provide valuable information in the euro area, with forecasts from models with the output gap outperforming a naïve random walk forecast from a simple benchmark model. Claus *et al*. (2000) report that the output gap is a good indicator of inflationary pressures in New Zealand as it provides a useful signal about the direction of inflationary pressures, with actual and forecast inflation generally moving in the same direction. However, the significance of this result is limited as the authors do not verify whether simpler models would have performed as well. For Norway, Bjørnland *et al*. (2006) find that multivariate measures of the output gap in a Phillips-curve-type forecasting equation produce more accurate inflation forecasts than an AR benchmark model. However, alternative indicators of the cycle, such as the employment gap or an index of financial variables, are found to perform equally well and in some cases even better than the multivariate methods. The inflation forecasts obtained using univariate measures of the output gap are found to be less accurate than those from the autoregressive benchmark, especially for forecasting horizons above one year. The usefulness of output gaps is also questioned by Camba-Mendez and Rodriguez-Palenzuela (2001) and Billmeier (2004). Camba-Mendez and Rodriguez-Palenzuela (2001) evaluate the usefulness of output gaps for forecasting inflation in the United States and the euro area. Whilst some of the output gap based forecasting models perform better than a naïve random walk forecast, all are outperformed by an AR benchmark model. Billmeier (2004) reports related findings for Finland, France, Greece, Italy and the United Kingdom.

Studies using real-time or survey data

The study by Orphanides and van Norden (2005) also compares the usefulness of real-time and *ex-post* output gap estimates for forecasting inflation, with the former found to perform relatively poorly. When using real-time data, some inflation models with an output gap are found to outperform a simple AR model but none perform as well as a model using only lagged inflation and output growth. Similar results are obtained by Robinson *et al*. (2003) for Australia and by Kamada (2005) for Japan. The Phillips-curve type forecasting equations examined by these authors do not in general outperform a simple AR model.

The study by Kamada (2005) suggests that survey data can at times prove a useful alternative indicator of inflationary pressures. Augmenting real-time output gap measures with information from the Tankan survey, it is found that some output-gap-based forecasting models begin to outperform AR models of inflation. This suggests that survey data do contain some valuable information about future inflation in Japan. For the United States, Dotsey and Stark (2005) forecast US core consumer price inflation directly using survey data on capacity utilisation. The results suggest that capacity utilisation helped to predict inflation during the late 1980s, but was not particularly useful in subsequent years.

68. To help evaluate whether business cycle indicators are useful predictors of inflationary pressures, the separate Phillips-curve models with the production-function-based output gap, the Kalman-filter-based unemployment gap and capacity utilisation were used for an out-of-sample forecasting exercise.[60] As projections and outturn estimates of the output and unemployment gap are subject to significant and sometimes persistent revisions over time, the conclusions of such exercises can be expected to be sensitive to whether the forecasts use *ex-post* or real-time data. For this reason, the analysis was carried out using both.[61] This illustrates the practical usefulness of gaps, as policy decisions are often based only on preliminary estimates or projections. The forecasting performance of the four constructed gap measures was compared with that of capacity utilisation to examine whether survey data provide a better means of forecasting inflation.

69. The simulated out-of-sample forecasting exercise consisted of the following steps: first, a model was estimated for the period 1980Q1 through 2003Q2 (using data from the OECD *Economic Outlook* published in autumn 2003 in the case of the real-time exercise) and forecasts of inflation for the next eight quarters were made using the estimated models. Next, the same procedure was repeated including data until the fourth quarter of 2003 (published in the spring 2004 issue of the OECD *Economic Outlook* in the case of the real-time exercise) with inflation projected until the end of 2005.[62] Though quarterly data were used, the focus was on the projections of the year-on-year inflation rate four quarters and eight quarters ahead of the last quarter for which national accounts data were published at the time of the forecast.[63] In all, seven one-year-ahead forecasts and six two-year-ahead forecasts were formed using data up to the end of 2006.

70. The forecasts were dynamic, with projected values of domestic inflation being used for the lagged dependent variables on the right-hand side of the equations.[64] However, the data published in the spring 2007 issue of the EO were used for all the remaining explanatory variables in the *ex-post* exercise. In the real-time exercise two alternative approaches were adopted. The first used the projections published in the EO at the time the inflation forecast was made (so that the projections published in the autumn-2003 issue of the EO were used for the forecast starting in the third quarter of 2003). In contrast, the second approach extrapolated the levels of the other explanatory variables using the *ex-post* growth rates, as published in the spring 2007 OECD *Economic Outlook*.

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60. For simplicity, the two HP-filter-based gap measures are not considered in the analysis.

61. The *ex-post* analysis uses data published in the spring 2007 OECD *Economic Outlook* (EO); the real-time data set is constructed from historical versions of the EO published between autumn 2003 (when quarterly data were published for the first time) and spring 2006. Estimates of capacity utilisation are drawn from the OECD *Main Economic Indicators* database. Real-time estimates were generated by assuming that data are available up to the final quarter of the previous year if the forecast is done in spring and up to the second quarter of the year if the forecast is done in the autumn. Future projections of capacity utilisation are obtained by extrapolating the series using an AR(4) process.

62. Throughout the forecast, the constrained models derived in section 3.5 are employed. In principle, the optimal choice of the cross-country constraints and the optimal number of lags of the explanatory variables might change with each different sample period and data vintage, but this is not explored here.

63. Specifically, the one-year-ahead forecast is defined as $\ln(PCP_{t+4}/PCP_t)*100$ and the two-year-ahead forecast is defined as $\ln(PCP_{t+8}/PCP_{t+4})*100$ where PCP_t is the last published data for the private consumption deflator.

64. This applies to both the lagged changes in domestic inflation and the backward-looking moving average of domestic inflation.

71. To provide a benchmark for comparison, inflation was also forecast using a simple autoregressive process.[65] As it is possible that business cycle indicators improve on simple univariate forecasts of inflation but not on forecasts using a broader range of inputs, a more sophisticated benchmark model was also considered, based on equation (10) but with the business cycle term omitted.[66] A final point of comparison was provided by the actual real-time projections from the OECD *Economic Outlook*. The forecast accuracy of the different models was compared using the root mean squared error (RMSE) of the respective forecasts, with the inflation series published in the spring 2007 *Economic Outlook* serving as the reference value.[67]

72. Comparing the root mean squared errors (RMSEs) of the inflation forecasts from the different models with business cycle terms, it is clear that the performance of the output gap and the unemployment gap models are both better when *ex-post* data are used, although the gains in forecast accuracy compared with using real-time data are often small (see Table 35).[68] The production-function-based output gap model is found to have smaller RMSEs than the other specifications for five of the G7 countries in the four-quarter-ahead *ex-post* inflation forecast (the United Kingdom and Japan being the exceptions), but for two countries only in the eight-quarter-ahead forecast. Using real-time data, the output gap model is found to have the smallest RMSEs for Canada, Japan and the United States, whereas for the United Kingdom the unemployment gap model is preferred. For the three euro area countries, the model with the capacity utilisation rate delivers the best results using real-time data. However, the differences between the accuracy of forecasts from the different models are generally small.

[Table 35. Accuracy of inflation forecasts (Root Mean Squared Error)]

73. Comparing the forecasts from the Phillips-curve models with those of the pure autoregressive model of inflation suggests that models with business cycle measures improve on a univariate forecast for Canada, the United Kingdom and the United States, but not for the euro area countries. The relative performance of the conventional Phillips-curve models is similar when real-time data are used. Japan is the only country for which the choice of the data set seems to make a difference, with the forecasts from the Phillips curve models outperforming those of the autoregressive benchmark when *ex-post* data are used, but not when real-time data are used.

74. The evidence supporting the usefulness of business cycle measures for inflation forecasting is weakened further when comparing the conventional Phillips curve models with similar (re-estimated) specifications that omit the gap terms. The United Kingdom is the only country for which all three Phillips-curve models with the gap outperform the alternative model when real-time data are used. In addition, the performance of the benchmark model can be improved on by taking into account information from the production-function-based output gap in the case of Canada and from capacity utilisation in the cases of

65. Initially, the coefficients on the lagged inflation terms were allowed to exhibit a structural break in 1995 by interacting them with a dummy variable. As the resulting forecasts were very close to those of a model without a break, only the no-break model was retained.

66. The model is again estimated jointly for all G7 economies, with cross-country restrictions being imposed as the data permit. All parameters that exhibit a structural break in the mid-1990s are interacted with a break dummy that is equal to unity from 1995 onwards.

67. A statistically meaningful test of the significance of any observed differences in forecast accuracy cannot be undertaken given the small sample size.

68. About half of the improvement with *ex-post* data can be attributed to better knowledge of the path of the explanatory variables (the gaps plus other explanatory variables such as import prices) over the projection period, with the remainder stemming from changes in the parameters when *ex-post* information is used in estimation.

Germany and France. For the remaining countries, incorporating a measure of the business cycle in the inflation equation is found to reduce the accuracy of the resulting inflation projections.

75. The limited usefulness of the output and unemployment gap for predicting inflationary pressures might be related to the observed break in the relationship between inflation and activity. Although the Phillips-curve models allow for a structural break in the parameter estimates in the mid-1990s, it is likely that the change in the relationship was a more gradual process continuing into the forecast period.[69]

76. The difficulties of projecting inflation accurately using only a single-equation model are illustrated by the good performance of the real-time *Economic Outlook* inflation projections, whose root mean squared errors are also reported in Table 35. The *Economic Outlook* projections have the lowest RMSEs for six out of seven countries in the one-year-ahead forecast (the United States being the exception) and in three out of seven countries in the two-year-ahead forecast. One explanation for this is that qualitative judgements by forecasters are important, at least in the near-term, enabling account to be taken of emerging structural changes and additional information, including one-time events such as VAT increases that have an impact on inflation but which cannot be easily captured in a simple forecasting equation.[70]

3.7 The cyclically-adjusted budget balance

77. The cyclically-adjusted budget balance is obtained by using the output and unemployment gaps to adjust components of government revenues and expenditures that vary over the business cycle (see Box 2). In the approach used by the OECD, personal income taxes, social security contributions, corporate income taxes and indirect taxes are adjusted for movements in the output gap. In addition, unemployment related expenditures are adjusted for movements in the unemployment gap. The elasticities employed in the adjustment process are reported by Girouard and André (2005).

78. Given the direct link between the output and unemployment gaps and the cyclically-adjusted budget balance, revisions to output and unemployment gap estimates will have a direct impact on estimates of the cyclically-adjusted budget balance, and hence on judgements about fiscal sustainability and the fiscal stance. This section explores this linkage in more detail, examining the reliability of early estimates of the cyclically-adjusted budget balance and the sources of revisions to these estimates. The analysis makes use of the real-time data set described above; the sample period is 1997 to 2006 for all analyses that involve the overall budget balance and 2003 to 2006 when investigating revenues and disbursements separately.[71]

79. A first impression of the size of the respective revisions to the current-year projections and the initial outturn estimates is given in Table 36, with the final outturn estimates being the ones made in year t+4. On average across countries, the mean absolute revision made to the initial outturn estimate of the cyclically-adjusted budget balance is equal to 0.8 percentage points of GDP. Revisions are higher for the current-year projections, averaging 1.2 percentage points of GDP across countries. Revisions to the change

69. Rolling regressions reported in Ihrig *et al*. (2007) support this conjecture.

70. The *Economic Outlook* projections will also reflect additional information gained from knowledge of the monthly movements in inflation subsequent to the last quarter of national accounts data.

71. The sample period for revenues and disbursements starts in 2003 because of a change in their definitions between the 2002 *Economic Outlook* and that in 2003. It is also the case that data on the budget balance and its components become available with a considerable lag in some countries. Nonetheless, sufficient information is available by the time of the spring *Economic Outlook* is published to provide a reasonable assessment of last year's outturn.

in the CABB are also sizable, averaging 0.7 percentage points of GDP for the current-year-projection and ½ percentage point of GDP for the initial outturn estimate.

[Table 36. Revisions to estimates of the CABB and CAPB]

80. Nonetheless, initial outturn estimates of the level of the cyclically-adjusted primary balance (CAPB), which provides an indication of the likely sustainability of the current fiscal position, are generally strongly positively correlated with subsequent revised estimates (see Table 37). For most countries, the initial outturn estimate is also found to be an unbiased and efficient predictor of the revised estimate (see Table 38).[72,73] In three of the 21 countries in the sample – Italy, Canada and Greece – the initial outturn estimate overstates the revised size of the CAPB for most of the observation period (1997-2006), leading to subsequent downward revisions (see Figure 9).[74] Nonetheless, the sign of the initial outturn estimate is identical to the sign of the final estimate for more than 90% of the observations (see Table 39). Overall, this suggests that the initial outturn estimate provides a broadly reliable assessment of the sustainability of fiscal policy.

[Table 37. Correlation analysis – cyclically-adjusted primary balance]
[Table 38. Test for efficiency and unbiasedness, cyclically-adjusted primary balance]
[Table 39. Sign of the cyclically-adjusted primary balance]

81. The direction of change of the CAPB in the initial outturn estimates (*i.e.* the estimate in year $t+1$ of the change between year t and year $t-1$), which provides one indication of the fiscal stance, is found to be identical to the direction of change in the final outturn estimate (published in year t+4) for more than 80% of all observations over 1997-2006 (see Table 40). Moreover, the size of the change in the initial outturn estimate is an unbiased and efficient predictor of the size of the change in the final outturn estimate for all countries but Finland, where the initial outturn estimate appears to have been revised downwards over time. Thus the initial outturn estimate generally provides a reasonably accurate estimate of the change in the fiscal stance.

[Table 40. Predicted and actual change of the cyclically-adjusted primary balance]

82. Equally, the current-year projections of the current-year level and change in the CAPB provide a reasonable picture of the level and change in the cyclically-adjusted balance in subsequent outturn estimates. The one-year-ahead predictions perform less well than the current-year projections, but still provide a reasonably accurate picture of the sign of the level and, more importantly, the change in the primary balance in the initial and final outturn estimates (see Tables 37 to 41).

[Table 41. Test for efficiency and unbiasedness, change in the cyclically-adjusted primary balance]

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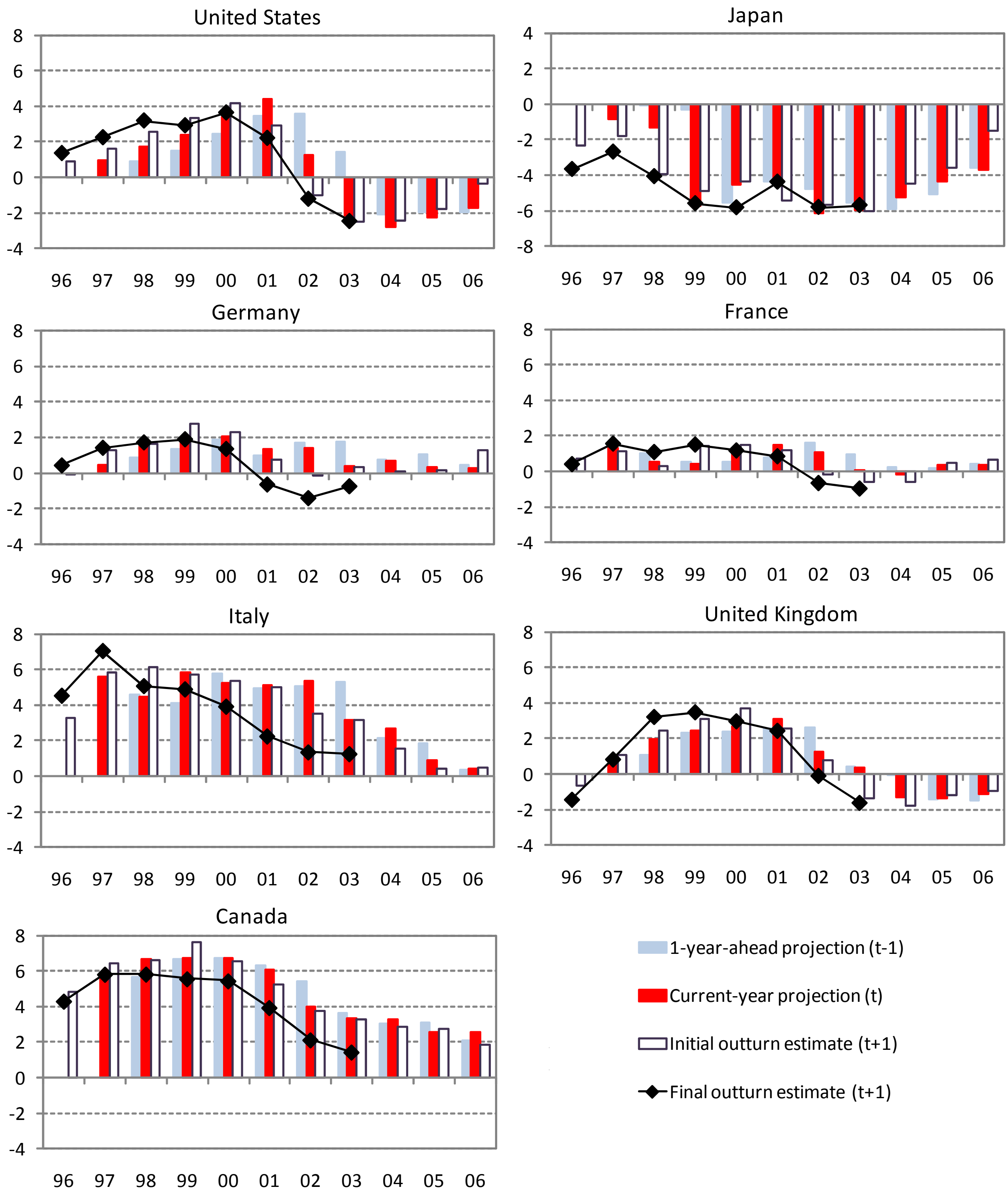
72. Although the unbiasedness and efficiency hypothesis is rejected for Japan, this is driven by sizable downward revisions in 1996 and 1997. For the period 1998 to 2003, the hypothesis cannot be rejected at conventional significance levels (the *p*-value of the respective Wald test is 0.39).

73. Mora and Norgueria Martins (2007) investigate the reliability of government deficit figures reported to the European Union by Member States and find that revisions to data on the actual budget balances are sizable for some countries. Over the period 1994 to 2002 the average revision between the initial data transmission (in spring of year t+1) and the final data transmission (in autumn of year t+4) ranged from -0.4% of GDP for Portugal and Italy to 0.75% of GDP for Luxembourg.

74. The failure to reject the unbiasedness hypothesis for Italy despite this persistent downward revision is due to upward revisions in 1996 and 1997. If these two years are removed from the sample, the unbiasedness and efficiency hypothesis is strongly rejected for Italy, with the constant being significantly negative.

Figure 9. **Projections and outturn estimates of the cyclically-adjusted primary balance**

Per cent of GDP



Note: A different scaling is used for Japan.

83. As revisions to the output and unemployment gap feed directly into revisions of the cyclically-adjusted primary balance, a number of equations are estimated to relate the CAPB revisions to revisions in the actual primary balance and revisions in the output and unemployment gap. The equations are estimated with pooled least squares, allowing for country-specific fixed effects, and have the following general form:

$$B^*_{i,t|t+4} - B^*_{i,t|t+1} = \alpha_i + \beta\left(GAP_{i,t|t+4} - GAP_{i,t|t+1}\right) + \gamma\left(UGAP_{i,t|t+4} - UGAP_{i,t|t+1}\right) + \delta\left(B_{i,t|t+4} - B_{i,t|t+1}\right) \qquad (12)$$

where B^* is the GDP share of the cyclically-adjusted primary balance, B is the GDP share of the actual primary balance and all other variables are defined as above. Analogous equations are estimated for the revisions to the current-year projections of the primary balance (relative to the final outturn estimates in year t+4).

84. The analysis suggests that revisions to the primary balance are significantly positively related to output gap revisions but not to unemployment gap revisions (see Table 42).[75] The size of the estimated coefficients suggests that over the sample period the contribution of revisions to the output gap to revisions in the CAPB has averaged between 0.3-0.6 percentage points of GDP, although some caution is required given the relatively short time period used in estimation. Revisions to the estimates of the gap terms can explain some, but by no means all, of the revisions made to estimates of the CAPB. Looking at the separate revisions to revenues and disbursements suggests that the former are the main factor behind revisions to the primary balance, as their size is notably larger in absolute terms (see Figure 10 and Table 43).

[Table 42. Revisions to the cyclically-adjusted primary balance – regression results]
[Table 43. Revisions to revenues and disbursements]

85. To provide further insights into the sources of revisions to the CAPB, revisions to the balance were decomposed into three components. The first one comprises those that are due to revisions in the GDP share of actual revenues and disbursements, the second those due directly to output and unemployment gap revisions, and the third those that are due to methodological changes (see Figure 11).[76] Revisions to the output and unemployment gaps appear to be a significant source of the revisions to the CAPB in Germany, Italy and the United Kingdom, but are of only minor importance in the other countries, where revisions to the GDP share of actual revenues and disbursements are more important.

4. The impact of output gap uncertainty on policy variables

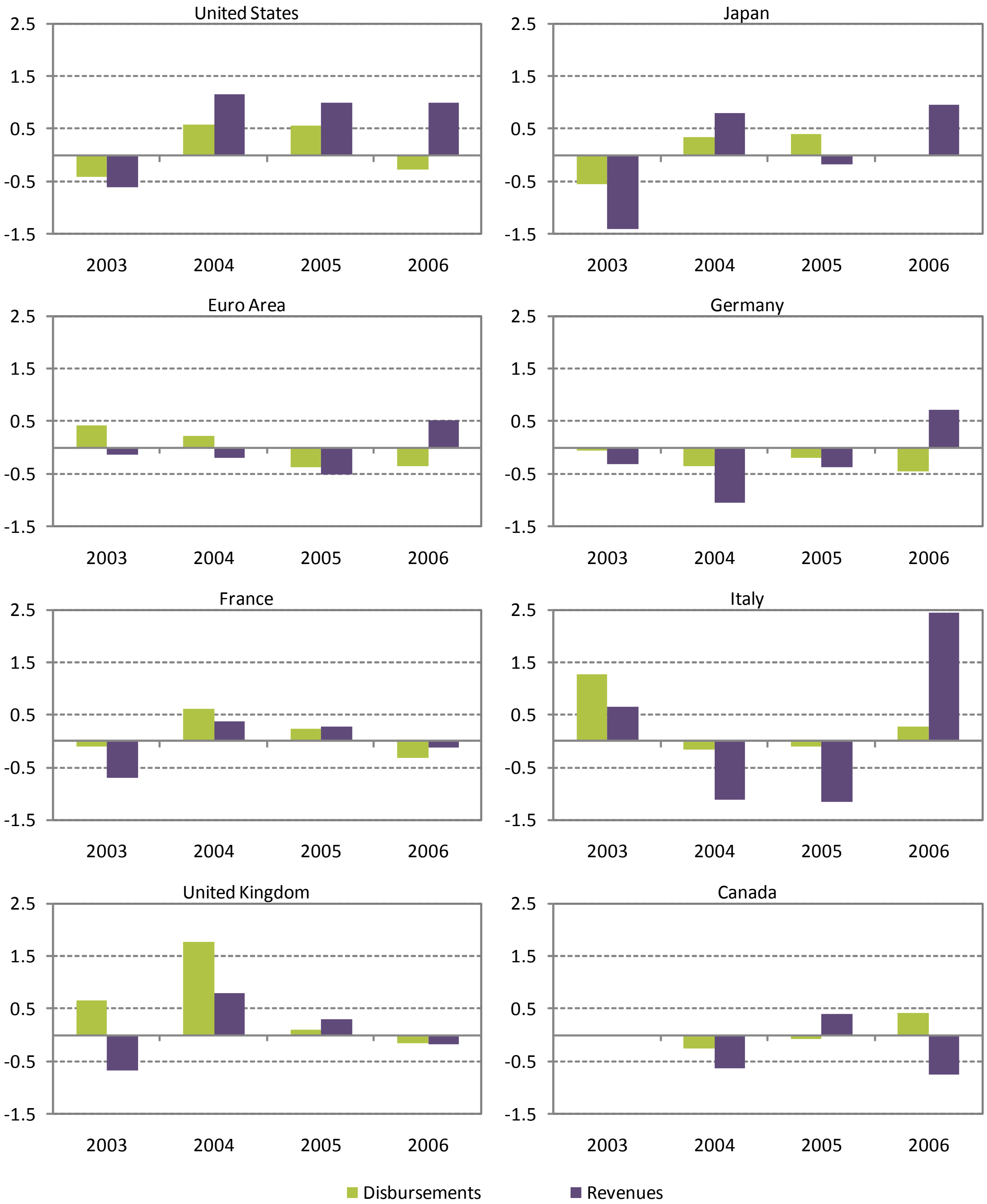
86. Revisions to estimates of the output and unemployment gaps suggest that early estimates of the two indicators might provide misleading signals as to the future path of inflation or the size of the cyclically-adjusted budget balance and, thus, the appropriateness of the policy stance. This section investigates this issue in more detail, illustrating one way of quantifying the impact of data uncertainty on the policy variables of interest.

75. The latter finding might be related to the fact that adjustments for cyclical movements in the unemployment rate represent a very small part of the overall adjustment of the primary balance, making the influence of unemployment gap revisions difficult to detect in the short sample period of the study.

76. The analysis is restricted to the G7 economies.

Figure 10. **Revisions to revenues and disbursements**

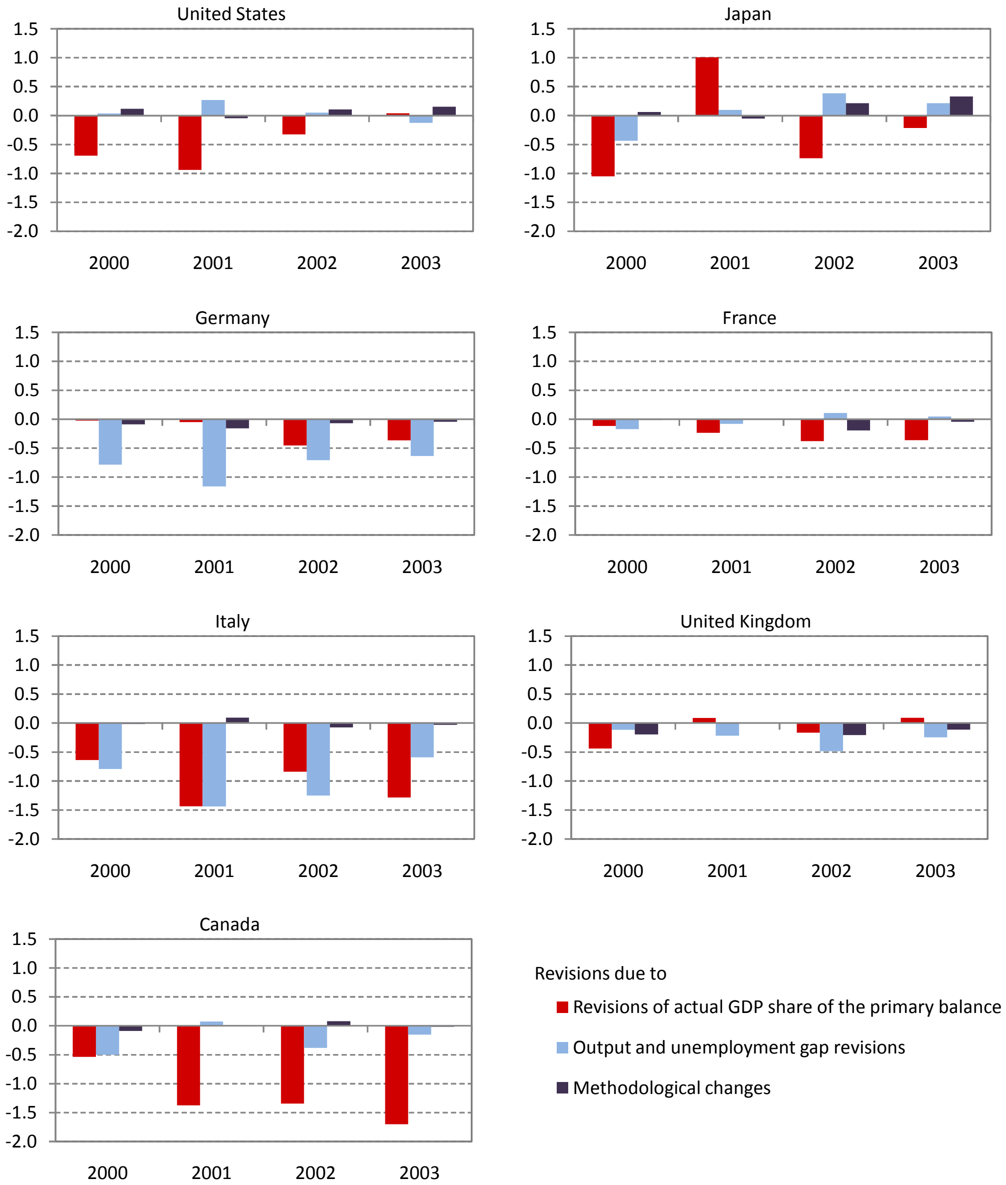
Per cent of GDP



Note: Revisions are defined as the difference between the final outturn estimate at *t*+4 and the initial outturn estimate at *t*+1. The sample starts in 2003 due to methodological changes between 2002 and 2003.

Figure 11. **Decomposition of revisions to the cyclically-adjusted primary balance**

Per cent of GDP



Notes: The figures are based on the following decomposition: $B^*_{t|t+4}(GAP_{t|t+4}, \Lambda_{t+4}) - B^*_{t|t+1}(GAP_{t|t+1}, \Lambda_{t+1}) = [B^*_{t|t+4}(GAP_{t|t+1}, \Lambda_{t+1}) - B^*_{t|t+1}(GAP_{t|t+1}, \Lambda_{t+1})] + [B^*_{t|t+4}(GAP_{t|t+4}, \Lambda_{t+1}) - B^*_{t|t+4}(GAP_{t|t+1}, \Lambda_{t+1})] + [B^*_{t|t+4}(GAP_{t|t+4}, \Lambda_{t+4}) - B^*_{t|t+4}(GAP_{t|t+4}, \Lambda_{t+1})]$, where $B^*_{t|t+4}(GAP_{t|t+1}, \Lambda_{t+1})$ is the GDP share of the cyclically adjusted primary balance at time *t* obtained by applying the methodology Λ prevailing at time *t*+1 on data on the actual balance published at time *t*+4 and data on the output and unemployment gap published at time *t*+1.

4.1 Output gap uncertainty and inflation forecasting

87. Using the Phillips-curve models of inflation (discussed in section 3.5), a series of scenario analyses were undertaken to obtain illustrative estimates of the impact of output gap uncertainty on projections of inflation.[77] The scenario analyses reflect the findings discussed in section 3.3 on the size of revisions to projections of the levels of the output and unemployment gaps.

88. A baseline scenario was obtained by estimating the Phillips-curve models until the end of 2004 and then generating a dynamic forecast of consumer price inflation out to the end of 2006 using the actual values of all the exogenous variables. Two alternative scenarios were then created with modified data for the output gap over the baseline period. In the first scenario, the level of the gap for each of the G7 economies was altered by the mean absolute revision observed during the period 1995 to 2006 between the current-year projection and the final outturn estimate at time t+4 (see Table 16). In the second scenario, the level of the gap was altered by the maximum absolute revision observed over this period. This provides a backward-looking estimate of the upper bound of the possible degree of uncertainty about the output gap.

89. Figure 12 compares the different projections of inflation for the G7 economies and the euro area.[78] The degree of inflation uncertainty varies considerably across countries, reflecting both different coefficient estimates in the country models of inflation and the different degrees of output gap uncertainty. For Canada, France, the United Kingdom and the United States the uncertainty around the inflation forecast is relatively low, with the difference between the baseline and the scenario employing the mean absolute revision ranging from 0.15 to 0.25 percentage points in the fourth quarter of 2006 and the difference between the baseline and the scenario employing the maximum absolute revision ranging from 0.3 to 0.6 percentage points.

90. The uncertainty around the inflation forecast is notably higher for Japan and the euro area, with the difference from the baseline being equal to around ½ percentage points in the scenario employing the mean absolute revision to the gap and around 1 percentage point in the scenario employing the maximum absolute revision to the gap. For these economies, output gap uncertainty potentially presents a major challenge to inflation forecasting if it is incorporated into the procedures used to project inflation. The high degree of uncertainty around the constructed euro area inflation projection reflects the high uncertainty around the projections for Germany and Italy. This is offset in part by the comparatively low uncertainty around the French forecast, the latter being a combination of low output gap uncertainty and a small output gap elasticity of inflation.

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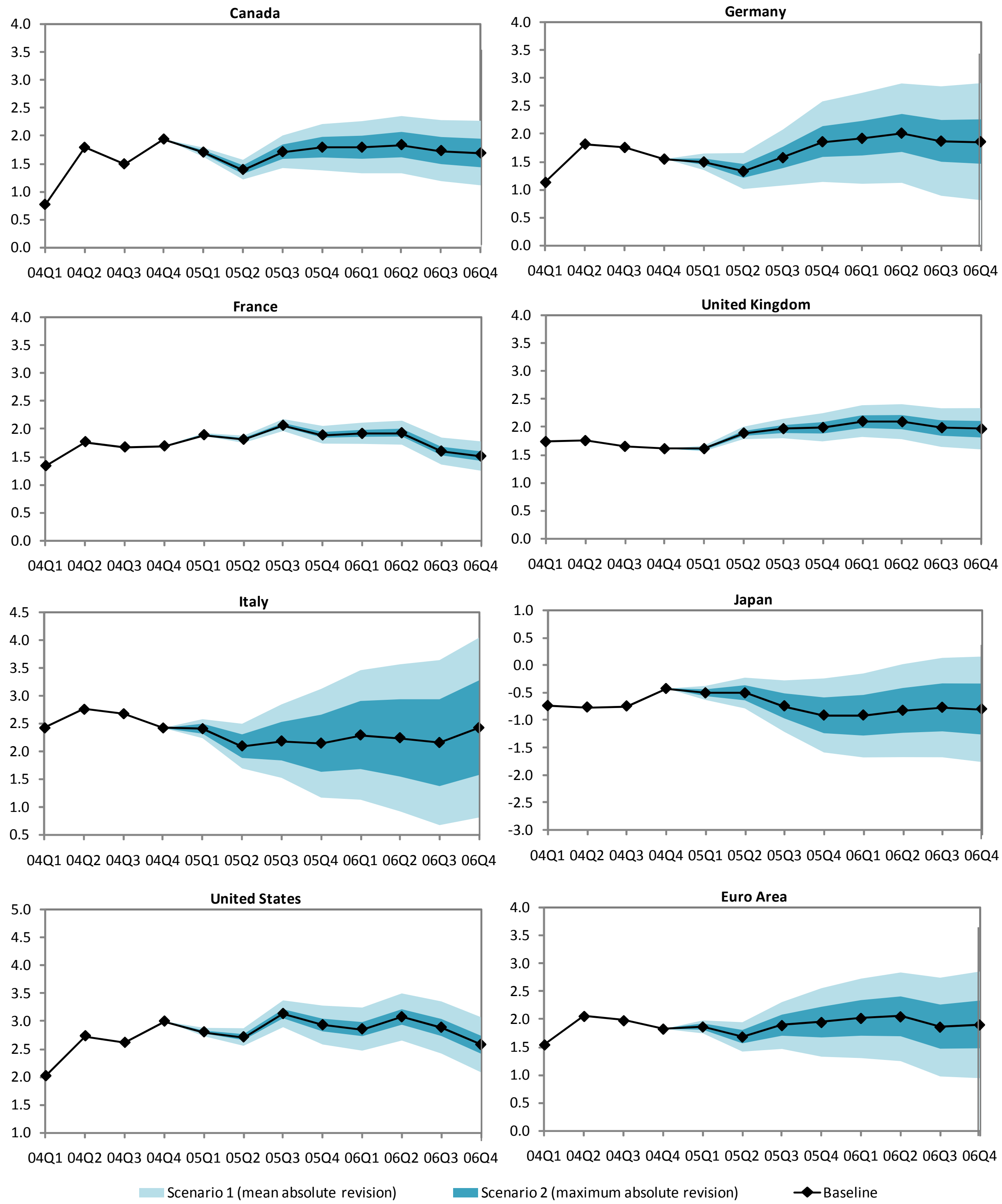
77. For simplicity, the focus is again on the models that use the production-function-based output gap and the Kalman-filter-based unemployment gap, respectively.

78. The euro area forecasts are obtained as a weighted average of the forecasts for Germany, France and Italy, employing 2005 consumption weights. The inflation rate is defined as the percentage change over the same quarter of the previous year.

Figure 12. **The impact of output gap uncertainty on inflation forecasting**

Percentage points



Notes: Inflation is defined as the percentage change over the same quarter of the previous year. The baseline scenario employs actual data of the output gap as published in the spring 2007 issue of the *OECD Economic Outlook* (EO81). In scenario 1 (scenario 2) the output gap are varied by the mean (maximum) absolute revision observed during the period 1995 to 2003 for the current-year-prediction versus the final outturn estimate at time t+4.

4.2 Output gap uncertainty and the cyclically-adjusted budget balance

91. The importance of data uncertainty for the evaluation of fiscal sustainability is examined by calculating the cyclically-adjusted budget balance with different levels of the output and unemployment gaps. The baseline scenario is constructed using the output and unemployment gaps published in the spring 2007 *Economic Outlook*. Two alternative scenarios are obtained by varying the level of the output and unemployment gaps by the mean absolute revision and the maximum absolute revision observed during the period 1995 to 2003, as calculated by the difference between the current-year-projections of the gaps and the final outturn estimates at time *t*+4.

92. The results are displayed in Figure 13 for the G7 economies; summary statistics for all 21 economies are provided in Table 44. The degree of uncertainty around the cyclically-adjusted budget balance varies markedly across countries, reflecting different tax and expenditure elasticities and different degrees of output and unemployment gap uncertainty. The uncertainty around the CABB is somewhat higher for Japan, Germany, Italy, Denmark, Finland and Ireland than for other countries. A high degree of uncertainty about the gaps is the main reason for the large error bands around the budget balance in Japan and Italy; for the other four countries it is a combination of comparatively high gap uncertainty and comparatively high tax/expenditure elasticities.

[Table 44. Output/unemployment gap uncertainty and the cyclically-adjusted budget balance]

93. On average, across the G7 economies and across the full sample of economies, the mean absolute revision in the level of the output gap is found to be associated with a revision of just over 0.4 percentage points in the level of the cyclically-adjusted balance to GDP ratio.[79] This is broadly consistent with the magnitudes found from the regression evidence discussed above (section 3.7).

94. In countries facing a high degree of uncertainty, this uncertainty is usually not enough to change the overall assessment of fiscal sustainability. However, in some instances revisions to the output and unemployment gap can at times be so large that they are associated with revisions to the level of CABB of more than 1% of GDP. If this persisted, this would imply a substantial change in the eventual government net debt to GDP ratio.[80] More generally, even a small degree of output gap uncertainty might matter if a country was close to meeting or missing a policy target for the level of the CABB.

95. The impact of output and unemployment gap uncertainty on estimates of the change in the cyclically-adjusted balance can be examined in a similar manner, with the change in the output and unemployment gaps adjusted by the mean absolute revision and the maximum absolute revision observed during the period 1995 to 2003.[81] The resulting estimates are shown in Figure 14 and Table 44.

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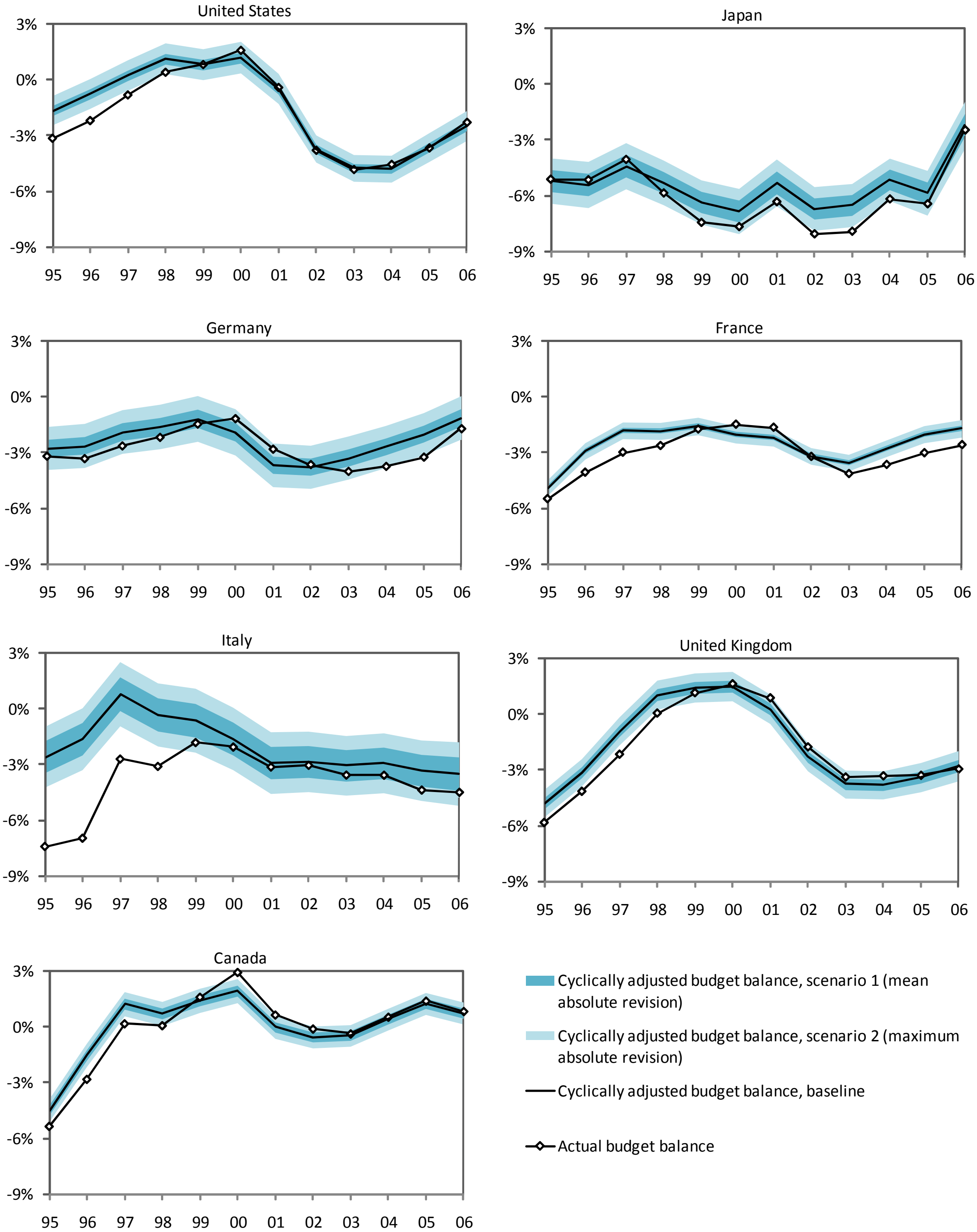
79. On average across countries, the mean absolute revision to the output gap projection for year *t* between year *t* and year *t*+4 is 1.1% (Table 16). The equivalent average revision to the structural balance is 1.2% of GDP (Table 36).

80. For instance, in an economy with nominal GDP rising by 4% per annum on average, a 1 percentage point rise in the deficit to GDP ratio would ultimately raise the net debt to GDP ratio by 25 percentage points.

81. The revisions are calculated from the differences between the projected current-year change in the gaps and the revised estimate of that change made four years later.

Figure 13. **Gap uncertainty and the level of the cyclically-adjusted budget balance**

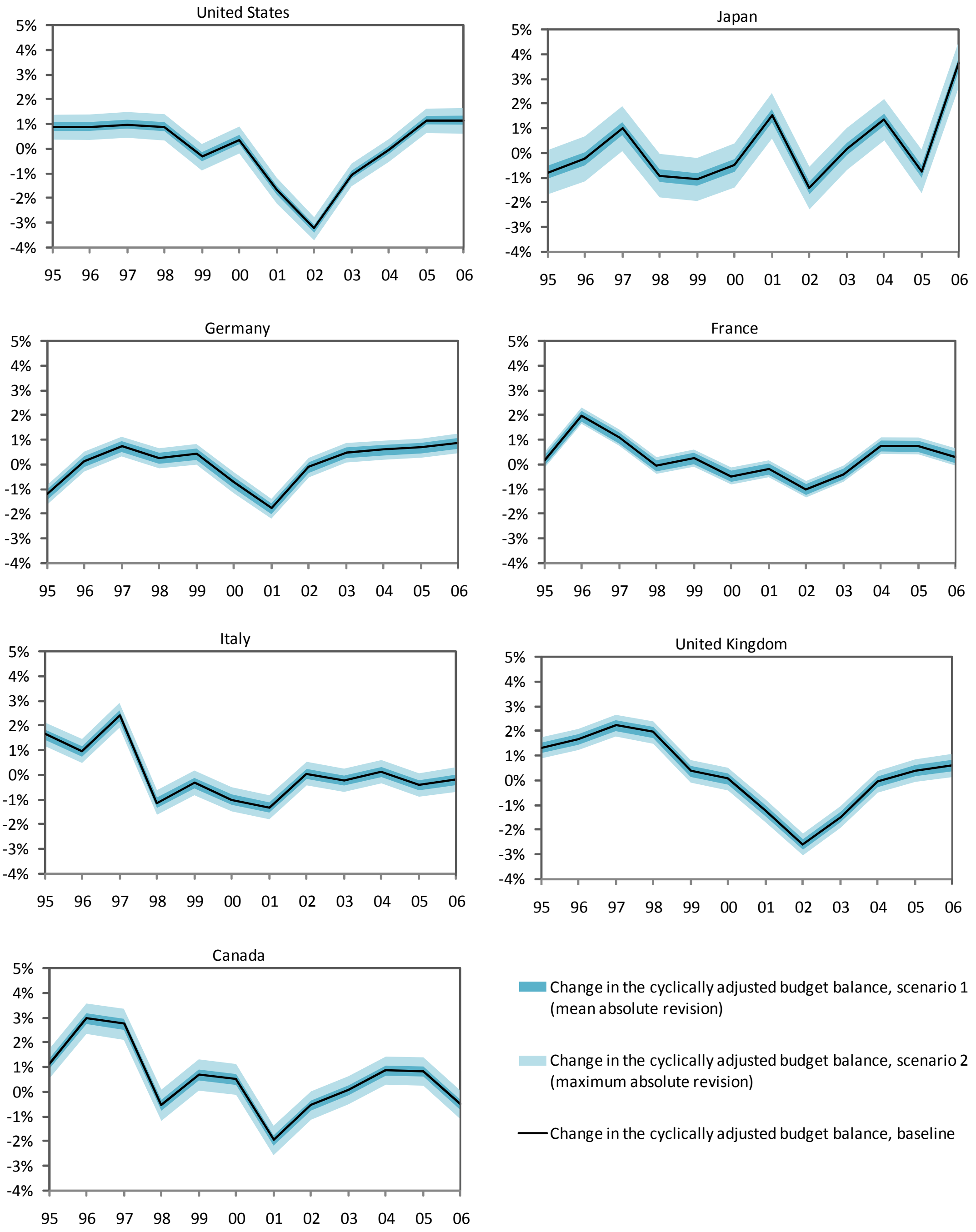
Per cent of GDP



Notes: The budget balances exclude one-off revenues from the sale of mobile telephone licences. The baseline scenario employs actual data of the output and unemployment gaps as published in the spring 2007 issue of the *OECD Economic Outlook* (EO81). In scenario 1 (scenario 2) the output and unemployment gaps are varied by the mean (maximum) absolute revision observed during the period 1995 to 2003 for the current-year-prediction versus the final outturn estimate at time *t*+4.

Figure 14. **Gap uncertainty and the fiscal stimulus**

Percentage points



Note: The figures show the annual change in the GDP share of the cyclically-adjusted budget balance. The budget balances exclude one-off revenues from the sale of mobile telephone licences. The baseline scenario employs actual changes of the output and unemployment gaps as published in the spring 2007 issue of the *OECD Economic Outlook* (EO81). In scenario 1 (scenario 2) the changes in the output and unemployment gaps are varied by the mean (maximum) absolute revision observed during the period 1995 to 2003 for the current-year-prediction versus the final outturn estimate at time *t*+4.

96. On average, across the countries considered, the uncertainty around the change in the output and unemployment gaps produces error bands around the change in the cyclically-adjusted budget balance of about 0.3% of GDP if uncertainty is measured by the mean absolute revision and of about 0.6% of GDP if it is measured by the maximum absolute revision.[82] The uncertainty about the size of the fiscal stimulus is particularly high in Ireland, with the size of the error band being equal to 0.7% of GDP for the mean absolute revision and 1.25% of GDP for the maximum revision. For Japan, Finland, New Zealand and Sweden the error band is also relatively high when considering the maximum absolute revision, with the size of the error band ranging from 0.9 to 1% of GDP.

5. The policy implications of output gap uncertainty

97. Clearly, empirical estimates of the output and unemployment gaps can be subject to substantial and persistent revisions over time. On average, the analysis in this paper suggests that the extent of revisions to gap estimates has only a limited impact on the evaluation of the budgetary position and on the projected rate of inflation. But it can clearly matter much more if revisions are large, or if inflation and the structural budget balance are on the threshold of their target levels, and for assessments of the fiscal stimulus. It could also matter if different estimates of the gap are used in monetary and fiscal policy decisions (Balboni *et al*. 2007). This raises questions as to whether it is useful to continue to focus on measures of the gap in policy analysis and, if so, how best to incorporate the associated uncertainty into policy decisions. This section discusses the choices faced by monetary and fiscal policymakers and considers the ways in which output gap uncertainty affects policy decisions.

5.1 The implications of output gap uncertainty for monetary policy

98. The output gap provides an indication of potential inflationary pressures within the economy, giving it a potentially important role in the conduct of monetary policy. However, a number of studies have argued that the size of the revisions made to real-time estimates of the output gap are such that direct information about the output gap should be disregarded, with the extent of underlying demand pressures instead being inferred from real or nominal GDP growth (Orphanides and Williams, 2002; Rudebusch, 2001), the acceleration in the inflation rate (Leitemo and Lønning, 2006), or the behaviour of domestic costs (Horn *et al.*, 2007).

99. The disadvantage of such approaches is that they omit potentially useful supply-side information that might affect judgements about the current state of the economy and prospective developments. The estimates in this paper suggest that current-year projections of output gaps and initial outturn estimates typically contain useful information in many countries -- they are positively correlated with subsequent estimates, and the sign and direction of movement are, on average, estimated accurately (see also Gruen *et al*., 2005). Equally, changes in GDP growth need to be put into context and judged against current and prospective supply-side developments, however imperfectly estimated.

82. A similar analysis is undertaken by Chalk (2002), who reports that a 1 percentage point error in the growth rate of potential output produces an error in the cyclically-adjusted budget balance of about ¼ per cent of potential GDP. Langedijk and Larch (2007) investigate the sensitivity of the cyclically-adjusted budget balance of 14 EU countries to variations in the smoothness of potential output (obtained by applying an HP filter to real GDP). They conclude that the general assessment of the current fiscal adjustment is relatively robust to changes in the smoothness of potential output, although there are specific instances where real-time assessments are incorrect.

100. Greater difficulties may result from using projected output gaps for one or two years' ahead in policy decisions. Such projections are clearly prone to large revisions. Nonetheless, output gaps remain important, if only as a necessary benchmark when considering the potential inflationary pressures associated with economic projections. It would be surprising to find policy decisions being made against a backdrop of projections in which the path of the output gap was completely at odds with that of inflation, even if the projected evolution of the gap has only a modest direct impact on the projection of inflation and on policy decisions.

101. Uncertainty about output gaps is only one element of the overall uncertainty faced by policymakers, reflecting imperfect knowledge about the current and future state and structure of the economy and about the way in which policy decisions will affect the actions and expectations of private agents. For instance, all official data are snapshots of the economy that are prone to subsequent revision. Indeed, as shown above, in almost two-thirds of the OECD countries considered the revisions in estimated output gaps are more likely to originate from revisions to official data (or projections) than from changes in estimates of potential output growth. Studies of forecasting performance typically find that projections of one-year-ahead GDP growth can exhibit marked inefficiencies (Vogel, 2007). So even if output gaps were to be discarded from the policy framework, substantial data uncertainty would remain.

102. A large body of literature has explored the implications of data uncertainty, including output gap uncertainty, for monetary policy decisions (Box 4). These studies typically make use of a simple macroeconomic modelling framework to examine the impact of data uncertainty for the optimal behaviour of a central bank, as modelled by some policy rule (often a Taylor-type rule).[83] The studies generally differ in the structure of the underlying model, the design of the monetary policy rule, the loss function and the way output gap uncertainty is incorporated into the model. Few consider the more general impact of uncertainty about official data, and the structure of the economy.

103. A number of common findings emerge from this literature. First, as might be expected, incomplete information about the cyclical position of the economy in real time may result in policy decisions that are judged *ex-post* to be mistakes. Nonetheless, these policy errors may be unavoidable in real time even if the central bank uses the most efficient procedures to forecast inflation. Such policy errors are usually small but can be sizable during periods of substantial changes in potential output (Cukierman and Lippi, 2005; Nelson and Nikolov, 2003).

104. The flattening of the Phillips curve in most economies is likely to have augmented uncertainty about the output gap. As is well-established, this is almost certainly being reinforced by the ongoing impact of globalisation (OECD, 2007). One aspect of globalisation, reflected in the empirical results in this paper, has been the decline in the impact of the domestic output gap on domestic inflation and the increase in the impact of foreign economic conditions, as reflected through import prices (see also Pain *et al*., 2006). To the extent that import prices reflect global demand pressures, uncertainty about the global output gap is becoming more important for monetary policymakers in OECD economies. A second feature of globalisation is the effects it has on supply-side developments in national economies, and hence potential output or the NAIRU. Examples include enhanced competitive pressures, greater net in-migration and the potential productivity gains from outsourcing and offshoring. As with any structural change, the difficulties in estimating such effects precisely and in a timely fashion may force policymakers to place greater emphasis on the actual behaviour of prices and costs and reduce the attention paid to signals from the estimated domestic output and unemployment gap.

83. Optimality is judged against some loss function, typically involving the variation of inflation and the output gap.

105. A third finding from the literature on data uncertainty and monetary policy is that policy should account explicitly for the presence of data uncertainty in the policy framework (Orphanides *et al*., 2000). This can be done in a variety of ways, including analysis of a range of possible scenarios about the state (and structure) of the economy, or attempts to quantify formally a range for inflation based on the calibrated uncertainty thought to be attached to gap estimates and other data, or through adjusting initial data/outturn estimates for likely revisions (Cunningham and Jeffrey, 2007; Bean, 2007).

106. Allowing for a range of possible outcomes may even, in some circumstances, cause policymakers to react more rather than less aggressively, if particular undesirable outcomes become more probable (Bernanke, 2007; Mishkin, 2008).[84] Furthermore, the observed flattening of the Phillips curve over time suggests that whilst changes in the output gap may have only a limited short-term direct impact on inflation, it has become much more costly or difficult for monetary policy to bring inflation back to target after the point at which it has begun to rise or decline markedly. In some circumstances, such as the perceived risk of deflation, signals from the gap may thus lead to a more aggressive policy action to minimise the risk of having to make long and costly adjustments at a later time.[85] These factors need to be weighed against the broader uncertainty about the levels of potential output and gaps resulting from the flattening of the Phillips curve; at times this could result in such measures being given a reduced role in policy formulation, especially if they appear at odds with other cyclical indicators, such as surveys, or observed inflationary pressures (Orphanides, 2003; Ehrmann and Smets, 2003; Mishkin, 2007). The implication of these different forces for the aggressiveness of monetary policy actions is finely balanced.

107. Output gap uncertainty reinforces the case for policymakers to focus on a wide range of available indicators. Survey data may help to provide a clearer picture of the present state of the economic cycle and the degree of resource utilisation, especially at times when the uncertainty about the output gap is high. However, looking forward a year or two, there is no reason to expect that it is any easier to project survey variables than it is to project output growth or the output gap. Estimated gaps and survey data may also provide different signals at times, although on average the results in this paper suggest that there is little difference in their impact on inflation. Judgement will thus remain an important part of monetary policy decisions.

84. Orphanides and Williams (2002) argue that in the absence of a good measure of the magnitude of uncertainty policymakers should assume that it is high, as the costs (in terms of missing the policy objective) of underestimating the degree of uncertainty are higher than the costs of overestimating it.

85. An alternative course of action in such circumstance might be to change the inflation target (Krugman, 1998; Giannoni and Woodford, 2003).

Box 4. **The implications of data uncertainty for the conduct of monetary policy**

A number of studies have investigated the implications of data uncertainty, including incomplete information about potential output or the NAIRU, for the conduct of monetary policy. These studies examine the optimal reaction of monetary policy to variations in inflation and economic activity within simple macroeconomic models. Although the general set-up is very similar across studies, they differ in the precise structure of the underlying model, the design of the monetary policy rule, the loss function of the central bank against which optimality is judged, and in the way output gap uncertainty modelled.

Orphanides (2001, 2003) and Orphanides and Williams (2007) show for the US economy that noisy information regarding the level of potential output implies that optimal policy should become less responsive to apparent deviations between actual and potential output. If the behaviour of the central bank is modelled using a Taylor rule, the output gap coefficient in the policy rule is likely to be reduced considerably once the noise content of the data is taken into account. However, even in the presence of considerable data uncertainty the output gap should not be completely ignored. While Orphanides (2001) obtains the result by fitting Taylor rules to *ex-post* and real-time data of the US economy, Orphanides (2003) and Orphanides and Williams (2007) simulate the impact of data uncertainty in an estimated model of the US economy. Similar conclusions are drawn by Tetlow (2000), Rudebusch (2001) and Smets (2002) which all make use of simple macroeconomic models of the US economy to assess the impact of output gap uncertainty on optimal monetary policy.[1]

Ehrmann and Smets (2003), Wieland (2003) and Gerdesmeier and Roffia (2005) investigate the impact of data uncertainty on the optimal behaviour of the European Central Bank and also conclude that policy should react more cautiously if the precise level of potential output or the NAIRU is unknown. While the first two studies use an estimated macroeconomic model of the euro area to address the issue, Gerdesmeier and Roffia (2005) parallel Orphanides (2001) in using a real-time data set to compare the reaction coefficients in a Taylor rule for *ex-post* and real-time data.

Although most existing studies on the monetary policy impact of data uncertainty focus on the United States and the euro area a number of recent papers have looked at other OECD economies as well. For example, Bernhardsen *et al*. (2005) investigate the issue for Norway and Mahadeva and Muscatelli (2005) for the United Kingdom. Moreover, Aoki (2003) addresses the issue within a general macroeconomic model that does not make reference to any specific country. Overall, these studies reach the same conclusions as those on the US or the euro area in that central banks place less weight on the output gap when adjusting their policy decisions for data uncertainty. However, the output gap cannot be ignored completely by the central bank and matters even with a very high degree of uncertainty.[2]

If policy makers are uncertain as to the true state of the economy they will try to correct for this uncertainty in their decision making process. Orphanides and Williams (2002) argue that policy makers who wish to account for data uncertainty but do not possess a precise estimate of its degree should act as if the uncertainty they are facing were higher than their baseline estimates suggest. The reason is that the welfare loss of falsely overestimating the degree of uncertainty is smaller than the loss of falsely underestimating it.

Even after accounting for data uncertainty, the welfare loss due to imperfect information can be substantial as shown by Orphanides and Williams (2007) for the United States and Ehrmann and Smets (2003) for the euro area. The loss occurs to a large extent in the form of higher interest rate and output gap variability rather than higher inflation.

Data uncertainty is not the only problem monetary policy makers are facing. A second potential source of uncertainty that is directly linked to the output or unemployment gap relates to its relationship with inflation.[3] Estrella and Mishkin (1999) show for the US economy that uncertainty about the short-run inflation-unemployment trade-off causes optimal monetary policy to react less aggressively to any deviations of the unemployment rate from the NAIRU. The result is confirmed by Wieland (2003) for the euro area.

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1. Earlier studies on the issue generally conclude that data uncertainty does not affect the optimal behaviour of central banks (see, for example, Estrella and Mishkin 1999). However, this result is specific to the linear-quadratic framework on which most of these studies are based.

2. In the study by Mahadeva and Muscatelli (2005) this result is specific to the type of uncertainty considered, namely price-volume uncertainty. If the authors were to increase the variance of the measurement error per se, the weight on the output gap in the policy rule would be driven to zero.

3. Another source of uncertainty that poses major difficulties to central banks is model uncertainty. Although a large body of literature has begun investigating the impact of model uncertainty on monetary policy, this literature is not dealt with within this paper given that model uncertainty is not directly linked to the output or unemployment gap.

5.2 The implications of output gap uncertainty for fiscal policy

108. The uncertainty around output gaps does not, on average, appear to generate large changes in estimates of the cyclically-adjusted budget balance at a particular point in time. However, there is evidence for at least some countries that revisions to the gap over time can lead to revisions in the structural balance of 1 per cent of GDP or more. Thus, output gap uncertainty will clearly matter at times.

109. As with monetary policy, gap uncertainty is only part of the overall uncertainty attached to any calculation of the cyclically-adjusted budget balance. Even if the gap were not subject to revision, uncertainty would remain. Expenditure, revenue and GDP data are all subject to revision, implying that the actual budget balance is uncertain as well, and the parameters used in the cyclical adjustment process are sensitive to the choice of estimation technique (Murchison and Robbins, 2003).

110. The concept of the cyclically-adjusted balance, and in particular the extent to which it changes over time and whether it is above or below the actual balance, remains useful even if the level cannot be measured perfectly.[86] Understanding whether movements in the fiscal position are long-lasting or due to the state of the economic cycle is essential for policymakers when judging both fiscal sustainability and changes in the fiscal stance. Fiscal measures with a permanent impact on the budget may be rethought if they are a response to budget fluctuations that are in fact only temporary. Equally, calculations of the future level of potential output using the production function approach are essential if some prospective developments, such as known demographic changes, are to be properly accounted for in considering fiscal sustainability over the medium term.

111. One way of incorporating the uncertainty around the current output gap into fiscal monitoring would be to generate a range of estimates within which the cyclically-adjusted balance is believed to lie. Such an approach would be similar to the broader attempts to incorporate uncertainty into the budgeting process (Dupuis and Hostland, 2001; Hostland, 2003; Crippen, 2003). For instance, the uncertainty about the cyclically-adjusted budget balance could be reflected in a fan chart, analogous to the ones used by monetary policymakers for the prospective path of inflation.[87] Such charts would help to provide a clearer illustration of the risks associated with the current fiscal policy framework.

112. Looking forward, the difficulties inherent in predicting short-term cyclical fluctuations in the economy and also the longer-term path of potential output make it prudent for policymakers to consider a range of possible scenarios for the future evolution of the economy and the overall public sector balance sheet. In such a context, policy decisions may try to minimise the risks of unfavourable budgetary outcomes (Hostland, 2003). One approach is to base budgetary planning on deliberately cautious assumptions about the rate of growth of potential output. Allowances can also be made for possible misjudgements about the current output gap. An illustration of these types of budgetary planning is provided by the current fiscal framework in the United Kingdom (HM Treasury, 2007), although the framework does not indicate the full range of possible outcomes from incorporating uncertainty about the output gap and the rate of growth of potential output. However, whilst such an approach reduces the risks of unexpectedly weak budgetary outcomes, it also has a bias towards windfall tax gains, raising the risk that the cyclically-adjusted budget balance could be over-estimated in unexpectedly strong cyclical upswings and potentially generating upward pressures on expenditure (Cotis *et al*, 2005).

86. Even in countries that face a high degree of uncertainty, this uncertainty is usually not enough to change the overall assessment of the fiscal stance (Chalk, 2002).

87. An example of this is illustrated by Murchison and Robbins (2003).

Table 1. **Correlation between business cycle indicators**

		GAP	GAPHP	CAP	UGAP	UGAPHP			GAP	GAPHP	CAP	UGAP	UGAPHP
USA	GAP	1.00 (0.00)	0.92 (0.04)	0.56 (0.08)	0.87 (0.05)	0.82 (0.06)	JPN	GAP	1.00 (0.00)	0.77 (0.06)	0.41 (0.09)	0.69 (0.07)	0.63 (0.08)
	GAPHP		1.00 (0.00)	0.63 (0.08)	0.77 (0.06)	0.89 (0.04)		GAPHP		1.00 (0.00)	0.41 (0.09)	0.30 (0.09)	0.71 (0.07)
	CAP			1.00 (0.00)	0.66 (0.07)	0.68 (0.07)		CAP			1.00 (0.00)	0.68 (0.07)	0.45 (0.09)
	UGAP				1.00 (0.00)	0.85 (0.05)		UGAP				1.00 (0.00)	0.46 (0.09)
	UGAPHP					1.00 (0.00)		UGAPHP					1.00 (0.00)
EURO	GAP	1.00 (0.00)	0.88 (0.05)	0.75 (0.07)	0.92 (0.04)	0.86 (0.05)	DEU	GAP	1.00 (0.00)	0.70 (0.07)	0.69 (0.07)	0.80 (0.06)	0.78 (0.06)
	GAPHP		1.00 (0.00)	0.70 (0.08)	0.77 (0.06)	0.86 (0.05)		GAPHP		1.00 (0.00)	0.41 (0.09)	0.47 (0.09)	0.63 (0.08)
	CAP			1.00 (0.00)	0.66 (0.08)	0.64 (0.08)		CAP			1.00 (0.00)	0.43 (0.09)	0.38 (0.09)
	UGAP				1.00 (0.00)	0.89 (0.04)		UGAP				1.00 (0.00)	0.85 (0.05)
	UGAPHP					1.00 (0.00)		UGAPHP					1.00 (0.00)
FRA	GAP	1.00 (0.00)	0.90 (0.04)	0.69 (0.07)	0.87 (0.05)	0.77 (0.06)	ITA	GAP	1.00 (0.00)	0.92 (0.04)	0.52 (0.08)	0.33 (0.09)	0.29 (0.09)
	GAPHP		1.00 (0.00)	0.67 (0.07)	0.81 (0.06)	0.81 (0.06)		GAPHP		1.00 (0.00)	0.48 (0.08)	0.28 (0.09)	0.31 (0.09)
	CAP			1.00 (0.00)	0.81 (0.06)	0.75 (0.06)		CAP			1.00 (0.00)	-0.05 (0.10)	-0.20 (0.10)
	UGAP				1.00 (0.00)	0.93 (0.04)		UGAP				1.00 (0.00)	0.82 (0.06)
	UGAPHP					1.00 (0.00)		UGAPHP					1.00 (0.00)
GBR	GAP	1.00 (0.00)	0.85 (0.05)	0.65 (0.07)	0.87 (0.05)	0.65 (0.07)	CAN	GAP	1.00 (0.00)	0.86 (0.05)	0.63 (0.08)	0.88 (0.05)	0.75 (0.06)
	GAPHP		1.00 (0.00)	0.65 (0.07)	0.61 (0.08)	0.77 (0.06)		GAPHP		1.00 (0.00)	0.60 (0.08)	0.75 (0.06)	0.87 (0.05)
	CAP			1.00 (0.00)	0.40 (0.09)	0.40 (0.09)		CAP			1.00 (0.00)	0.61 (0.08)	0.51 (0.08)
	UGAP				1.00 (0.00)	0.64 (0.07)		UGAP				1.00 (0.00)	0.84 (0.05)
	UGAPHP					1.00 (0.00)		UGAPHP					1.00 (0.00)

Table 1. **Correlation between business cycle indicators** (cont'd)

		GAP	GAPHP	CAP	UGAP	UGAPHP			GAP	GAPHP	CAP	UGAP	UGAPHP
AUS	GAP	1.00 (0.00)	0.78 (0.06)	NA	0.83 (0.05)	0.65 (0.07)	AUT	GAP	1.00 (0.00)	0.78 (0.06)	0.57 (0.13)	0.63 (0.08)	0.54 (0.08)
	GAPHP		1.00 (0.00)	NA	0.62 (0.08)	0.83 (0.05)		GAPHP		1.00 (0.00)	0.66 (0.12)	0.60 (0.08)	0.55 (0.08)
	CAP			NA	NA	NA		CAP			1.00 (0.00)	0.58 (0.13)	0.58 (0.13)
	UGAP				1.00 (0.00)	0.75 (0.06)		UGAP				1.00 (0.00)	0.89 (0.04)
	UGAPHP					1.00 (0.00)		UGAPHP					1.00 (0.00)
BEL	GAP	1.00 (0.00)	0.91 (0.04)	0.40 (0.09)	0.73 (0.07)	0.74 (0.07)	DNK	GAP	1.00 (0.00)	0.95 (0.03)	0.45 (0.10)	0.79 (0.06)	0.78 (0.06)
	GAPHP		1.00 (0.00)	0.37 (0.09)	0.58 (0.08)	0.75 (0.06)		GAPHP		1.00 (0.00)	0.43 (0.10)	0.67 (0.07)	0.75 (0.06)
	CAP			1.00 (0.00)	0.52 (0.08)	0.31 (0.09)		CAP			1.00 (0.00)	0.51 (0.10)	0.50 (0.10)
	UGAP				1.00 (0.00)	0.81 (0.06)		UGAP				1.00 (0.00)	0.88 (0.05)
	UGAPHP					1.00 (0.00)		UGAPHP					1.00 (0.00)
FIN	GAP	1.00 (0.00)	0.75 (0.06)	0.11 (0.14)	0.92 (0.04)	0.67 (0.07)	GRC	GAP	1.00 (0.00)	0.88 (0.05)	0.07 (0.11)	0.25 (0.09)	0.26 (0.09)
	GAPHP		1.00 (0.00)	0.55 (0.11)	0.54 (0.08)	0.77 (0.06)		GAPHP		1.00 (0.00)	0.05 (0.11)	0.18 (0.10)	0.20 (0.10)
	CAP			1.00 (0.00)	0.06 (0.14)	0.39 (0.13)		CAP			1.00 (0.00)	0.05 (0.11)	0.18 (0.11)
	UGAP				1.00 (0.00)	0.69 (0.07)		UGAP				1.00 (0.00)	0.82 (0.06)
	UGAPHP					1.00 (0.00)		UGAPHP					1.00 (0.00)
IRL	GAP	1.00 (0.00)	0.72 (0.07)	0.34 (0.10)	0.85 (0.05)	0.60 (0.08)	NLD	GAP	1.00 (0.00)	0.91 (0.04)	0.55 (0.08)	0.85 (0.05)	0.72 (0.07)
	GAPHP		1.00 (0.00)	0.14 (0.11)	0.41 (0.09)	0.58 (0.08)		GAPHP		1.00 (0.00)	0.43 (0.09)	0.65 (0.07)	0.66 (0.07)
	CAP			1.00 (0.00)	0.43 (0.10)	0.33 (0.10)		CAP			1.00 (0.00)	0.58 (0.08)	0.29 (0.09)
	UGAP				1.00 (0.00)	0.70 (0.07)		UGAP				1.00 (0.00)	0.83 (0.05)
	UGAPHP					1.00 (0.00)		UGAPHP					1.00 (0.00)

Table 1. **Correlation between business cycle indicators** (cont'd)

		GAP	GAPHP	CAP	UGAP	UGAPHP			GAP	GAPHP	CAP	UGAP	UGAPHP
NZL	GAP	1.00	0.85	NA	0.74	0.64	NOR	GAP	1.00	0.66	0.04	0.84	0.47
		(0.00)	(0.05)		(0.07)	(0.07)			(0.00)	(0.07)	(0.11)	(0.05)	(0.09)
	GAPHP		1.00	NA	0.55	0.71		GAPHP		1.00	0.50	0.54	0.70
			(0.00)		(0.08)	(0.07)				(0.00)	(0.10)	(0.08)	(0.07)
	CAP			NA	NA	NA		CAP			1.00	0.13	0.42
											(0.00)	(0.11)	(0.10)
	UGAP				1.00	0.73		UGAP				1.00	0.75
					(0.00)	(0.07)						(0.00)	(0.06)
	UGAPHP					1.00		UGAPHP					1.00
						(0.00)							(0.00)
PRT	GAP	1.00	0.84	0.56	0.80	0.58	ESP	GAP	1.00	0.81	0.23	0.90	0.68
		(0.00)	(0.05)	(0.08)	(0.06)	(0.08)			(0.00)	(0.06)	(0.09)	(0.04)	(0.07)
	GAPHP		1.00	0.39	0.75	0.69		GAPHP		1.00	0.35	0.71	0.79
			(0.00)	(0.09)	(0.06)	(0.07)				(0.00)	(0.09)	(0.07)	(0.06)
	CAP			1.00	0.38	0.17		CAP			1.00	0.35	0.47
				(0.00)	(0.09)	(0.10)					(0.00)	(0.09)	(0.09)
	UGAP				1.00	0.90		UGAP				1.00	0.77
					(0.00)	(0.04)						(0.00)	(0.06)
	UGAPHP					1.00		UGAPHP					1.00
						(0.00)							(0.00)
SWE	GAP	1.00	0.74	0.32	0.83	0.59	CHE	GAP	1.00	0.82	0.67	0.83	0.70
		(0.00)	(0.07)	(0.15)	(0.05)	(0.08)			(0.00)	(0.06)	(0.07)	(0.05)	(0.07)
	GAPHP		1.00	0.33	0.52	0.71		GAPHP		1.00	0.46	0.55	0.63
			(0.00)	(0.15)	(0.08)	(0.07)				(0.00)	(0.09)	(0.08)	(0.08)
	CAP			1.00	-0.14	-0.20		CAP			1.00	0.56	0.47
				(0.00)	(0.15)	(0.15)					(0.00)	(0.08)	(0.09)
	UGAP				1.00	0.74		UGAP				1.00	0.76
					(0.00)	(0.07)						(0.00)	(0.06)
	UGAPHP					1.00		UGAPHP					1.00
						(0.00)							(0.00)

Notes: GAP = production-function-based output gap, GAPHP = HP-filter-based output gap (λ=1600), UGAP = Kalman-filter-based unemployment gap, UGAPHP = HP-filter-based unemployment gap (λ=1600), CAP = capacity utilisation rate. The sample period is 1980Q1 to 2006Q4 for all correlations but those that involve capacity utilisation in the euro area (1985Q1 to 2006Q4), Austria (1996Q1 to 2006Q4), Denmark (1987Q1 to 2006Q4), Finland (1993Q1 to 2006Q4), Greece (1985Q1 to 2006Q4), Ireland (1985Q1 to 2006Q4), Norway (1987Q1 to 2006Q4) and Sweden (1996Q1 to 2006Q4). The numbers in parentheses are the standard errors of the estimates. All calculations are based on data from the spring-2007 issue of the *Economic Outlook*.

Table 2. **Correlation between output gap components**

	Gap	TFP	HRS	LFPR	UNR		Gap	TFP	HRS	LFPR	UNR
United States	TFP	1.00* (0.00)	0.37* (0.09)	-0.01 (0.10)	0.41* (0.09)	Japan	TFP	1.00* (0.00)	-0.03 (0.10)	0.15 (0.10)	0.57* (0.08)
	HRS		1.00* (0.00)	0.19* (0.10)	0.46* (0.09)		HRS		1.00* (0.00)	-0.53* (0.08)	0.19 (0.10)
	LFPR			1.00* (0.00)	0.61* (0.08)		LFPR			1.00* (0.00)	-0.04 0.10
	UNR				1.00* (0.00)		UNR				1.00* (0.00)
Germany	TFP	1.00* (0.00)	0.05 (0.10)	0.17 (0.10)	0.16 (0.10)	France	TFP	1.00* (0.00)	-0.39* (0.09)	0.15 (0.10)	0.66* (0.07)
	HRS		1.00* (0.00)	-0.29* (0.09)	-0.25* (0.09)		HRS		1.00* (0.00)	-0.26* (0.09)	-0.11 (0.10)
	LFPR			1.00* (0.00)	0.59* (0.08)		LFPR			1.00* (0.00)	-0.37* (0.09)
	UNR				1.00* (0.00)		UNR				1.00* (0.00)
Italy	TFP	1.00* (0.00)	0.26* (0.09)	-0.08 (0.10)	-0.36* (0.09)	United Kingdom	TFP	1.00* (0.00)	-0.05 (0.10)	-0.44* (0.09)	-0.15 (0.10)
	HRS		1.00* (0.00)	0.21* (0.09)	0.01* (0.10)		HRS		1.00* (0.00)	0.51* (0.08)	0.66* (0.07)
	LFPR			1.00* (0.00)	0.40* (0.09)		LFPR			1.00* (0.00)	-0.45* (0.09)
	UNR				1.00* (0.00)		UNR				1.00* (0.00)
Canada	TFP	1.00* (0.00)	0.43* (0.09)	0.08 (0.10)	0.45* (0.09)	Australia	TFP	1.00* (0.00)	0.13 (0.12)	-0.13 (0.12)	-0.01 (0.12)
	HRS		1.00* (0.00)	0.11 (0.10)	0.47* (0.09)		HRS		1.00* (0.00)	0.27* (0.12)	0.41* (0.11)
	LFPR			1.00* (0.00)	0.59* (0.08)		LFPR			1.00* (0.00)	-0.28* (0.11)
	UNR				1.00* (0.00)		UNR				1.00* (0.00)
Belgium	TFP	1.00* (0.00)	-0.37* (0.11)	0.34* (0.12)	-0.28* (0.12)	Denmark	TFP	1.00* (0.00)	-0.03 (0.13)	0.77* (0.08)	0.15 (0.13)
	HRS		1.00* (0.00)	-0.02 (0.12)	0.21 (0.12)		HRS		1.00* (0.00)	-0.29* (0.12)	0.00 (0.13)
	LFPR			1.00* (0.00)	0.09 (0.13)		LFPR			1.00* (0.00)	-0.01 (0.13)
	UNR				1.00* (0.00)		UNR				1.00* (0.00)
Finland	TFP	1.00* (0.00)	-0.59* (0.12)	0.00 (0.15)	0.54* (0.13)	Greece	TFP	1.00* (0.00)	0.43* (0.15)	-0.78* (0.10)	0.66* (0.12)
	HRS		1.00* (0.00)	0.19* (0.10)	-0.58* (0.10)		HRS		1.00* (0.00)	-0.51* (0.11)	0.47* (0.13)
	LFPR			1.00* (0.00)	-0.74* (0.08)		LFPR			1.00* (0.00)	0.85* (0.08)
	UNR				1.00* (0.00)		UNR				1.00* (0.00)

Table 2. **Correlation between output gap components** (cont'd)

	Gap	TFP	HRS	LFPR	UNR		Gap	TFP	HRS	LFPR	UNR
Ireland	TFP	1.00* (0.00)	-0.19 (0.12)	-0.19 (0.12)	0.53* (0.15)	Nether-lands	TFP	1.00* (0.00)	-0.64* (0.09)	-0.53* (0.10)	-0.46* (0.12)
	HRS		1.00* (0.00)	-0.51* (0.11)	0.45* (0.16)		HRS		1.00* (0.00)	0.47* (0.11)	0.00 (0.13)
	LFPR			1.00* (0.00)	-0.78* (0.11)		LFPR			1.00* (0.00)	0.27* (0.13)
	UNR				1.00* (0.00)		UNR				1.00* (0.00)
New Zealand	TFP	1.00* (0.00)	0.13 (0.13)	0.10 (0.13)	-0.12 (0.19)	Norway	TFP	1.00* (0.00)	0.44* (0.15)	-0.02 (0.17)	0.10 (0.17)
	HRS		1.00* (0.00)	-0.09 (0.12)	-0.04 (0.20)		HRS		1.00* (0.00)	-0.26* (0.10)	-0.03 (0.10)
	LFPR			1.00* (0.00)	0.76* (0.13)		LFPR			1.00* (0.00)	-0.05 (0.10)
	UNR				1.00* (0.00)		UNR				1.00* (0.00)
Spain	TFP	1.00* (0.00)	-0.30* (0.12)	-0.67* (0.12)	-0.64* (0.13)	Sweden	TFP	1.00* (0.00)	-0.29* (0.11)	0.24* (0.12)	0.20 (0.11)
	HRS		1.00* (0.00)	0.74* (0.11)	0.77* (0.11)		HRS		1.00* (0.00)	0.18 (0.12)	-0.02 (0.11)
	LFPR			1.00* (0.00)	0.80* (0.10)		LFPR			1.00* (0.00)	-0.65* (0.09)
	UNR				1.00* (0.00)		UNR				1.00* (0.00)
Switzer-land	TFP	1.00* (0.00)	-0.64* (0.12)	0.42* (0.14)	-0.05* (0.16)						
	HRS		1.00* (0.00)	-0.19 (0.12)	0.67* (0.12)						
	LFPR			1.00* (0.00)	0.70* (0.12)						
	UNR				1.00* (0.00)						

Notes: TFP = total factor productivity, HRS = hours worked, LFPR = labour force participation rate, UNR = unemployment rate. The unemployment gap is defined as (1-UNR/100)/(1-NAIRU/100) so that a positive value of the gap has the same interpretation as for the other gaps. The numbers in parentheses are the standard errors of the estimates. All calculations are based on data from the spring-2007 issue of the *Economic Outlook*. An asterisk denotes significance at the 5% level. The sample period is 1980 to 2006 for the G7 economies. For the remaining countries, the sample period varies according to data availability. No results are reported for Austria and Portugal due to lacking data.

Table 3. **Descriptive statistics**

	Periods with positive gap		Periods with negative gap		Average gap	Proportion of quarters with positive gap
	Duration (quarters)	Magnitude (ppts)	Duration (quarters)	Magnitude (ppts)		
	United States					
GAP	9.00	1.61	18.50	-3.14	-0.87	31.48
UGAP	15.00	0.85	25.33	-2.52	-0.62	29.63
GAPHP	5.63	0.99	6.00	-1.32	-0.10	50.00
UGAPHP	9.00	0.53	6.43	-0.69	-0.04	58.33
	Japan					
GAP	7.00	1.96	10.83	-1.38	-0.38	39.81
UGAP	14.00	0.39	11.00	-0.93	-0.32	25.93
GAPHP	4.20	1.16	4.82	-1.06	-0.02	50.93
UGAPHP	7.33	0.19	6.86	-0.23	0.00	55.56
	Euro Area					
GAP	15.00	2.56	28.00	-2.63	-0.64	32.41
UGAP	12.00	1.40	31.50	-1.93	-0.79	25.00
GAPHP	6.60	0.82	10.83	-1.23	-0.04	39.81
UGAPHP	16.00	0.99	21.00	-0.66	-0.01	41.67
	Germany					
GAP	6.80	1.50	11.50	-1.79	-0.42	36.11
UGAP	17.50	1.73	21.00	-1.98	-0.22	41.67
GAPHP	3.70	0.98	5.45	-1.13	-0.06	44.44
UGAPHP	8.60	0.55	9.00	-0.72	-0.02	50.00
	France					
GAP	12.00	1.66	30.00	-3.39	-1.07	25.00
UGAP	8.00	0.61	26.50	-1.88	-0.96	14.81
GAPHP	5.75	0.61	7.13	-0.80	-0.03	45.37
UGAPHP	10.50	0.77	11.80	-0.60	-0.01	45.37
	Italy					
GAP	14.50	2.46	23.67	-3.93	-0.75	34.26
UGAP	5.00	0.33	25.50	-1.62	-0.93	12.04
GAPHP	5.29	1.00	7.63	-1.22	-0.01	43.52
UGAPHP	7.40	0.52	10.17	-0.42	0.01	43.52
	United Kingdom					
GAP	10.33	1.91	23.33	-3.66	-1.23	28.70
UGAP	16.50	0.90	37.00	-4.10	-1.38	30.56
GAPHP	5.38	0.69	6.89	-0.89	-0.13	42.59
UGAPHP	6.29	0.41	7.86	-0.42	-0.03	44.44
	Canada					
GAP	9.00	1.94	11.80	-2.98	-0.76	43.52
UGAP	8.33	0.67	18.75	-2.22	-0.99	30.56
GAPHP	5.50	1.16	6.14	-1.54	-0.04	48.15
UGAPHP	8.20	0.58	7.20	-0.92	0.01	51.85

Table 3. **Descriptive statistics** (cont'd)

	Periods with positive gap		Periods with negative gap		Average gap	Proportion of quarters with positive gap
	Duration (quarters)	Magnitude (ppts)	Duration (quarters)	Magnitude (ppts)		
	Australia					
GAP	3.67	0.93	7.67	-1.99	-1.24	31.48
UGAP	5.00	0.20	60.00	-2.44	-1.62	7.41
GAPHP	4.70	0.94	4.60	-1.26	0.01	52.78
UGAPHP	6.67	0.70	7.71	-0.71	0.03	50.00
	Austria					
GAP	13.50	2.34	28.00	-2.94	-0.85	28.70
UGAP	5.67	0.30	20.67	-0.52	-0.30	23.15
GAPHP	4.38	0.81	7.44	-1.03	-0.03	37.96
UGAPHP	5.83	0.29	9.00	-0.30	0.00	41.67
	Belgium					
GAP	10.50	1.61	29.50	-3.39	-1.05	25.00
UGAP	8.50	0.95	31.00	-3.18	-1.41	15.74
GAPHP	5.57	0.73	7.13	-1.18	0.02	47.22
UGAPHP	7.60	0.59	10.50	-0.73	-0.02	41.67
	Denmark					
GAP	4.22	1.24	6.50	-1.42	-0.39	39.81
UGAP	12.00	0.99	16.00	-1.63	-0.38	40.74
GAPHP	3.33	1.00	4.69	-1.02	-0.11	43.52
UGAPHP	7.83	0.58	7.43	-0.63	-0.02	51.85
	Finland					
GAP	5.60	2.33	11.50	-2.98	-1.53	36.11
UGAP	4.50	0.29	13.25	-2.95	-1.88	23.15
GAPHP	8.50	2.30	12.60	-2.06	0.02	41.67
UGAPHP	6.33	0.90	8.71	-0.82	0.04	43.52
	Greece					
GAP	2.06	1.78	3.11	-2.13	-0.21	48.15
UGAP	4.60	0.32	12.83	-1.19	-0.51	28.70
GAPHP	1.53	0.82	1.94	-0.65	-0.04	44.44
UGAPHP	11.75	0.71	9.80	-0.81	-0.02	54.63
	Ireland					
GAP	7.40	3.15	9.67	-2.26	-0.47	46.30
UGAP	6.00	1.51	31.00	-3.75	-0.64	42.59
GAPHP	4.10	1.79	5.00	-1.75	-0.04	49.07
UGAPHP	6.80	1.13	13.80	-1.09	0.03	36.11
	Netherlands					
GAP	12.00	2.37	16.00	-3.61	-0.40	38.89
UGAP	22.50	1.98	21.50	-2.95	-0.36	45.37
GAPHP	4.67	1.01	5.22	-1.16	-0.08	40.74
UGAPHP	15.67	0.74	12.33	-1.15	-0.03	51.85

Table 3. **Descriptive statistics** (cont'd)

	Periods with positive gap		Periods with negative gap		Average gap	Proportion of quarters with positive gap
	Duration (quarters)	Magnitude (ppts)	Duration (quarters)	Magnitude (ppts)		
	New Zealand					
GAP	10.50	2.13	7.60	-2.73	-0.09	58.33
UGAP	6.33	0.55	13.00	-1.50	-0.34	44.44
GAPHP	6.20	1.67	4.00	-1.39	0.03	59.26
UGAPHP	6.57	0.63	6.00	-0.76	0.00	55.56
	Norway					
GAP	5.33	1.65	11.00	-2.57	-1.22	38.89
UGAP	5.29	0.25	7.75	-0.56	-0.30	42.59
GAPHP	3.55	1.07	4.83	-1.56	-0.08	46.30
UGAPHP	4.11	0.40	5.80	-0.42	-0.02	46.30
	Portugal					
GAP	16.50	4.06	27.00	-7.82	-1.84	34.26
UGAP	1.83	0.32	7.40	-0.96	-1.58	10.19
GAPHP	12.33	1.85	15.33	-2.48	0.02	48.15
UGAPHP	5.00	0.63	4.80	-0.85	0.01	50.93
	Spain					
GAP	15.50	4.02	28.00	-4.62	-1.26	28.70
UGAP	15.00	2.32	17.50	-3.98	-1.60	35.19
GAPHP	5.43	1.10	9.43	-0.99	-0.08	38.89
UGAPHP	10.00	0.99	11.40	-0.98	-0.02	47.22
	Sweden					
GAP	5.80	1.45	15.20	-3.72	-1.52	29.63
UGAP	10.33	0.56	18.75	-1.72	-0.85	30.56
GAPHP	3.83	1.11	4.46	-1.03	-0.05	46.30
UGAPHP	6.67	0.55	8.57	-0.76	-0.02	44.44
	Switzerland					
GAP	9.00	2.49	10.50	-1.97	-0.17	41.67
UGAP	17.00	1.27	19.00	-0.76	-0.60	25.00
GAPHP	6.17	1.33	8.29	-1.43	0.08	46.30
UGAPHP	9.50	0.48	9.50	-0.48	-0.01	46.30

Notes: Duration is the length of time during which output is above (below) potential or during which the unemployment rate is below (above) the NAIRU. The magnitude is the highest (lowest) value that the gap reaches during a period of positive (negative) gaps. GAP = production-function-based output gap, UGAP = Kalman-filter-based unemployment gap, GAPHP = HP-filter-based output gap (λ=1600), UGAPHP = HP-filter-based unemployment gap (λ=1600). All calculations are based on data from the spring-2007 issue of the *Economic Outlook*.

Table 4. **Variability of actual and potential activity/unemployment**

	Actual output	Potential output, PF	Potential output, HP	Actual unemployment rate	NAIRU, KF	NAIRU, HP
	Level (coefficient of variation)					
United States	0.241	0.235	0.240	0.238	0.105	0.187
Japan	0.174	0.174	0.173	0.332	0.222	0.316
Euro Area	0.172	0.167	0.172	0.150	0.128	0.118
Germany	0.161	0.146	0.161	0.274	0.170	0.227
France	0.158	0.157	0.157	0.141	0.122	0.119
Italy	0.142	0.141	0.143	0.180	0.156	0.161
United Kingdom	0.201	0.189	0.199	0.295	0.193	0.262
Canada	0.222	0.213	0.221	0.195	0.066	0.142
Australia	0.262	0.253	0.262	0.215	0.093	0.160
Austria	0.183	0.182	0.184	0.260	0.235	0.241
Belgium	0.167	0.166	0.168	0.158	0.048	0.106
Denmark	0.168	0.165	0.166	0.247	0.143	0.192
Finland	0.199	0.193	0.198	0.478	0.353	0.416
Greece	0.192	0.189	0.190	0.294	0.323	0.278
Ireland	0.471	0.453	0.471	0.452	0.333	0.428
Netherlands	0.209	0.208	0.209	0.357	0.279	0.297
New Zealand	0.195	0.188	0.193	0.366	0.308	0.321
Norway	0.203	0.186	0.202	0.328	0.240	0.271
Portugal	0.225	0.212	0.224	0.254	0.167	0.200
Spain	0.241	0.234	0.241	0.232	0.194	0.194
Sweden	0.169	0.164	0.169	0.486	0.356	0.417
Switzerland	0.120	0.126	0.121	0.667	0.510	0.609
	Growth rate (standard deviation)			First difference (standard deviation)		
United States	3.10	0.35	0.87	0.39	0.04	0.10
Japan	3.47	1.79	0.77	0.24	0.07	0.09
Euro Area	1.77	0.27	0.51	0.21	0.07	0.10
Germany	2.45	0.37	0.80	0.29	0.11	0.14
France	2.25	0.58	0.67	0.26	0.07	0.11
Italy	3.43	1.10	1.38	0.12	0.02	0.05
United Kingdom	2.91	0.24	0.60	0.29	0.01	0.07
Canada	1.86	0.54	0.52	0.19	0.12	0.10
Australia	3.33	0.36	0.62	0.34	0.07	0.09
Austria	2.28	0.31	0.49	0.13	0.04	0.04
Belgium	1.89	0.21	0.48	0.30	0.07	0.12
Denmark	3.21	0.41	0.66	0.30	0.08	0.10
Finland	4.63	0.62	1.61	0.54	0.15	0.27
Greece	10.60	1.24	1.53	0.24	0.12	0.11
Ireland	5.93	1.78	2.28	0.49	0.21	0.24
Netherlands	3.60	0.54	0.87	0.28	0.11	0.14
New Zealand	4.11	0.75	1.05	0.36	0.11	0.13
Norway	5.21	0.96	1.00	0.31	0.06	0.08
Portugal	3.05	0.59	1.36	0.58	0.05	0.11
Spain	3.20	0.71	1.07	0.46	0.16	0.25
Sweden	4.23	0.58	0.99	0.34	0.07	0.14
Switzerland	2.70	0.54	0.62	0.16	0.05	0.06

Note: PF = production function approach, HP = Hodrick-Prescott filter. All calculations are based on quarterly data from the spring-2007 issue of the *Economic Outlook*. The sample period is 1980 to 2006.

Table 5. **Variability of business cycle indicators**

		GAP	UGAP	GAPHP	UGAPHP	CAP
United States	80-94	2.22	1.16	1.50	0.74	3.73
	95-06	1.30	0.68	0.94	0.41	3.78
Japan	80-94	2.43	0.43	1.22	0.14	5.95
	95-06	1.68	0.49	1.04	0.20	4.63
Euro Area	80-94	1.96	1.17	0.95	0.51	2.43a)
	95-06	1.22	0.79	0.73	0.42	1.22
Germany	80-94	2.32	1.48	1.33	0.62	3.96
	95-06	1.34	0.83	0.92	0.57	1.62
France	80-94	1.68	0.78	0.87	0.48	2.31
	95-06	1.12	0.76	0.75	0.53	1.73
Italy	80-94	2.05	0.83	1.18	0.50	2.88
	95-06	1.33	0.74	0.85	0.28	1.23
United Kingdom	80-94	3.14	1.91	1.50	0.86	3.75
	95-06	0.70	0.62	0.37	0.20	2.18
Canada	80-94	2.82	1.64	1.89	1.08	4.70
	95-06	1.80	0.66	0.89	0.38	1.73
Australia	80-94	2.30	1.30	1.80	1.03	NA
	95-06	1.14	0.70	0.61	0.34	NA
Austria	80-94	1.86	0.36	0.92	0.26	NA
	95-06	1.94	0.40	0.90	0.28	1.67
Belgium	80-94	1.92	1.41	1.10	0.64	1.94
	95-06	0.98	0.88	0.79	0.59	1.80
Denmark	80-94	2.11	1.24	1.39	0.77	1.54[b)]
	95-06	1.11	0.55	0.91	0.43	1.63
Finland	80-94	5.30	3.19	2.64	1.49	NA
	95-06	3.22	2.42	1.08	0.66	2.32
Greece	80-94	3.04	0.77	2.58	0.57	1.86[a)]
	95-06	1.69	0.71	1.01	0.53	1.85
Ireland	80-94	2.69	2.01	1.82	1.16	4.00 [a)]
	95-06	2.86	1.52	1.53	0.64	2.67
Netherlands	80-94	2.03	1.80	1.30	0.89	2.73
	95-06	2.04	1.21	1.03	0.54	1.26
New Zealand	80-94	2.51	0.93	1.64	0.80	NA
	95-06	1.21	0.47	1.25	0.60	NA
Norway	80-94	2.62	0.70	1.70	0.56	1.58[b)]
	95-06	1.73	0.49	1.07	0.39	1.94
Portugal	80-94	4.76	1.18	2.21	0.71	2.73
	95-06	2.37	1.20	1.04	0.67	1.62
Spain	80-94	3.36	2.95	1.25	1.17	2.22
	95-06	1.65	2.03	0.68	0.81	1.45
Sweden	80-94	2.95	1.38	1.59	0.73	NA
	95-06	1.70	1.32	0.91	0.57	1.72
Switzerland	80-94	2.01	0.79	1.44	0.37	3.19
	95-06	1.38	0.62	0.97	0.39	1.88

Note: All calculations are based on quarterly data from the spring-2007 issue of the *Economic Outlook*. a) 1985-1994. b) 1987-1994.

Table 6. **Test for efficiency and unbiasedness of initial data releases**

	GAP			UGAP			GAPHP			UGAPHP		
	α	β	Wald	α	β	Wald	α	β	Wald	α	β	Wald
USA	-0.32	0.86	0.10	-0.16	1.21	0.00	-0.10	1.01	0.85	0.14	1.35	0.00
	(0.21)	(0.14)		(0.07)	(0.09)		(0.17)	(0.25)		(0.03)	(0.06)	
JPN	-1.79	-0.21	0.00	-0.46	0.69	0.00	0.35	1.48	0.27	-0.12	0.31	0.30
	(1.10)	(0.44)		(0.06)	(0.05)		(0.26)	(0.33)		(0.09)	(0.68)	
DEU	0.09	0.52	0.08	0.51	1.03	0.18	0.21	0.72	0.22	0.23	1.43	0.01
	(0.97)	(0.64)		(0.48)	(0.52)		(0.22)	(0.41)		(0.09)	(0.30)	
FRA	-0.11	0.89	0.80	-0.14	1.13	0.73	0.18	0.94	0.54	0.08	1.14	0.05
	(0.30)	(0.16)		(0.19)	(0.38)		(0.18)	(0.33)		(0.06)	(0.13)	
ITA	1.15	0.81	0.00	0.00	1.30	0.97	0.44	1.05	0.00	-0.17	1.09	0.00
	(0.91)	(0.39)		(0.49)	(1.57)		(0.11)	(0.22)		(0.08)	(0.23)	
GBR	0.21	0.31	0.00	0.42	-0.09	0.00	0.17	0.51	0.02	-0.03	0.76	0.54
	(0.16)	(0.11)		(0.08)	(0.12)		(0.09)	(0.20)		(0.06)	(0.41)	
CAN	0.50	0.86	0.08	0.01	0.68	0.00	0.28	1.21	0.13	0.05	1.08	0.38
	(0.36)	(0.22)		(0.04)	(0.09)		(0.15)	(0.30)		(0.04)	(0.11)	
AUS	0.36	0.61	0.25	0.23	1.88	0.01	0.02	0.67	0.48	-0.16	0.93	0.00
	(0.24)	(0.32)		(0.13)	(0.31)		(0.14)	(0.29)		(0.02)	(0.07)	
AUT	0.97	1.83	0.05	0.24	1.51	0.00	0.04	1.01	0.98	-0.02	1.53	0.22
	(0.40)	(0.41)		(0.08)	(0.19)		(0.20)	(0.48)		(0.07)	(0.33)	
BEL	1.26	1.48	0.09	-0.05	0.81	0.00	0.17	0.89	0.58	0.10	1.18	0.01
	(0.63)	(0.35)		(0.03)	(0.04)		(0.21)	(0.38)		(0.06)	(0.13)	
DNK	0.25	1.41	0.18	-0.02	0.58	0.00	-0.01	0.70	0.61	0.18	1.50	0.10
	(0.24)	(0.23)		(0.09)	(0.11)		(0.16)	(0.31)		(0.08)	(0.39)	
FIN	-0.66	1.26	0.05	1.41	2.49	0.00	-0.12	0.83	0.66	-0.01	0.97	0.95
	(0.55)	(0.24)		(0.04)	(0.05)		(0.23)	(0.24)		(0.06)	(0.24)	
GRC	-0.65	1.02	0.03	0.07	0.85	0.00	-0.16	0.95	0.03	0.09	0.74	0.86
	(0.32)	(0.21)		(0.06)	(0.06)		(0.06)	(0.18)		(0.18)	(0.69)	
IRL	-1.71	1.13	0.10	-0.05	1.04	0.92	-0.45	0.65	0.18	-0.17	1.22	0.48
	(1.02)	(0.29)		(0.36)	(0.18)		(0.50)	(0.49)		(0.14)	(0.25)	
NLD	0.71	1.05	0.25	-1.02	1.53	0.02	0.27	0.88	0.46	-0.21	1.24	0.45
	(0.43)	(0.36)		(0.39)	(0.29)		(0.24)	(0.42)		(0.20)	(0.41)	
NZL	0.43	0.75	0.04	0.12	1.08	0.85	0.07	1.09	0.96	-0.24	0.79	0.00
	(0.23)	(0.19)		(0.31)	(0.72)		(0.29)	(0.43)		(0.17)	(0.53)	
NOR	0.40	0.97	0.27	0.17	0.46	0.00	0.05	0.74	0.60	0.17	1.19	0.07
	(0.26)	(0.18)		(0.10)	(0.20)		(0.22)	(0.25)		(0.09)	(0.40)	
PRT	1.55	1.12	0.00	0.05	0.81	0.11	0.64	1.21	0.00	0.33	0.97	0.00
	(0.36)	(0.19)		(0.21)	(0.14)		(0.16)	(0.21)		(0.10)	(0.21)	
ESP	-0.34	0.81	0.84	0.20	3.04	0.06	0.04	0.99	0.94	-0.14	1.37	0.02
	(0.59)	(0.38)		(0.17)	(1.00)		(0.11)	(0.19)		(0.10)	(0.13)	
SWE	-0.05	0.99	1.00	0.11	0.56	0.11	0.18	1.36	0.47	0.10	1.14	0.30
	(0.54)	(0.36)		(0.19)	(0.24)		(0.20)	(0.37)		(0.15)	(0.37)	
CHE	1.12	1.13	0.05	0.00	1.15	0.66	0.32	1.28	0.02	0.11	0.77	0.08
	(0.72)	(0.30)		(0.21)	(0.23)		(0.12)	(0.18)		(0.06)	(0.13)	
All			0.00			0.00			0.00			0.00

Notes: The estimated equation is $X_{t|t+4} = \alpha + \beta X_{t|t+1} + \varepsilon_t$ where X represents the business cycle measure. The equation is estimated as a system of equations across all 21 countries using least squares. The columns labelled "Wald" contain the *p*-values of Wald tests of the joint hypothesis $\alpha = 0$ and $\beta = 1$. The row labelled "All" contains the *p*-values of the same test applied to all 21 economies jointly. The sample period is 1994 to 2003 for GAP and GAPHP (apart from New Zealand where it is 1996 to 2003) and 2000 to 2003 for UGAP and UGAPHP.

Table 7. **Sign of initial and final gap estimates**

	Initial sign (*t*+1) \ Final sign (*t*+4)	Number of occurrences: -	Number of occurrences: +	Probability that observed frequencies are random
GAP	-	118	30	0.00
	+	9	51	
UGAP	-	37	11	0.00
	+	3	33	
GAPHP	-	78	38	0.00
	+	22	70	
UGAPHP	-	23	7	0.00
	+	12	42	

Notes: The probability that the observed frequencies are random is calculated from the χ^2-distributed test statistic $N((|AD-BC|-N/2)^2/((A+B)(C+D)(A+C)(B+D))$, where *A*, *B*, *C*, and *D* are the upper-right, upper-left, lower-right and lower-left entries of the 2*x*2 contingency table and *N* is the total number of observations. A rejection of the null hypothesis of random frequencies means that the initial sign is equal (opposite) to the final sign if the sum of the entries in *A* and *D* is larger (smaller) than the sum of the entries in *B* and *C*. The sample period is 1994 to 2003 for GAP and GAPHP and 2000 to 2003 for UGAP and UGAPHP for all countries but New Zealand (1996 to 2003 for GAP and GAPHP).

Table 8. **Revision with respect to initial outturn estimate at *t*+1**

	Maximum absolute revision				Mean absolute revision			
	GAP		UGAP		GAP		UGAP	
	t+2	*t*+4	*t*+2	*t*+4	*t*+2	*t*+4	*t*+2	*t*+4
United States	0.92	1.17	0.30	0.30	0.38	0.61	0.11	0.25
Japan	3.04	3.66	0.27	0.27	1.27	1.64	0.05	0.12
Euro Area	0.86	1.76	0.24	0.36	0.38	0.91	0.15	0.20
Germany	1.38	2.69	0.92	1.08	0.51	1.05	0.27	0.49
France	1.38	1.26	0.30	0.50	0.40	0.46	0.12	0.26
Italy	1.89	3.00	1.32	0.75	0.90	1.59	0.43	0.53
United Kingdom	0.97	1.97	0.94	0.96	0.56	1.00	0.21	0.35
Canada	1.12	1.65	0.24	0.21	0.53	0.93	0.15	0.17
Australia	1.34	1.22	0.28	0.41	0.35	0.67	0.08	0.20
Austria	1.22	1.98	0.35	0.38	0.38	0.93	0.13	0.17
Belgium	1.36	2.76	0.59	0.23	0.44	0.73	0.23	0.15
Denmark	1.41	1.15	0.69	0.73	0.58	0.67	0.18	0.30
Finland	2.15	3.59	0.27	0.61	0.72	1.28	0.05	0.31
Greece	0.94	1.60	0.27	0.33	0.50	0.85	0.09	0.16
Ireland	3.08	4.61	0.25	0.24	0.94	1.87	0.10	0.13
Netherlands	1.51	2.66	0.91	0.87	0.73	1.07	0.27	0.48
New Zealand	1.32	1.68	0.33	0.63	0.39	0.55	0.12	0.33
Norway	1.62	1.86	0.58	0.59	0.50	0.57	0.13	0.37
Portugal	1.45	2.46	0.45	0.45	0.49	1.40	0.20	0.37
Spain	0.56	2.36	0.80	0.80	0.33	0.91	0.28	0.41
Sweden	1.35	1.79	0.39	0.51	0.61	0.99	0.16	0.32
Switzerland	2.27	2.29	0.46	0.37	0.56	1.11	0.15	0.22

Notes: The columns labelled *t*+2 (*t*+4) refer to the total revision made between *t*+1 and *t*+2 (*t*+4). For GAP the sample period is 1994 to 2005 for the revision between *t*+1 and *t*+2 and 1994 to 2003 for the revision between *t*+1 and *t*+4 for all countries but the euro and New Zealand where the sample periods start in 1996 and 1997, respectively. For UGAP the sample period is 2000 to 2005 for the revision between *t*+1 and *t*+2 and 2000 to 2003 for the revision between *t*+1 and *t*+4.

Table 9. **Mean absolute revision between *t*+1 and *t*+4**

	$\Delta \ln GAP_t$	$\Delta \ln GDPV_t$	$\Delta \ln GDPVTR_t$
United States	0.46	0.61	0.43
Japan	1.09	0.82	0.35
Euro Area	0.26	0.20	0.14
Germany	0.41	0.43	0.35
France	0.36	0.35	0.15
Italy	0.35	0.22	0.34
United Kingdom	0.38	0.42	0.22
Canada	0.37	0.50	0.26
Australia	0.52	0.29	0.37
Austria	0.19	0.12	0.20
Belgium	0.32	0.33	0.21
Denmark	0.53	0.41	0.25
Finland	0.34	0.35	0.39
Greece	0.34	0.32	0.61
Ireland	1.10	1.08	0.52
Netherlands	0.40	0.51	0.34
New Zealand	0.34	0.32	0.19
Norway	0.43	0.62	0.77
Portugal	0.21	0.30	0.17
Spain	0.22	0.36	0.45
Sweden	0.48	0.27	0.36
Switzerland	0.11	0.27	0.26

Notes: GAP = output gap (production function approach), GDPV = actual GDP, GDPVTR = potential GDP, $\Delta \ln$ = log difference. The sample period is 1994 to 2003 for all countries but the euro area and New Zealand where it is 1997 to 2003 and 1996 to 2003, respectively.

Table 10. **Sign of initial gap estimate and direction of gap revision**

	Sign of initial gap	Number of occurrences		Probability that upward and downward revisions are equally likely
		Downward revision	Upward revision	
GAP	-	55	93	0.00
	+	27	33	0.26
	Total	*82*	*126*	*0.00*
UGAP	-	20	28	0.16
	+	20	16	0.31
	Total	*40*	*44*	*0.37*
GAPHP	-	40	76	0.00
	+	56	36	0.02
	Total	*96*	*112*	*0.15*
UGAPHP	-	14	16	0.43
	+	24	30	0.25
	Total	*38*	*46*	*0.22*

Notes: The probability is derived from the binomial distribution. The sign of the initial outturn estimate at *t*+1 is compared to the sign of the revision taking place from *t*+1 to *t*+4. The sample period is 1994 to 2003 for GAP and GAPHP and 2000 to 2003 for UGAP and UGAPHP for all countries but New Zealand (1996 to 2003 for GAP and GAPHP).

Table 11. **Predicting the production-function-based output gap and the Kalman-filter-based unemployment gap**

	(a)			(b)		(c)			(d)		(e)			(f)			(g)	
	α_i	β_i	γ_i	α_i	β_i	α_i	β_i	γ_i	α_i	β_i	α_i	β_i	γ_i	α_i	β_i	γ_i	α_i	β_i
USA	-0.40	-0.72	1.17*	-0.33	0.11	3.32	-0.05	0.95*	4.73	-0.06	4.51	-0.06	0.03	-0.03	-0.05	1.17*	-0.05	-0.22
	(0.21)	(0.60)	(0.29)	(0.22)	(0.23)	(5.62)	(0.07)	(0.20)	(4.84)	(0.06)	(5.56)	(0.07)	(0.26)	(0.07)	(0.35)	(0.17)	(0.06)	(0.13)
JPN	-2.57*	1.47*	-0.81*	-2.34	1.75*	-21.89*	0.21*	-0.15	-27.33	0.28*	-16.24*	0.14	1.43*	-0.19	0.46	0.86*	-0.20	0.16
	(0.90)	(0.57)	(0.41)	(0.80)	(0.39)	(9.36)	(0.10)	(0.37)	(11.53)	(0.11)	(7.86)	(0.08)	(0.39)	(0.13)	(0.38)	(0.13)	(0.12)	(0.12)
DEU	-0.13	0.62	0.25	-0.05	0.72	-1.64	0.02	0.50	0.69	0.00	10.04	-0.12	0.86	-0.95	2.38*	-0.15	-0.27	0.36
	(1.08)	(1.06)	(0.82)	(0.91)	(0.75)	(24.61)	(0.29)	(0.77)	(23.60)	(0.28)	(25.38)	(0.30)	(0.86)	(0.56)	(1.10)	(0.58)	(0.59)	(0.56)
FRA	0.13	-0.81	1.16*	-0.03	0.05	-16.88	0.19	0.62	-8.52	0.10	-11.65	0.13	0.11	-0.12	0.46	0.77	-0.03	0.02
	(0.35)	(0.67)	(0.27)	(0.35)	(0.23)	(18.53)	(0.21)	(0.34)	(16.43)	(0.19)	(18.82)	(0.22)	(0.26)	(0.17)	(0.52)	(0.37)	(0.15)	(0.33)
ITA	1.11	0.07	0.79	1.08	0.25	2.42	-0.02	0.83	0.93	0.01	5.77	-0.06	0.29	-0.91	2.28	0.74	-0.36	0.46
	(1.19)	(1.23)	(0.63)	(1.11)	(0.56)	(28.00)	(0.36)	(0.51)	(26.38)	(0.33)	(29.83)	(0.38)	(0.65)	(0.47)	(1.42)	(0.42)	(0.25)	(0.43)
GBR	0.25	-0.24	0.35*	0.16	0.68*	4.28	-0.05	0.30	-13.63	0.17	20.56*	-0.25*	1.16*	0.37*	0.57	-0.07	0.33*	1.10*
	(0.18)	(0.37)	(0.13)	(0.23)	(0.17)	(5.79)	(0.07)	(0.12)	(9.46)	(0.12)	(8.85)	(0.11)	(0.25)	(0.11)	(0.62)	(0.19)	(0.10)	(0.19)
CAN	0.44	0.81	0.79*	0.40	0.24	-17.63	0.22	0.85*	-15.35	0.19	-14.24	0.18	0.02	-0.04	0.40	0.39*	-0.04	0.62*
	(0.35)	(0.58)	(0.21)	(0.35)	(0.21)	(16.14)	(0.19)	0.22	(11.80)	(0.14)	(21.95)	(0.26)	(0.39)	(0.04)	(0.21)	(0.17)	(0.05)	(0.20)
Wald		0.09			0.00		0.36			0.12		0.18	0.00		0.05			0.00

Notes: The numbers in parentheses denote the standard errors of the estimated coefficients. All equations are estimated using least squares. An asterisk denotes significance at the 5% level. The sample period is 1994 to 2003 for specifications (a) through (e) and 2000 to 2005 for specifications (f) and (g). The row labelled "Wald" shows the *p*-values of Wald tests that the coefficients in the respective column are equal to zero for all countries jointly.

Specification (a): $GAP_{i,t|t+4} = \alpha_i + \beta_i\, GAPHP_{i,t|t+1} + \gamma_i\, GAP_{i,t|t+1} + \varepsilon_{i,t}$.
Specification (b): $GAP_{i,t|t+4} - GAP_{i,t|t+1} = \alpha_i + \beta_i\, (GAPHP_{i,t|t+1} - GAP_{i,t|t+1}) + \varepsilon_{i,t}$.
Specification (c): $GAP_{i,t|t+4} = \alpha_i + \beta_i\, CAP_{i,t|t+1} + \gamma_i\, GAP_{i,t|t+1} + \varepsilon_{i,t}$.
Specification (d): $GAP_{i,t|t+4} - GAP_{i,t|t+1} = \alpha_i + \beta_i\, (CAP_{i,t|t+1} - GAP_{i,t|t+1}) + \varepsilon_{i,t}$.
Specification (e): $GAP_{i,t|t+4} - GAP_{i,t|t+1} = \alpha_i + \beta_i\, (CAP_{i,t|t+1} - GAP_{i,t|t+1}) + \gamma_i\, (GAPHP_{i,t|t+1} - GAP_{i,t|t+1}) + \varepsilon_{i,t}$.
Specification (f): $UGAP_{i,t|t+2} = \alpha_i + \beta_i\, UGAPHP_{i,t|t+1} + \gamma_i\, UGAP_{i,t|t+1} + \varepsilon_{i,t}$.
Specification (g): $UGAP_{i,t|t+2} - UGAP_{i,t|t+1} = \alpha_i + \beta_i\, (UGAPHP_{i,t|t+1} - UGAP_{i,t|t+1}) + \varepsilon_{i,t}$.

Table 12. **Relationship between business cycle indicators, pooled regression results**

	(a)	(b)	(c)	(d)
GAP	0.536	0.515	0.448	0.441
	(0.000)	(0.000)	(0.000)	(0.000)
GAPHP	0.107	0.400	0.552	0.559
	(0.727)	(0.003)	(0.000)	(0.000)
CAP	0.108	0.085	0.000	
	(0.054)	(0.094)	(0.922)	
Fixed effects	Yes	Yes	No	No

Notes: The sample period is 1994 to 2003. The numbers in parentheses denote the *p*-values of *t*-tests against zero.

Specification (a): $GAP_{i,t|t+4} = \alpha_i + \beta\, GAP_{i,t|t+1} + \gamma\, GAPHP_{i,t|t+1} + \delta\, CAP_{i,t|t+1} + \varepsilon_{i,t}$.
Specification (b): $GAP_{i,t|t+4} = \alpha_i + \beta\, GAP_{i,t|t+1} + \gamma\, GAPHP_{i,t|t+1} + (1 - \beta - \gamma)\, CAP_{i,t|t+1} + \varepsilon_{i,t}$.
Specification (c): $GAP_{i,t|t+4} = \beta\, GAP_{i,t|t+1} + \gamma\, GAPHP_{i,t|t+1} + (1 - \beta - \gamma)\, CAP_{i,t|t+1} + \varepsilon_{i,t}$.
Specification (d): $GAP_{i,t|t+4} = \beta\, GAP_{i,t|t+1} + (1 - \beta)\, GAPHP_{i,t|t+1} + \varepsilon_{i,t}$.

Table 13. **Correlation between gap projections and outturn estimates**

Business cycle measure / Time of data release	Correlation with current year projection (made at *t*) GAP		UGAP		GAPHP		UGAPHP	
	t+1	t+4	*t*+1	*t*+2[a)]	*t*+1	*t*+4	*t*+1	*t*+2[a)]
United States	0.90*	0.85*	0.96*	1.00*	0.83*	0.75*	0.96*	0.89*
	(0.14)	(0.20)	(0.15)	(0.05)	(0.17)	(0.25)	(0.14)	(0.27)
Japan	0.76*	-0.50	0.89*	0.82*	0.77*	0.63*	0.46	0.93*
	(0.20)	(0.33)	(0.23)	(0.33)	(0.20)	(0.29)	(0.44)	(0.22)
Euro Area	0.86*	0.82*	0.94*	0.98*	0.71*	0.63	0.88*	0.96*
	(0.19)	(0.28)	(0.17)	(0.11)	(0.27)	(0.39)	(0.24)	(0.15)
Germany	0.59*	0.28	0.84*	0.81*	0.61*	0.50	0.72*	0.96*
	(0.26)	(0.36)	(0.27)	(0.34)	(0.25)	(0.33)	(0.35)	(0.16)
France	0.93*	0.94*	0.93*	0.96*	0.75*	0.57	0.93*	0.90*
	(0.12)	(0.13)	(0.18)	(0.16)	(0.21)	(0.31)	(0.19)	(0.26)
Italy	0.08	0.56	0.36	-0.31	0.50	0.58	0.83*	0.81*
	(0.32)	(0.31)	(0.47)	(0.55)	(0.27)	(0.31)	(0.28)	(0.34)
United Kingdom	0.77*	0.77*	0.60	0.50	0.70*	0.62*	0.92*	0.91*
	(0.20)	(0.24)	(0.40)	(0.50)	(0.22)	(0.30)	(0.20)	(0.24)
Canada	0.94*	0.89*	0.87*	0.91*	0.77*	0.63*	0.92*	0.75
	(0.10)	(0.17)	(0.24)	(0.23)	(0.20)	(0.29)	(0.20)	(0.38)
Australia	0.45	0.51	0.96*	0.94*	0.76*	0.44	0.89*	0.98*
	(0.28)	(0.33)	(0.14)	(0.19)	(0.21)	(0.34)	(0.23)	(0.12)
Austria	0.92*	0.92*	0.77*	0.89*	0.68*	0.67*	0.56	0.67
	(0.12)	(0.15)	(0.32)	(0.26)	(0.23)	(0.28)	(0.42)	(0.43)
Belgium	0.84*	0.92*	0.83*	0.94*	0.77*	0.61*	0.74*	0.97*
	(0.17)	(0.15)	(0.28)	(0.20)	(0.20)	(0.30)	(0.34)	(0.13)
Denmark	0.71*	0.26	0.76*	0.70	0.83*	0.49	0.96*	0.75
	(0.22)	(0.36)	(0.33)	(0.41)	(0.18)	(0.33)	(0.14)	(0.38)
Finland	0.84*	0.78*	0.96*	0.86*	0.80*	0.45	0.50	0.56
	(0.17)	(0.24)	(0.13)	(0.29)	(0.19)	(0.34)	(0.43)	(0.48)
Greece	0.93*	0.80*	0.32	0.18	0.52	0.57	-0.09	0.23
	(0.12)	(0.23)	(0.47)	(0.57)	(0.27)	(0.31)	(0.50)	(0.56)
Ireland	0.77*	0.75*	0.91*	0.96*	0.49	-0.22	0.56	0.85*
	(0.20)	(0.25)	(0.21)	(0.15)	(0.28)	(0.37)	(0.41)	(0.31)
Netherlands	0.92*	0.95*	0.92*	0.93*	0.79*	0.63*	0.62	0.99*
	(0.13)	(0.12)	(0.19)	(0.21)	(0.19)	(0.29)	(0.39)	(0.07)
New Zealand	0.74*	0.67*	0.79*	0.83*	0.72*	0.36	0.77*	0.56
	(0.24)	(0.33)	(0.31)	(0.32)	(0.24)	(0.42)	(0.32)	(0.48)
Norway	0.85*	0.84*	0.71*	0.49	0.83*	0.48	0.72*	-0.42
	(0.17)	(0.20)	(0.35)	(0.50)	(0.18)	(0.33)	(0.35)	(0.52)
Portugal	0.96*	0.93*	0.98*	0.95*	0.85*	0.59	0.91*	0.84*
	(0.09)	(0.14)	(0.09)	(0.17)	(0.17)	(0.30)	(0.21)	(0.32)
Spain	0.80*	0.77*	0.89*	0.64	0.75*	0.52	0.94*	0.90*
	(0.19)	(0.24)	(0.23)	(0.45)	(0.21)	(0.32)	(0.17)	(0.25)
Sweden	0.67*	0.69*	0.92*	0.94*	0.79*	0.69*	0.65	0.73
	(0.23)	(0.27)	(0.20)	(0.19)	(0.19)	(0.28)	(0.38)	(0.40)
Switzerland	0.79*	0.71*	0.83*	0.92*	0.84*	0.85*	0.78*	0.76*
	(0.20)	(0.27)	(0.28)	(0.23)	(0.17)	(0.20)	(0.31)	(0.38)

Table 13. **Correlation between gap projections and outturn estimates** (cont'd)

Business cycle measure Time of data release	Correlation with 1-year-ahead projection (made at *t*-1)							
	GAP		UGAP		GAPHP		UGAPHP	
	t+1	t+4	*t*+1	*t*+2[a)]	*t*+1	*t*+4	*t*+1	*t*+2[a)]
United States	0.40	0.31	0.33	-0.12	-0.02	-0.37	0.80*	0.85*
	(0.31)	(0.39)	(0.54)	(0.70)	(0.33)	(0.38)	(0.34)	(0.37)
Japan	0.60*	0.08	0.50	0.17	0.52	0.25	0.48	0.52
	(0.27)	(0.41)	(0.50)	(0.70)	(0.29)	(0.40)	(0.51)	(0.60)
Euro Area	0.55	0.56	-0.44	0.90*	0.24	0.33	0.51	0.28
	(0.34)	(0.48)	(0.52)	(0.30)	(0.40)	(0.54)	(0.50)	(0.68)
Germany	0.37	0.65*	0.34	0.91*	0.34	0.31	0.40	0.24
	(0.31)	(0.31)	(0.54)	(0.29)	(0.31)	(0.39)	(0.53)	(0.69)
France	0.76*	0.85*	0.81*	1.00*	0.13	-0.29	0.70	0.48
	(0.22)	(0.22)	(0.34)	(0.05)	(0.33)	(0.39)	(0.41)	(0.62)
Italy	-0.03	0.19	-0.42	-0.70	0.18	0.04	0.75	0.81
	(0.33)	(0.40)	(0.52)	(0.50)	(0.33)	(0.41)	(0.38)	(0.41)
United Kingdom	0.09	0.26	-0.10	-0.83*	0.33	-0.14	0.48	0.95*
	(0.33)	(0.39)	(0.57)	(0.39)	(0.32)	(0.40)	(0.51)	(0.22)
Canada	0.62*	0.59	0.97*	0.87*	-0.19	-0.47	0.84*	0.78
	(0.26)	(0.33)	(0.15)	(0.35)	(0.33)	(0.36)	(0.31)	(0.44)
Australia	0.12	0.05	0.93*	0.86*	-0.05	-0.20	0.85*	0.51
	(0.33)	(0.41)	(0.21)	(0.36)	(0.33)	(0.40)	(0.30)	(0.61)
Austria	0.61*	0.55	0.75	0.95*	0.34	0.55	0.20	-0.96*
	(0.26)	(0.34)	(0.38)	(0.23)	(0.31)	(0.34)	(0.57)	(0.19)
Belgium	0.45	0.68*	0.46	0.99*	0.12	-0.30	-0.20	-0.02
	(0.30)	(0.30)	(0.51)	(0.10)	(0.33)	(0.39)	(0.57)	(0.71)
Denmark	0.00	-0.18	-0.18	0.01	0.26	-0.11	0.54	-0.55
	(0.33)	(0.40)	(0.57)	(0.71)	(0.32)	(0.41)	(0.49)	(0.59)
Finland	0.60*	0.84*	0.62	0.28	0.40	-0.02	0.32	-0.33
	(0.27)	(0.22)	(0.45)	(0.68)	(0.30)	(0.41)	(0.55)	(0.67)
Greece	0.95*	0.81*	-0.14	0.34	-0.18	-0.35	0.29	0.18
	(0.10)	(0.24)	(0.57)	(0.67)	(0.33)	(0.38)	(0.55)	(0.70)
Ireland	0.75*	0.71*	0.79*	0.94*	0.80*	-0.11	-0.05	0.44
	(0.22)	(0.29)	(0.35)	(0.24)	(0.20)	(0.41)	(0.58)	(0.64)
Netherlands	0.61*	0.67*	0.87*	0.93*	0.25	0.08	-0.45	-0.05
	(0.26)	(0.30)	(0.29)	(0.27)	(0.32)	(0.41)	(0.51)	(0.71)
New Zealand	0.26	0.19	0.00	0.20	0.07	0.60	-0.03	-0.95*
	(0.36)	(0.49)	(0.58)	(0.69)	(0.38)	(0.40)	(0.58)	(0.22)
Norway	0.40	0.49	0.26	0.25	0.15	-0.28	0.44	-0.95*
	(0.31)	(0.36)	(0.56)	(0.69)	(0.33)	(0.39)	(0.52)	(0.23)
Portugal	0.80*	0.78*	0.75	0.74	0.39	-0.08	-0.20	-0.65
	(0.20)	(0.26)	(0.38)	(0.47)	(0.31)	(0.41)	(0.57)	(0.54)
Spain	0.52	0.86*	0.81*	0.88*	0.25	-0.18	0.84*	0.77
	(0.28)	(0.21)	(0.33)	(0.33)	(0.32)	(0.40)	(0.31)	(0.45)
Sweden	0.36	0.40	0.78*	0.87*	0.44	0.04	-0.18	-0.40
	(0.31)	(0.37)	(0.36)	(0.35)	(0.30)	(0.41)	(0.57)	(0.65)
Switzerland	0.37	0.30	0.75	0.72	0.26	0.05	0.25	-0.40
	(0.31)	(0.39)	(0.38)	(0.49)	(0.32)	(0.41)	(0.56)	(0.65)

Notes: a) Sample size too small to calculate correlation with the outturn estimate at *t*+4. The sample period is 1996 to 2006 and 1996 to 2003 (1995 to 2006 and 1995 to 2003) for the correlation between the 1-year-ahead (current-year) projection of GAP and GAPHP and the outturn estimates at *t*+1 and *t*+4 for all countries but the euro area and New Zealand where the sample starts in 1999 and 1998 (1998 and 1997). The sample period is 2002 to 2006 and 2002 to 2005 for the correlation between the 1-year-ahead (current-year) projection of UGAP and UGAPHP and the outturn estimates at *t*+1 and *t*+2. An asterisk denotes significance at the 5% level.

Table 14. **Sign of projected gap vs. outturn estimate**

			Initial outturn estimate (*t*+1)			Final outturn estimate (*t*+4)		
			Number of occurrences		Probability that observed frequencies are random	Number of occurrences		Probability that observed frequencies are random
			-	+		-	+	
GAP	Current-year projection (*t*)	-	156	16	0.000	94	34	0.000
		+	17	61		14	45	
UGAP		-	69	10	0.000	31	10	0.000
		+	8	39		3	19	
GAPHP		-	107	25	0.000	58	34	0.000
		+	29	89		26	69	
UGAPHP		-	59	22	0.000	31	13	0.000
		+	6	39		1	18	
GAP	1-year-ahead projection (*t*-1)	-	117	30	0.000	69	35	0.000
		+	36	46		20	42	
UGAP		-	52	10	0.000	20	2	0.004
		+	15	28		9	11	
GAPHP		-	43	17	0.007	22	24	0.588
		+	85	84		50	70	
UGAPHP		-	39	24	0.598	26	7	0.108
		+	23	19		4	5	

Notes: See notes to Table 10. The sample period is 1995 to 2006 and 1995 to 2003 (1996 to 2006 and 1996 to 2003) when comparing the current-year (1-year-ahead) projections of GAP and GAPHP to the outturn estimates at *t*+1 and *t*+4 and 2001 to 2006 and 2001 to 2003 (2002 to 2006 and 2002 to 2003) when comparing the current-year (1-year-ahead) projections of UGAP and UGAPHP to the outturn estimates at *t*+1 and *t*+4. For New Zealand the sample starts two years later for all calculations that involve GAP or GAPHP.

Table 15. **Projected vs. actual change of the output/unemployment gap**

			Initial outturn estimate (*t*+1)			Final outturn estimate (*t*+4)		
			Number of occurrences		Fisher test of change of sign (*p*-value)	Number of occurrences		Fisher test of change of sign (*p*-value)
			Down	Up		Down	Up	
GAP	Current-year projection (*t*)	down	102	21	0.000	69	23	0.000
		up	22	105		20	75	
UGAP		down	62	10	0.000	38	8	0.000
		up	6	48		3	14	
GAPHP		down	99	27	0.000	80	29	0.000
		up	17	107		19	59	
UGAPHP		down	56	18	0.000	41	13	0.029
		up	8	44		3	6	
GAP	1-year-ahead projection (*t*-1)	down	36	29	0.450	22	25	0.881
		up	80	84		59	60	
UGAP		down	23	9	0.021	14	3	0.913
		up	33	40		19	6	
GAPHP		down	34	23	0.073	29	22	0.855
		up	77	95		62	53	
UGAPHP		down	32	10	0.000	23	3	0.240
		up	20	43		11	5	

Note: See notes to Table 14.

Table 16. **Size of revisions to output gap and unemployment gap projections**

	GAP											
	Maximum absolute revision						Mean absolute revision					
	Revision with respect to 1-year-ahead projection (*t*-1)			Revision with respect to current-year projection (*t*)			Revision with respect to 1-year-ahead projection (*t*-1)			Revision with respect to current-year projection (*t*)		
	t+1	*t* +2	*t* +4	*t*+1	*t* +2	*t* +4	*t*+1	*t* +2	*t* +4	*t*+1	*t* +2	*t* +4
United States	3.02	3.41	3.61	1.63	2.14	2.67	1.13	1.11	1.23	0.52	0.74	0.86
Japan	2.53	5.29	4.11	2.04	4.65	4.52	1.42	1.94	2.33	0.88	1.86	2.17
Euro Area	1.34	1.30	2.07	0.87	1.16	1.81	0.66	0.54	0.63	0.38	0.49	0.96
Germany	1.88	1.25	2.12	1.30	1.80	2.93	0.70	0.56	0.80	0.58	0.59	1.11
France	1.92	2.03	1.57	0.93	0.76	0.97	0.67	0.64	0.78	0.35	0.35	0.31
Italy	2.22	2.62	3.97	2.38	2.40	3.35	0.95	0.94	1.46	0.80	1.24	1.76
United Kingdom	1.54	2.40	1.56	1.33	1.87	1.87	0.91	0.99	0.66	0.57	0.75	0.74
Canada	1.51	2.14	2.53	0.76	1.27	1.66	0.59	0.90	1.05	0.30	0.46	0.74
Australia	1.84	2.05	2.07	1.79	2.05	1.67	0.88	1.03	0.86	0.60	0.82	0.93
Austria	1.98	1.31	2.55	0.85	1.11	1.92	0.73	0.77	1.23	0.34	0.53	0.94
Belgium	1.70	1.46	2.88	1.27	1.17	2.27	0.75	0.95	0.81	0.40	0.59	0.76
Denmark	2.15	2.58	2.89	1.32	2.45	2.30	1.04	1.20	1.38	0.58	0.78	1.21
Finland	2.45	2.50	2.62	1.39	2.85	3.70	0.89	1.15	1.21	0.67	0.89	1.21
Greece	1.01	1.17	1.77	1.04	1.14	1.85	0.31	0.53	0.75	0.43	0.37	0.81
Ireland	2.93	3.60	4.21	4.00	4.73	3.23	1.40	1.13	1.44	1.13	1.36	1.50
Netherlands	2.87	2.26	3.40	1.36	1.57	1.68	1.28	0.85	1.20	0.64	0.69	0.96
New Zealand	2.36	2.82	2.37	1.55	2.28	1.56	1.06	1.26	1.19	0.69	0.97	0.87
Norway	1.90	1.70	2.48	1.31	1.26	1.50	1.11	1.01	1.26	0.59	0.54	0.87
Portugal	2.45	2.22	2.81	0.98	1.92	2.67	0.69	0.68	1.52	0.41	0.77	1.46
Spain	1.86	1.49	2.19	1.00	0.90	1.83	0.77	0.63	0.69	0.52	0.54	0.79
Sweden	2.63	1.59	3.07	1.41	2.06	1.99	0.80	0.96	1.35	0.76	0.97	1.00
Switzerland	3.20	2.58	3.58	2.50	2.60	2.88	1.21	1.02	1.80	0.57	0.80	1.35

Table 16. **Size of revisions to output gap and unemployment gap projections** (cont'd)

	UGAP									
	Maximum absolute revision					Mean absolute revision				
	Revision with respect to 1-year-ahead projection (*t*-1)		Revision with respect to current-year projection (*t*)			Revision with respect to 1-year-ahead projection (*t*-1)		Revision with respect to current-year projection (*t*)		
	t+1	*t* +2	*t*+1	*t* +2	*t* +4	*t*+1	*t* +2	*t*+1	*t* +2	*t* +4
United States	0.70	1.00	0.29	0.29	0.52	0.28	0.48	0.14	0.19	0.37
Japan	0.96	0.96	0.49	0.49	0.62	0.54	0.66	0.29	0.32	0.49
Euro Area	0.43	0.39	0.26	0.10	0.27	0.26	0.32	0.13	0.06	0.21
Germany	0.95	0.93	0.58	0.69	1.12	0.59	0.68	0.31	0.36	0.63
France	0.84	0.93	0.37	0.42	0.87	0.56	0.73	0.19	0.19	0.40
Italy	1.00	0.87	0.71	0.77	0.53	0.55	0.70	0.43	0.50	0.19
United Kingdom	0.67	0.65	0.57	0.56	0.56	0.34	0.42	0.26	0.31	0.46
Canada	0.28	0.17	0.35	0.30	0.50	0.11	0.14	0.21	0.20	0.26
Australia	0.69	0.69	0.57	0.59	0.16	0.24	0.24	0.19	0.18	0.09
Austria	0.32	0.44	0.34	0.35	0.43	0.20	0.23	0.26	0.20	0.28
Belgium	1.40	1.12	0.80	0.62	0.60	0.60	0.63	0.39	0.31	0.34
Denmark	1.46	1.48	0.97	1.00	0.76	1.10	1.10	0.45	0.58	0.60
Finland	0.55	0.64	0.32	0.43	0.66	0.37	0.40	0.17	0.23	0.56
Greece	1.07	1.06	1.36	1.32	0.64	0.69	0.62	0.51	0.46	0.33
Ireland	0.84	0.84	0.70	0.46	0.51	0.35	0.51	0.26	0.29	0.36
Netherlands	1.55	0.89	1.28	1.33	0.31	0.47	0.43	0.56	0.58	0.24
New Zealand	1.29	1.01	0.63	0.54	0.83	0.58	0.58	0.37	0.29	0.61
Norway	1.02	0.74	0.55	0.56	0.56	0.62	0.51	0.33	0.37	0.27
Portugal	2.12	1.67	0.71	0.71	0.45	0.81	0.93	0.28	0.47	0.28
Spain	0.88	0.41	0.68	0.73	0.73	0.35	0.30	0.27	0.52	0.51
Sweden	1.50	1.26	0.61	0.61	0.68	0.80	0.86	0.42	0.40	0.33
Switzerland	1.19	1.41	0.68	0.73	0.23	0.75	0.84	0.33	0.27	0.18

Notes: In the analyses of GAP revisions the sample period is 1996 to 2006, 1996 to 2005 and 1996 to 2003 (1995 to 2006, 1995 to 2005 and 1995 to 2003) for the revisions of the 1-year-ahead (current-year) projections with respect to the outturn estimates at time *t*+1, *t*+2 and *t*+4. In the analyses of UGAP revisions the sample period is 2002 to 2006 and 2002 to 2005 for the revisions of the 1-year-ahead projections with respect to the outturn estimates at time *t*+1 and *t*+2 (for the revision with respect to the outturn estimate at *t*+4 no results are reported given the very small sample size), and 2001 to 2006, 2001 to 2005 and 2001 to 2003 for the revisions of the current-year projections with respect to the outturn estimates at time *t*+1, *t*+2 and *t*+4.

Table 17. **Test for efficiency and unbiasedness of output gap projections**

	GAP											
	(a)			(b)			(c)			(d)		
	α	β	Wald	α	β	Wald	α	β	Wald	α	β	Wald
USA	-0.55	0.75	0.01	-0.23	0.82	0.07	-0.20	0.44	0.35	0.03	0.52	0.44
	(0.31)	(0.18)		(0.19)	(0.13)		(0.69)	(0.55)		(0.45)	(0.40)	
JPN	-4.34	-0.97	0.00	-0.68	0.54	0.00	-0.64	0.15	0.00	-0.98	0.34	0.00
	(2.08)	(0.64)		(0.41)	(0.15)		(2.53)	(0.71)		(0.48)	(0.15)	
DEU	0.04	0.48	0.10	-0.75	0.43	0.00	0.45	1.11	0.62	-1.27	0.23	0.00
	(1.01)	(0.62)		(0.36)	(0.19)		(0.62)	(0.52)		(0.31)	(0.20)	
FRA	-0.02	1.02	0.95	-0.13	0.82	0.15	-0.59	0.96	0.15	-0.64	0.65	0.04
	(0.23)	(0.14)		(0.18)	(0.11)		(0.32)	(0.24)		(0.26)	(0.19)	
ITA	1.47	0.87	0.00	-1.59	0.08	0.00	0.10	0.23	0.00	-1.85	-0.03	0.01
	(1.12)	(0.48)		(0.75)	(0.33)		(0.96)	(0.50)		(0.63)	(0.33)	
GBR	0.35	0.33	0.00	0.12	0.76	0.23	0.26	0.15	0.00	-0.05	0.09	0.02
	(0.12)	(0.10)		(0.21)	(0.20)		(0.18)	(0.23)		(0.26)	(0.34)	
CAN	0.64	1.08	0.06	0.05	0.97	0.82	0.30	0.85	0.72	-0.16	0.63	0.37
	(0.29)	(0.21)		(0.13)	(0.11)		(0.53)	(0.48)		(0.25)	(0.27)	
AUS	0.72	0.44	0.00	0.25	0.44	0.03	0.70	0.05	0.01	0.24	0.11	0.00
	(0.21)	(0.28)		(0.20)	(0.27)		(0.27)	(0.42)		(0.24)	(0.30)	
AUT	1.18	1.67	0.00	0.01	0.82	0.03	0.40	1.12	0.81	-0.55	0.49	0.05
	(0.32)	(0.27)		(0.16)	(0.11)		(0.62)	(0.70)		(0.29)	(0.21)	
BEL	1.19	1.28	0.00	-0.34	0.67	0.02	0.29	1.03	0.85	-0.89	0.34	0.01
	(0.40)	(0.21)		(0.25)	(0.14)		(0.65)	(0.46)		(0.34)	(0.23)	
DNK	0.26	0.40	0.36	0.11	0.76	0.37	0.26	-0.33	0.17	-0.08	0.01	0.10
	(0.51)	(0.55)		(0.22)	(0.23)		(0.53)	(0.74)		(0.32)	(0.46)	
FIN	-0.97	0.97	0.13	-0.06	0.75	0.24	-1.15	1.02	0.01	-0.23	0.49	0.05
	(0.52)	(0.29)		(0.24)	(0.15)		(0.39)	(0.27)		(0.28)	(0.22)	
GRC	-0.53	0.98	0.24	0.15	0.97	0.55	-0.55	1.01	0.17	0.16	1.10	0.39
	(0.38)	(0.28)		(0.16)	(0.12)		(0.34)	(0.30)		(0.13)	(0.12)	
IRL	-0.80	1.15	0.73	0.51	0.97	0.61	0.09	1.09	0.92	0.93	0.99	0.16
	(1.11)	(0.38)		(0.65)	(0.26)		(1.16)	(0.44)		(0.68)	(0.29)	
NLD	0.87	1.27	0.00	0.12	0.78	0.04	0.67	1.01	0.49	-0.20	0.52	0.11
	(0.22)	(0.16)		(0.21)	(0.11)		(0.57)	(0.46)		(0.44)	(0.23)	
NZL	0.46	0.71	0.21	0.30	0.90	0.51	0.16	0.25	0.46	0.31	0.44	0.46
	(0.39)	(0.35)		(0.29)	(0.28)		(0.59)	(0.66)		(0.44)	(0.60)	
NOR	0.52	1.22	0.05	0.20	1.19	0.22	0.97	0.74	0.16	0.65	0.64	0.34
	(0.31)	(0.30)		(0.24)	(0.23)		(0.52)	(0.53)		(0.44)	(0.49)	
PRT	1.85	1.33	0.00	-0.02	0.88	0.10	1.56	1.31	0.00	-0.32	0.92	0.76
	(0.33)	(0.20)		(0.22)	(0.08)		(0.53)	(0.43)		(0.46)	(0.23)	
ESP	0.01	1.05	0.98	-0.24	0.64	0.04	-0.31	1.14	0.40	-0.55	0.36	0.00
	(0.52)	(0.33)		(0.21)	(0.15)		(0.39)	(0.27)		(0.25)	(0.20)	
SWE	-0.14	0.92	0.96	-0.38	0.41	0.00	-0.54	0.53	0.55	-0.47	0.23	0.00
	(0.52)	(0.36)		(0.19)	(0.14)		(0.64)	(0.49)		(0.22)	(0.19)	
CHE	0.85	0.87	0.04	-0.43	0.72	0.29	-0.28	0.33	0.11	-1.21	0.33	0.05
	(0.85)	(0.33)		(0.41)	(0.18)		(1.01)	(0.43)		(0.58)	(0.28)	
All			0.00			0.00			0.00			0.00

Table 17. **Test for efficiency and unbiasedness of output gap projections** (cont'd)

	GAPHP											
	(a)			(b)			(c)			(d)		
	α	β	Wald	α	β	Wald	α	β	Wald	α	β	Wald
USA	-0.31	1.14	0.40	-0.17	1.06	0.37	-0.23	-1.68	0.29	0.06	-0.04	0.24
	(0.23)	(0.38)		(0.12)	(0.22)		(0.40)	(1.72)		(0.23)	(0.62)	
JPN	0.81	2.16	0.34	0.05	1.05	0.93	0.00	0.58	0.88	-0.25	0.63	0.05
	(0.55)	(1.01)		(0.14)	(0.28)		(0.45)	(0.91)		(0.18)	(0.35)	
DEU	0.28	0.92	0.33	-0.08	0.70	0.58	-0.38	1.13	0.43	-0.58	0.68	0.00
	(0.26)	(0.61)		(0.12)	(0.29)		(0.62)	(1.39)		(0.27)	(0.62)	
FRA	0.18	1.09	0.73	0.02	0.84	0.67	0.43	-0.71	0.11	-0.18	0.17	0.00
	(0.22)	(0.60)		(0.09)	(0.23)		(0.51)	(0.95)		(0.20)	(0.43)	
ITA	0.46	1.12	0.01	-0.03	0.64	0.47	0.17	0.07	0.14	-0.33	0.23	0.00
	(0.18)	(0.60)		(0.14)	(0.35)		(0.41)	(0.74)		(0.20)	(0.42)	
GBR	0.19	0.72	0.18	0.06	1.06	0.79	0.22	-0.12	0.00	0.00	0.36	0.15
	(0.11)	(0.35)		(0.10)	(0.34)		(0.16)	(0.34)		(0.14)	(0.35)	
CAN	0.12	1.21	0.78	-0.05	0.93	0.85	0.48	-0.99	0.03	-0.02	-0.27	0.00
	(0.22)	(0.56)		(0.09)	(0.24)		(0.38)	(0.76)		(0.20)	(0.47)	
AUS	0.14	0.61	0.48	0.16	1.01	0.24	0.11	-0.47	0.29	0.07	-0.12	0.31
	(0.17)	(0.47)		(0.09)	(0.28)		(0.21)	(0.93)		(0.17)	(0.75)	
AUT	0.23	1.54	0.59	0.05	0.79	0.38	-0.40	1.73	0.51	-0.26	0.52	0.00
	(0.24)	(0.65)		(0.10)	(0.27)		(0.34)	(1.08)		(0.15)	(0.48)	
BEL	0.22	1.22	0.62	0.05	0.94	0.73	0.36	-0.86	0.17	-0.18	0.22	0.00
	(0.23)	(0.59)		(0.09)	(0.25)		(0.49)	(1.13)		(0.24)	(0.59)	
DNK	0.15	0.94	0.72	0.13	1.29	0.25	0.07	-0.22	0.34	-0.06	0.39	0.29
	(0.20)	(0.63)		(0.09)	(0.28)		(0.25)	(0.83)		(0.17)	(0.48)	
FIN	-0.01	0.53	0.45	0.16	0.78	0.31	0.22	-0.02	0.03	0.05	0.35	0.03
	(0.32)	(0.40)		(0.13)	(0.18)		(0.44)	(0.40)		(0.25)	(0.27)	
GRC	-0.19	1.14	0.11	0.04	1.08	0.83	0.29	-0.62	0.00	0.20	-0.14	0.00
	(0.09)	(0.62)		(0.08)	(0.56)		(0.40)	(0.67)		(0.14)	(0.27)	
IRL	0.33	-0.33	0.05	0.38	0.58	0.16	0.28	-0.29	0.45	0.37	1.35	0.06
	(0.40)	(0.55)		(0.24)	(0.32)		(0.48)	(1.03)		(0.18)	(0.34)	
NLD	0.31	1.33	0.48	0.02	0.93	0.91	0.24	0.21	0.74	-0.29	0.46	0.06
	(0.26)	(0.62)		(0.12)	(0.23)		(0.40)	(1.12)		(0.20)	(0.58)	
NZL	-0.19	0.80	0.87	0.12	1.30	0.66	-0.98	1.94	0.01	0.05	0.17	0.68
	(0.37)	(0.92)		(0.17)	(0.44)		(0.40)	(1.28)		(0.29)	(0.95)	
NOR	0.15	0.84	0.85	0.03	1.36	0.44	0.08	-0.53	0.07	0.04	0.23	0.28
	(0.31)	(0.58)		(0.14)	(0.29)		(0.41)	(0.74)		(0.27)	(0.49)	
PRT	0.48	1.04	0.18	-0.08	0.81	0.46	0.54	-0.15	0.30	-0.49	0.49	0.00
	(0.27)	(0.53)		(0.10)	(0.16)		(0.44)	(0.74)		(0.22)	(0.39)	
ESP	0.03	0.89	0.97	0.02	0.85	0.78	0.21	-0.26	0.04	-0.07	0.24	0.00
	(0.19)	(0.56)		(0.07)	(0.24)		(0.33)	(0.58)		(0.16)	(0.32)	
SWE	0.10	1.41	0.67	-0.06	0.77	0.29	0.03	0.08	0.30	-0.25	0.39	0.00
	(0.24)	(0.57)		(0.07)	(0.19)		(0.49)	(0.82)		(0.14)	(0.26)	
CHE	0.33	2.10	0.05	-0.01	1.31	0.40	-0.05	0.14	0.30	-0.49	0.53	0.00
	(0.18)	(0.49)		(0.10)	(0.26)		(0.72)	(1.23)		(0.36)	(0.66)	
All			0.23			0.92			0.00			0.00

Notes: Specification (a): $X_{t|t+4} = \alpha + \beta X_{t|t} + \varepsilon_t$; specification (b): $X_{t|t+1} = \alpha + \beta X_{t|t} + \varepsilon_t$; specification (c): $X_{t|t+4} = \alpha + \beta X_{t|t-1} + \varepsilon_t$; specification (d): $X_{t|t+1} = \alpha + \beta X_{t|t-1} + \varepsilon_t$, where X is the output gap. The sample period is 1995 to 2003 for specification (a), 1995 to 2006 for specification (b), 1996 to 2003 for specification (c) and 1996 to 2006 for specification (d).
The columns labelled "Wald" contain the *p*-values of Wald tests of the joint hypothesis $\alpha = 0$ and $\beta = 1$.

Table 18. **Test for efficiency and unbiasedness of unemployment gap projections**

	UGAP						UGAPHP					
	(a)			(b)			(a)			(b)		
	α	β	Wald	α	β	Wald	α	β	Wald	α	β	Wald
USA	-0.12	0.95	0.21	-0.40	0.42	0.19	-0.04	1.10	0.52	-0.27	1.12	0.11
	(0.07)	(0.15)		(0.23)	(0.70)		(0.05)	(0.16)		(0.13)	(0.48)	
JPN	-0.31	0.59	0.02	-0.52	0.32	0.08	0.05	0.46	0.21	-0.09	0.59	0.00
	(0.18)	(0.15)		(0.41)	(0.32)		(0.05)	(0.45)		(0.11)	(0.62)	
DEU	0.25	1.11	0.71	-0.88	0.37	0.31	0.01	1.07	0.99	-0.27	0.43	0.01
	(0.44)	(0.35)		(0.61)	(0.59)		(0.12)	(0.51)		(0.12)	(0.57)	
FRA	0.00	0.97	0.98	-0.50	0.55	0.00	0.17	1.43	0.10	-0.07	0.88	0.82
	(0.13)	(0.19)		(0.16)	(0.23)		(0.09)	(0.29)		(0.11)	(0.52)	
ITA	0.21	0.51	0.62	0.51	-0.61	0.04	0.26	0.85	0.00	0.33	0.56	0.00
	(0.24)	(0.67)		(0.23)	(0.76)		(0.04)	(0.29)		(0.07)	(0.28)	
GBR	0.17	0.38	0.05	0.26	-0.09	0.11	0.17	1.45	0.00	0.21	1.10	0.07
	(0.12)	(0.25)		(0.17)	(0.53)		(0.04)	(0.31)		(0.24)	(1.15)	
CAN	-0.01	0.77	0.56	0.05	1.19	0.49	0.00	1.11	0.89	-0.05	1.10	0.70
	(0.11)	(0.21)		(0.07)	(0.18)		(0.05)	(0.24)		(0.08)	(0.40)	
AUS	-0.01	0.57	0.00	0.04	0.49	0.00	0.05	0.59	0.00	0.12	0.55	0.00
	(0.05)	(0.08)		(0.06)	(0.11)		(0.02)	(0.15)		(0.03)	(0.19)	
AUT	0.14	0.96	0.26	-0.43	0.47	0.02	0.05	0.45	0.03	-0.08	0.26	0.05
	(0.31)	(0.39)		(0.15)	(0.24)		(0.08)	(0.34)		(0.05)	(0.74)	
BEL	-0.29	0.69	0.32	-0.80	0.23	0.00	0.02	0.96	0.96	-0.25	-0.23	0.14
	(0.22)	(0.23)		(0.21)	(0.26)		(0.12)	(0.43)		(0.14)	(0.68)	
DNK	-0.07	0.62	0.30	-0.05	-0.15	0.04	0.02	1.23	0.43	-0.18	0.75	0.38
	(0.22)	(0.27)		(0.39)	(0.48)		(0.04)	(0.18)		(0.14)	(0.68)	
FIN	0.09	0.87	0.01	0.04	0.69	0.56	0.06	0.69	0.53	-0.08	0.18	0.01
	(0.08)	(0.12)		(0.30)	(0.50)		(0.13)	(0.60)		(0.09)	(0.30)	
GRC	-0.03	0.27	0.19	0.06	-0.12	0.09	0.13	-0.15	0.36	0.02	0.27	0.21
	(0.25)	(0.40)		(0.30)	(0.52)		(0.13)	(0.82)		(0.13)	(0.52)	
IRL	0.37	0.89	0.09	0.73	0.45	0.00	0.21	0.76	0.17	-0.14	-0.03	0.00
	(0.25)	(0.20)		(0.21)	(0.20)		(0.21)	(0.56)		(0.19)	(0.32)	
NLD	0.27	0.89	0.40	0.06	0.77	0.48	0.23	0.81	0.31	-0.38	-0.63	0.05
	(0.30)	(0.18)		(0.43)	(0.26)		(0.26)	(0.52)		(0.35)	(0.71)	
NZL	0.42	0.80	0.03	0.83	-0.01	0.02	0.31	0.86	0.00	0.33	-0.03	0.00
	(0.17)	(0.32)		(0.39)	(1.31)		(0.05)	(0.36)		(0.15)	(0.57)	
NOR	-0.03	0.80	0.88	-0.23	0.25	0.36	-0.07	1.08	0.50	-0.23	0.61	0.07
	(0.21)	(0.40)		(0.32)	(0.54)		(0.09)	(0.52)		(0.13)	(0.71)	
PRT	-0.55	0.76	0.00	-1.78	0.40	0.00	0.12	1.19	0.63	-0.41	-0.18	0.00
	(0.16)	(0.07)		(0.40)	(0.20)		(0.12)	(0.28)		(0.15)	(0.49)	
ESP	0.20	0.52	0.00	0.16	0.42	0.00	0.24	1.21	0.01	0.21	0.81	0.03
	(0.07)	(0.13)		(0.11)	(0.17)		(0.08)	(0.21)		(0.14)	(0.30)	
SWE	-0.21	0.75	0.07	-0.49	0.44	0.00	0.02	1.10	0.99	-0.40	-0.36	0.36
	(0.15)	(0.17)		(0.20)	(0.21)		(0.23)	(0.64)		(0.30)	(1.12)	
CHE	-0.27	0.86	0.78	-1.19	0.50	0.00	0.08	1.09	0.84	-0.30	0.21	0.01
	(0.41)	(0.28)		(0.27)	(0.25)		(0.15)	(0.43)		(0.13)	(0.46)	
All			0.00			0.00			0.00			0.00

Notes: Specification (a): $X_{t|t+1} = \alpha + \beta X_{t|t} + \varepsilon_t$; specification (b): $X_{t|t+1} = \alpha + \beta X_{t|t-1} + \varepsilon_t$, where *X* is the unemployment gap. The sample period is 2001 to 2006 for specification (a) and 2002 to 2006 for specification (b). The columns labelled "Wald" contain the *p*-values of Wald tests of the joint hypothesis *α* = 0 and *β* = 1.

Table 19. **Sign of current-year projection and direction of revision**

	Sign of initial gap	Number of occurrences		Probability that upward and downward revisions are equally likely
		Downward revision	Upward revision	
GAP	-	40	88	0.00
	+	27	32	0.30
	Total	*67*	*120*	*0.00*
UGAP	-	13	28	0.01
	+	12	10	0.42
	Total	*25*	*38*	*0.07*
GAPHP	-	37	55	0.04
	+	46	49	0.42
	Total	*83*	*104*	*0.07*
UGAPHP	-	15	29	0.03
	+	2	17	0.00
	Total	*17*	*46*	*0.00*

Notes: The sign of the current-year projection is compared to the sign of the revision taking place from *t* to *t*+4. The sample period is 1995 to 2003 for GAP and GAPHP and 2001 to 2003 for UGAP and UGAPHP for all countries but New Zealand (1997 to 2003 for GAP and GAPHP).

Table 20. **Sign of 1-year-ahead projection and direction of revision**

	Sign of initial gap	Number of occurrences		Probability that upward and downward revisions are equally likely
		Downward revision	Upward revision	
GAP	-	37	67	0.00
	+	33	29	0.35
	Total	*70*	*96*	*0.03*
UGAP	-	12	10	0.42
	+	17	3	0.00
	Total	*29*	*13*	*0.01*
GAPHP	-	19	27	0.15
	+	83	37	0.00
	Total	*102*	*64*	*0.00*
UGAPHP	-	13	20	0.15
	+	5	4	0.50
	Total	*18*	*24*	*0.22*

Notes: The sign of the 1-year-ahead projection is compared to the sign of the revision taking place from *t*-1 to *t*+4. The sample period is 1996 to 2003 for GAP and GAPHP and 2002 to 2003 for UGAP and UGAPHP for all countries but New Zealand (1998 to 2003 for GAP and GAPHP).

Table 21. **Autocorrelation of revisions**

	Current-year projection								1-year-ahead projection			
	GAP		UGAP		GAPHP		UGAPHP		GAP		GAPHP	
	α	β	α	β	α	β	α	β	α	β	α	β
USA	-0.16	0.15	-0.20	-0.87	-0.20	-0.41	-0.05	0.21	0.04	0.24	0.03	0.18
	(0.19)	(0.26)	(0.05)	(0.29)	(0.12)	(0.32)	(0.07)	(0.57)	(0.46)	(0.32)	(0.27)	(0.34)
JPN	0.22	0.50	0.22	-0.10	0.08	0.03	0.03	0.08	0.60	0.17	-0.46	-0.33
	(0.33)	(0.32)	(0.14)	(0.37)	(0.13)	(0.33)	(0.06)	(0.46)	(0.62)	(0.37)	(0.21)	(0.33)
DEU	0.28	-0.37	0.02	0.17	-0.01	-0.42	-0.08	0.46	-0.11	0.35	-1.06	-0.53
	(0.22)	(0.32)	(0.17)	(0.48)	(0.09)	(0.30)	(0.10)	(0.55)	(0.34)	(0.41)	(0.23)	(0.29)
FRA	0.07	-0.26	0.01	-0.28	0.03	-0.18	0.00	0.49	-0.07	0.53	-0.34	0.07
	(0.12)	(0.26)	(0.14)	(0.59)	(0.09)	(0.32)	(0.10)	(0.41)	(0.28)	(0.31)	(0.18)	(0.26)
ITA	0.34	-0.10	0.22	0.12	0.04	0.07	0.29	-0.14	-0.11	-0.13	-1.01	-0.60
	(0.35)	(0.32)	(0.30)	(0.61)	(0.12)	(0.34)	(0.17)	(0.61)	(0.40)	(0.35)	(0.22)	(0.28)
GBR	0.19	0.29	0.13	0.00	0.09	0.21	-0.09	1.20	0.09	0.30	0.01	0.11
	(0.21)	(0.32)	(0.10)	(0.31)	(0.10)	(0.30)	(0.17)	(1.06)	(0.36)	(0.34)	(0.14)	(0.28)
CAN	0.16	-0.24	0.05	-0.82	-0.04	-0.38	-0.04	-0.29	0.10	-0.14	-0.27	-0.04
	(0.08)	(0.22)	(0.08)	(0.32)	(0.09)	(0.30)	(0.04)	(0.42)	(0.23)	(0.28)	(0.21)	(0.27)
AUS	0.56	-0.37	0.01	0.18	0.22	-0.16	-0.10	1.66	0.46	0.02	-0.05	0.28
	(0.25)	(0.29)	(0.10)	(0.36)	(0.11)	(0.32)	(0.05)	(0.45)	(0.38)	(0.34)	(0.18)	(0.36)
AUT	0.20	0.05	0.20	-0.34	0.15	-0.69	0.03	0.57	-0.04	0.29	-0.57	-0.63
	(0.14)	(0.34)	(0.14)	(0.58)	(0.07)	(0.23)	(0.12)	(0.52)	(0.32)	(0.35)	(0.14)	(0.27)
BEL	0.24	-0.04	-0.12	-0.14	0.11	-0.72	-0.02	0.15	-0.04	-0.01	-0.52	-0.33
	(0.18)	(0.31)	(0.27)	(0.57)	(0.07)	(0.23)	(0.15)	(0.78)	(0.32)	(0.34)	(0.20)	(0.30)
DNK	0.27	-0.08	-0.01	0.13	0.10	0.03	-0.03	-0.05	0.18	0.26	-0.09	0.18
	(0.23)	(0.32)	(0.31)	(0.54)	(0.11)	(0.33)	(0.05)	(0.54)	(0.39)	(0.35)	(0.19)	(0.35)
FIN	0.06	-0.13	0.26	-0.44	0.18	-0.53	-0.07	0.65	-0.11	0.42	-0.09	-0.15
	(0.27)	(0.36)	(0.07)	(0.34)	(0.14)	(0.32)	(0.06)	(0.24)	(0.38)	(0.35)	(0.21)	(0.23)
GRC	0.25	-0.62	-0.03	-0.15	0.05	0.45	-0.03	-0.06	0.23	-0.05	0.00	0.59
	(0.14)	(0.27)	(0.40)	(0.58)	(0.07)	(0.28)	(0.13)	(0.54)	(0.11)	(0.35)	(0.13)	(0.26)
IRL	0.68	-0.23	0.27	0.05	0.28	0.21	-0.03	0.70	0.92	0.07	0.37	0.07
	(0.48)	(0.31)	(0.25)	(0.63)	(0.30)	(0.33)	(0.18)	(0.41)	(0.60)	(0.35)	(0.26)	(0.36)
NLD	0.21	0.31	0.89	-1.16	0.07	-0.78	-0.21	1.10	0.10	0.42	-0.42	-0.21
	(0.25)	(0.33)	(0.18)	(0.26)	(0.07)	(0.22)	(0.37)	(0.73)	(0.52)	(0.39)	(0.23)	(0.34)
NZL	0.46	-0.27	0.56	-0.44	0.11	0.35	0.55	-0.77	0.69	-0.09	0.19	0.60
	(0.32)	(0.36)	(0.17)	(0.40)	(0.19)	(0.37)	(0.18)	(0.55)	(0.40)	(0.30)	(0.20)	(0.25)
NOR	0.31	-0.24	0.02	-0.54	0.04	-0.05	-0.10	0.05	0.46	-0.19	0.08	0.24
	(0.23)	(0.34)	(0.21)	(0.65)	(0.17)	(0.33)	(0.10)	(0.57)	(0.43)	(0.37)	(0.33)	(0.34)
PRT	0.21	0.10	0.04	0.47	0.00	0.25	0.01	0.20	-0.15	0.51	-0.37	0.35
	(0.18)	(0.34)	(0.19)	(0.52)	(0.10)	(0.32)	(0.10)	(0.60)	(0.30)	(0.30)	(0.24)	(0.29)
ESP	0.06	-0.13	0.30	0.02	0.02	0.27	0.18	-0.11	-0.08	0.19	-0.13	0.28
	(0.20)	(0.31)	(0.20)	(0.50)	(0.08)	(0.32)	(0.10)	(0.33)	(0.36)	(0.35)	(0.14)	(0.24)
SWE	-0.10	-0.17	-0.31	-0.30	-0.11	0.00	-0.10	0.63	-0.40	-0.15	-0.41	0.01
	(0.27)	(0.31)	(0.25)	(0.62)	(0.08)	(0.29)	(0.18)	(0.45)	(0.35)	(0.32)	(0.18)	(0.28)
CHE	0.14	-0.07	-0.20	-0.58	-0.09	-0.45	-0.05	0.63	0.08	0.24	-0.59	0.03
	(0.29)	(0.33)	(0.20)	(0.48)	(0.10)	(0.30)	(0.08)	(0.31)	(0.47)	(0.30)	(0.28)	(0.30)
Wald		0.69		0.00		0.00		0.01		0.87		0.06

Notes: The estimated equation is $X_{t|t+1} - X_{t|t} = \alpha + \beta\,(X_{t-1|t} - X_{t-1|t-1}) + \varepsilon_t$ for the current-year projections and $X_{t|t+1} - X_{t|t-1} = \alpha + \beta\,(X_{t-2|t-1} - X_{t-2|t-2}) + \varepsilon_t$ for the 1-year-ahead projections, where X represents the business cycle measure. The numbers in parentheses are the standard errors of the estimated coefficients. The sample period is 1996 to 2006 for the revisions to the current-year projections of GAP and GAPHP, 2002 to 2006 for the revisions to the current-year projections of UGAP and UGAPHP, and 1997 to 2006 for the revisions to the 1-year-ahead projections of GAP and GAPHP. The revisions to the 1-year-ahead projections of UGAP and UGAPHP are not investigated as the sample period would be too small.

Table 22. **Cross-country correlation of revisions**

		Current-year projection							1-year-ahead projection						
		CAN	FRA	DEU	ITA	JPN	GBR	USA	CAN	FRA	DEU	ITA	JPN	GBR	USA
GAP	CAN	1.00*	-0.35	-0.23	-0.40	0.38	0.09	0.47	1.00*	0.73*	0.34	0.03	0.15	0.37	0.53
		(0.00)	(0.30)	(0.31)	(0.29)	(0.29)	(0.31)	(0.28)	(0.00)	(0.23)	(0.31)	(0.33)	(0.33)	(0.31)	(0.28)
	FRA		1.00*	0.51	0.21	-0.27	-0.02	-0.03		1.00*	0.59*	0.01	-0.40	0.57*	0.71*
			(0.00)	(0.29)	(0.33)	(0.32)	(0.33)	(0.33)		(0.00)	(0.27)	(0.33)	(0.31)	(0.27)	(0.23)
	DEU			1.00*	0.41	-0.43	-0.19	0.11			1.00*	0.52	-0.45	0.30	0.59*
				(0.00)	(0.30)	(0.30)	(0.33)	(0.33)			(0.00)	(0.29)	(0.30)	(0.32)	(0.27)
	ITA				1.00*	-0.37	-0.46	-0.60*				1.00*	0.00	0.12	-0.01
					(0.00)	(0.31)	(0.30)	(0.27)				(0.00)	(0.33)	(0.33)	(0.33)
	JPN					1.00*	-0.09	0.01					1.00*	0.12	-0.14
						(0.00)	(0.33)	(0.33)					(0.00)	(0.33)	(0.33)
	GBR						1.00*	0.50						1.00*	0.73*
							(0.00)	(0.29)						(0.00)	(0.23)
	USA							1.00*							1.00*
								(0.00)							(0.00)
UGAP	CAN	1.00*	0.42	0.09	0.16	0.28	0.18	-0.92*	1.00*	0.55	0.00	0.62	0.21	0.29	0.74
		(0.00)	(0.45)	(0.50)	(0.49)	(0.48)	(0.49)	(0.20)	0.00	(0.48)	(0.58)	(0.45)	(0.56)	(0.55)	(0.39)
	FRA		1.00*	0.65	-0.39	-0.10	-0.23	-0.32		1.00*	0.72	0.19	-0.08	-0.26	0.63
			(0.00)	(0.38)	(0.46)	(0.50)	(0.49)	(0.47)		0.00	(0.40)	(0.57)	(0.58)	(0.56)	(0.45)
	DEU			1.00*	-0.72	-0.80	-0.88	-0.15			1.00*	-0.24	-0.48	-0.57	0.41
				(0.00)	(0.34)	(0.30)	(0.23)	(0.49)			0.00	(0.56)	(0.51)	(0.48)	(0.53)
	ITA				1.00*	0.54	0.78	0.09				1.00*	0.85*	0.89*	0.73
					(0.00)	(0.42)	(0.31)	(0.50)				0.00	(0.31)	(0.26)	(0.40)
	JPN					1.00*	0.93	-0.15					1.00*	0.93*	0.30
						(0.00)	(0.18)	(0.49)					0.00	(0.21)	(0.55)
	GBR						1.00*	0.00						1.00*	0.37
							(0.00)	(0.50)						0.00	(0.54)
	USA							1.00*							1.00*
								(0.00)							0.00
GAPHP	CAN	1.00*	0.25	0.24	0.20	0.22	0.17	0.65*	1.00*	0.81*	0.61*	0.40	0.37	0.70*	0.68*
		(0.00)	(0.31)	(0.31)	(0.31)	(0.31)	(0.31)	(0.24)	(0.00)	(0.19)	(0.26)	(0.30)	(0.31)	(0.24)	(0.24)
	FRA		1.00*	0.75*	0.70*	0.06	0.00	0.11		1.00*	0.71*	0.66*	0.32	0.73*	0.45
			(0.00)	(0.21)	(0.23)	(0.32)	(0.32)	(0.31)		(0.00)	(0.24)	(0.25)	(0.32)	(0.23)	(0.30)
	DEU			1.00*	0.58*	0.31	0.07	0.32			1.00*	0.76*	0.46	0.72*	0.68*
				(0.00)	(0.26)	(0.30)	(0.32)	(0.30)			(0.00)	(0.22)	(0.30)	(0.23)	(0.24)
	ITA				1.00*	0.03	-0.26	0.14				1.00*	0.50	0.38	0.22
					(0.00)	(0.32)	(0.31)	(0.31)				(0.00)	(0.29)	(0.31)	(0.32)
	JPN					1.00*	0.51	0.44					1.00*	0.20	0.37
						(0.00)	(0.27)	(0.28)					(0.00)	(0.33)	(0.31)
	GBR						1.00*	0.38						1.00*	0.79*
							(0.00)	(0.29)						(0.00)	(0.20)
	USA							1.00*							1.00*
								(0.00)							(0.00)
UGAPHP	CAN	1.00*	0.42	0.34	0.12	0.75*	0.02	0.69*	1.00*	-0.27	-0.31	-0.02	0.40	-0.54	0.96*
		(0.00)	(0.29)	(0.30)	(0.31)	(0.21)	(0.32)	(0.23)	(0.00)	(0.56)	(0.55)	(0.58)	(0.53)	(0.49)	(0.17)
	FRA		1.00*	0.91*	-0.33	0.85*	0.59*	0.54*		1.00*	0.84*	-0.53	-0.23	0.41	-0.17
			(0.00)	(0.13)	(0.30)	(0.17)	(0.26)	(0.27)		(0.00)	(0.31)	(0.49)	(0.56)	(0.53)	(0.57)
	DEU			1.00*	0.01	0.77*	0.84*	0.30			1.00*	-0.01	0.23	0.55	-0.22
				(0.00)	(0.32)	(0.20)	(0.17)	(0.30)			(0.00)	(0.58)	(0.56)	(0.48)	(0.56)
	ITA				1.00*	-0.06	0.35	-0.59*				1.00*	0.82*	-0.13	-0.15
					(0.00)	(0.32)	(0.30)	(0.26)				(0.00)	(0.33)	(0.57)	(0.57)
	JPN					1.00*	0.38	0.57*					1.00*	-0.24	0.29
						(0.00)	(0.29)	(0.26)					(0.00)	(0.56)	(0.55)
	GBR						1.00*	-0.16						1.00*	-0.28
							(0.00)	(0.31)						(0.00)	(0.55)
	USA							1.00*							1.00*
								(0.00)							(0.00)

Notes: The revision to the current-year (1-year-ahead) projection is the difference between the current-year (1-year-ahead) projection and the outturn estimate at *t*+1. The sample period is 1995 to 2006 (1996 to 2006) for the current-year (1-year-ahead) projections of GAP and GAPHP and 2001 to 2006 (2002 to 2006) for the current-year (1-year-ahead) projections of UGAP and UGAPHP. Standard errors in parentheses. * means significance at the 5% level.

Table 23. **Predicting the final outturn estimate of the production-function-based output gap**

	(a)			(b)			(c)		(d)		(e)		
	α_i	β_i	γ_i	α_i	β_i	γ_i	α_i	β_i	α_i	β_i	α_i	β_i	γ_i
USA	-0.54	0.05	0.73	1.36	-0.02	0.79*	-0.53	0.36	5.65	-0.08	3.32	-0.05	0.34
	(0.35)	(1.60)	(0.57)	(10.23)	(0.13)	(0.28)	(0.32)	(0.26)	(9.71)	(0.12)	(9.64)	(0.12)	(0.29)
JPN	-4.81*	1.68	-1.34	-21.97*	0.18*	-0.98*	-4.36*	2.29*	-19.53	0.21	-18.38*	0.14*	2.00*
	(1.99)	(1.21)	(0.66)	(6.57)	(0.06)	(0.46)	(1.75)	(0.62)	(11.37)	(0.11)	(6.59)	(0.07)	(0.52)
DEU	-0.32	0.98	0.05	16.40	-0.19	0.94	-0.32	0.94	26.04	-0.29	14.38	-0.17	0.66
	(1.40)	(2.41)	(1.25)	(52.64)	(0.60)	(1.62)	(1.25)	(0.98)	(29.09)	(0.34)	(38.00)	(0.43)	(1.27)
FRA	-0.02	0.05	1.02*	-14.94	0.17	0.80*	-0.03	-0.02	-14.33	0.17	-15.63	0.18	0.05
	(0.25)	(0.54)	(0.16)	(10.99)	(0.13)	(0.21)	(0.23)	(0.15)	(9.81)	(0.11)	(11.17)	(0.13)	(0.15)
ITA	1.51	-0.73	0.94	-23.14	0.31	0.63	1.65	0.05	-23.63	0.32	-24.81	0.34	-0.08
	(1.20)	(1.65)	(0.54)	(29.50)	(0.38)	(0.57)	(1.10)	(0.51)	(27.02)	(0.34)	(30.12)	(0.39)	(0.54)
GBR	0.36	0.24	0.36	-1.45	0.02	0.34	0.38	0.58	-11.45	0.15	5.17	-0.06	0.68
	(0.13)	(0.38)	(0.11)	(4.07)	(0.05)	(0.11)	(0.12)	(0.10)	(7.44)	(0.09)	(4.73)	(0.06)	(0.13)
CAN	0.62	0.40	1.10*	-6.41	0.08	1.08*	0.61*	-0.03	-2.75	0.04	-8.39	0.11	-0.16
	(0.31)	(0.66)	(0.22)	(11.53)	(0.14)	(0.22)	(0.30)	(0.20)	(9.48)	(0.11)	(14.18)	(0.17)	(0.29)
Wald		0.88			0.15			0.00		0.16		0.24	0.00

Notes: The numbers in parentheses denote the standard errors of the estimated coefficients. All equations are estimated using least squares. An asterisk denotes significance at the 5% level. The sample period is 1995 to 2003. The row labelled "Wald" shows the *p*-values of Wald tests that the coefficients in the respective column are all equal to zero.

Specification (a): $GAP_{i,t|t+4} = \alpha_i + \beta_i\, GAPHP_{i,t|t} + \gamma_i\, GAP_{i,t|t} + \varepsilon_{i,t}$.

Specification (g): $GAP_{i,t|t+4} = \alpha_i + \beta_i\, CAP_{i,t|t} + \gamma_i\, GAP_{i,t|t} + \varepsilon_{i,t}$.

Specification (c): $GAP_{i,t|t+4} - GAP_{i,t|t} = \alpha_i + \beta_i\, (GAPHP_{i,t|t} - GAP_{i,t|t}) + \varepsilon_{i,t}$.

Specification (d): $GAP_{i,t|t+4} - GAP_{i,t|t} = \alpha_i + \beta_i\, (CAP_{i,t|t} - GAP_{i,t|t}) + \varepsilon_{i,t}$.

Specification (e): $GAP_{i,t|t+4} - GAP_{i,t|t} = \alpha_i + \beta_i\, (CAP_{i,t|t} - GAP_{i,t|t}) + \gamma_i\, (GAPHP_{i,t|t} - GAP_{i,t|t}) + \varepsilon_{i,t}$.

Table 24. **Predicting the initial outturn estimate of the production-function-based output gap and the Kalman-filter-based unemployment gap**

	(a)			(b)			(c)		(d)		(e)			(f)			(g)	
	α_i	β_i	γ_i	α_i	β_i	γ_i	α_i	β_i	α_i	β_i	α_i	β_i	γ_i	α_i	β_i	γ_i	α_i	β_i
USA	-0.26	0.83	0.56*	-6.47	0.08	0.69*	-0.23	0.29	-2.06	0.02	-4.77	0.06	0.32	-0.12	0.10	0.92*	-0.12	0.08
	(0.20)	(0.80)	(0.28)	(6.85)	(0.09)	(0.19)	(0.19)	(0.17)	(6.84)	(0.09)	(6.42)	(0.08)	(0.18)	(0.08)	(0.29)	(0.20)	(0.07)	(0.17)
JPN	-1.36*	2.13*	0.05	-0.66	0.00	0.55*	-1.04*	0.67*	1.21	-0.01	0.15	-0.01	0.67*	-0.44	1.21	0.43	-0.37*	0.48*
	(0.29)	(0.49)	(0.14)	(5.99)	(0.06)	(0.17)	(0.37)	(0.15)	(7.92)	(0.08)	(4.82)	(0.05)	(0.16)	(0.27)	(1.75)	(0.28)	(0.19)	(0.17)
DEU	-0.86*	0.45	0.29	-3.42	0.03	0.39	-0.89*	0.77*	9.04	-0.10	6.10	-0.08	0.76*	0.07	1.46*	0.79*	-0.04	0.16
	(0.41)	(0.71)	(0.30)	(12.82)	(0.15)	(0.29)	(0.39)	(0.25)	(15.53)	(0.18)	(11.76)	(0.14)	(0.26)	(0.33)	(0.68)	(0.30)	(0.45)	(0.40)
FRA	-0.14	0.34	0.77*	4.90	-0.06	0.89*	-0.15	0.22	7.98	-0.09	3.13	-0.04	0.21	-0.01	0.49	0.80*	-0.02	0.13
	(0.18)	(0.38)	(0.12)	(9.41)	(0.11)	(0.17)	(0.17)	(0.11)	(9.74)	(0.11)	(9.37)	(0.11)	(0.12)	(0.14)	(0.67)	(0.31)	(0.13)	(0.26)
ITA	-1.60*	-0.73	0.17	-19.31	0.23	-0.06	-1.04	0.75	-31.87	0.41	-18.46	0.22	0.64	0.32	-1.85	0.16	0.16	0.15
	(0.76)	(0.86)	(0.35)	(21.30)	(0.27)	(0.38)	(0.78)	(0.39)	(25.08)	(0.32)	(25.38)	(0.33)	(0.43)	(0.24)	(1.45)	(0.68)	(0.24)	(0.56)
GBR	0.12	0.09	0.77*	-6.92	0.09	0.79*	0.13	0.21	-8.79	0.11	-7.32	0.09	0.06	0.56*	2.49*	-0.20	0.33*	0.89*
	(0.22)	(0.71)	(0.22)	(7.24)	(0.09)	(0.20)	(0.20)	(0.18)	(6.02)	(0.07)	(8.67)	(0.11)	(0.25)	(0.16)	(0.92)	(0.27)	(0.12)	(0.25)
CAN	0.03	-0.28	0.95*	8.68	-0.10	0.98*	0.07	-0.01	5.75	-0.07	11.24	-0.13	0.15	0.04	0.99	0.41	0.01	0.38
	(0.13)	(0.30)	(0.11)	(5.15)	(0.06)	(0.10)	(0.13)	(0.10)	(4.46)	(0.05)	(6.21)	(0.07)	(0.12)	(0.15)	(2.08)	(0.80)	(0.10)	(0.33)
Wald		0.00			0.59			0.00		0.47		0.60	0.00		0.04			0.00

Notes: The numbers in parentheses denote the standard errors of the estimated coefficients. All equations are estimated using least squares. An asterisk denotes significance at the 5% level. The sample period is 1995 to 2006 for specifications (a) through (e) and 2001 to 2006 for specifications (f) and (g). The row labelled "Wald" shows the *p*-values of Wald tests that the coefficients in the respective column are all equal to zero.

Specification (a): $GAP_{i,t|t+1} = \alpha_i + \beta_i\, GAPHP_{i,t|t} + \gamma_i\, GAP_{i,t|t} + \varepsilon_{i,t}$.

Specification (b): $GAP_{i,t|t+1} - GAP_{i,t|t} = \alpha_i + \beta_i\, (GAPHP_{i,t|t} - GAP_{i,t|t}) + \varepsilon_{i,t}$.

Specification (c): $GAP_{i,t|t+1} = \alpha_i + \beta_i\, CAP_{i,t|t} + \gamma_i\, GAP_{i,t|t} + \varepsilon_{i,t}$.

Specification (d): $GAP_{i,t|t+1} - GAP_{i,t|t} = \alpha_i + \beta_i\, (CAP_{i,t|t} - GAP_{i,t|t}) + \varepsilon_{i,t}$.

Specification (e): $GAP_{i,t|t+1} - GAP_{i,t|t} = \alpha_i + \beta_i\, (CAP_{i,t|t} - GAP_{i,t|t}) + \gamma_i\, (GAPHP_{i,t|t} - GAP_{i,t|t}) + \varepsilon_{i,t}$.

Specification (f): $UGAP_{i,t|t+1} = \alpha_i + \beta_i\, UGAPHP_{i,t|t+1} + \gamma_i\, UGAP_{i,t|t} + \varepsilon_{i,t}$.

Specification (g): $UGAP_{i,t|t+1} - UGAP_{i,t|t} = \alpha_i + \beta_i\, (UGAPHP_{i,t|t} - UGAP_{i,t|t}) + \varepsilon_{i,t}$.

Table 25. **Relationship between business cycle measures, pooled regression results**

	(a)	(b)	(c)	(d)
GAP	0.672	0.666	0.688	0.758
	(0.000)	(0.000)	(0.000)	(0.000)
GAPHP	0.098	0.348	0.314	0.242
	(0.698)	(0.000)	(0.000)	(0.000)
CAP	0.004	-0.015	-0.002	
	(0.921)	(0.653)	(0.051)	
Fixed effects	Yes	Yes	No	No

Notes: The sample period is 1995 to 2006. The numbers in parentheses denote the *p*-values of *t*-tests against zero.
Specification (a): $GAP_{i,t|t+1} = \alpha_i + \beta\ GAP_{i,t|t} + \gamma\ GAPHP_{i,t|t+1} + \delta\ CAP_{i,t|t} + \varepsilon_{i,t}$.
Specification (b): $GAP_{i,t|t+1} = \alpha_i + \beta\ GAP_{i,t|t} + \gamma\ GAPHP_{i,t|t+1} + (1 - \beta - \gamma)\ CAP_{i,t|t} + \varepsilon_{i,t}$.
Specification (c): $GAP_{i,t|t+1} = \beta\ GAP_{i,t|t} + \gamma\ GAPHP_{i,t|t+1} + (1 - \beta - \gamma)\ CAP_{i,t|t} + \varepsilon_{i,t}$.
Specification (d): $GAP_{i,t|t+1} = \beta\ GAP_{i,t|t} + (1 - \beta)\ GAPHP_{i,t|t} + \varepsilon_{i,t}$.

Table 26. **Identifying cyclical turning points**

		Year of decision	
		t	*t*+1
No turning point in year *t*	Correct decision	95	122
	Incorrect decision	112	67
	Probability that observed frequencies are random	0.134	0.000
Turning point in year *t*	Correct decision	19	25
	Incorrect decision	24	16
	Probability that observed frequencies are random	0.271	0.106

Notes: A decision is defined as correct if the sign of the change in the gap in year *t and t*+1 is correctly identified. EO81 data are used as reference for comparison. The sample period is 1995 to 2006 if the decision is made in year *t* and 1995 to 2005 if the decision is made in year *t*+1 for all countries except for New Zealand, where the sample period starts in 1996.

Table 27. **Mean absolute revision of output gap estimates**

	1-year-ahead prediction (*t*-1)	Current-year prediction (*t*)	Initial outturn estimate (*t*+1)
No turning point in year *t*	1.081	1.048	0.975
Turning point in year *t*	1.661	1.156	1.125

Notes: Years with/without a turning point are based on EO81 data. The size of the revision is calculated with respect to the outturn estimate at *t*+ 4. The sample period is 1995 to 2003 for all countries except for New Zealand, where the sample period starts in 1996.

Table 28. **Phillips curve estimates -- GAP**

	α_i	β_{1i}	β_{2i}	β_{3i}	γ_{0i}	γ_{2i}	γ_{3i}	γ_{4i}	δ_{0i}	θ_i
	1980-94									
USA	0.413 (0.000)	-0.407 (0.000)	-0.251 (0.000)	-0.199 (0.000)	0.372 (0.000)				0.760 (0.000)	0.0006 (0.0000)
JPN	0.653 (0.000)	-0.207 (0.000)		-0.084 (0.033)		0.156 (0.000)				0.0006 (0.0000)
DEU	0.653 (0.000)	-0.207 (0.000)	-0.242 (0.000)	-0.084 (0.033)	0.372 (0.000)		0.410 (0.001)	-0.274 (0.000)	0.297 (0.000)	0.0008 (0.0000)
FRA	0.162 (0.000)	-0.407 (0.000)	-0.242 (0.000)	-0.084 (0.033)	0.372 (0.000)	0.156 (0.000)		-0.274 (0.000)		0.0006 (0.0000)
ITA	0.162 (0.000)	-0.407 (0.000)	-0.242 (0.000)	-0.199 (0.000)	0.372 (0.000)					0.0008 (0.0000)
GBR	0.653 (0.000)	-0.407 (0.000)	-0.251 (0.000)	-0.199 (0.000)		0.156 (0.000)				0.0014 (0.0000)
CAN	0.413 (0.000)	-0.207 (0.000)		-0.084 (0.033)		0.156 (0.000)			0.297 (0.000)	0.0008 (0.0000)
	1995-2006									
USA	0.731 (0.000)	-0.219 0.002	-0.251 (0.000)		0.372 (0.000)				0.760 (0.000)	0.0003 (0.0004)
JPN	0.653 (0.000)	-0.207 (0.000)				0.156 (0.000)				0.0003 (0.0004)
DEU	0.653 (0.000)	-0.207 (0.000)	-0.242 (0.000)		0.372 (0.000)		0.410 (0.001)	-0.274 (0.000)	0.297 (0.000)	0.0005 (0.0001)
FRA	0.419 (0.000)	-0.219 (0.002)	-0.242 (0.000)		0.372 (0.000)	0.156 (0.000)		-0.274 (0.000)	0.309 (0.004)	0.0003 (0.0004)
ITA	0.419 (0.000)	-0.219 (0.002)	-0.242 (0.000)		0.372 (0.000)					0.0005 (0.0000)
GBR	0.653 (0.000)	-0.219 (0.002)	-0.251 0.000			0.156 (0.000)			0.309 (0.004)	0.0003 (0.0004)
CAN	0.731 (0.000)	-0.207 (0.000)				0.156 (0.000)			0.297 (0.000)	0.0005 (0.0000)

Notes: The parameters γ_{1i} and δ_{1i} through δ_{4i} were not significant for any country in either subsample. The numbers in parenthesis are the *p*-values of exclusion restrictions on the coefficients. The estimated system of equations is:

$$\Delta\pi_{it} = (\alpha_i + \varphi_i D)\pi_{it}^{5Y} - (\alpha_i + \varphi_i D)\pi_{it-1} + \sum_{j=1}^{3}(\beta_{ji} + \rho_{ji} D)\Delta\pi_{it-j} + \sum_{j=0}^{4}(\gamma_{ji} + \psi_{ji} D) MGS_{it-j}^{SH}\left(\pi_{it-j}^{MGS} - \pi_{it-j}^{ULC}\right)$$
$$+ \sum_{j=0}^{4}(\delta_{ji} + \omega_{ji} D) MNW_{it-j}^{SH}\left(\pi_{it-j}^{MNW} - \pi_{it-j}^{ULC}\right) + (\theta_i + \nu_i D) GAP_{it-1}$$

Table 29. **Phillips curve estimates -- UGAP**

	α_i	β_{1i}	β_{2i}	β_{3i}	γ_{0i}	γ_{2i}	γ_{3i}	γ_{4i}	δ_{0i}	θ_i
					1980-94					
USA	0.465 (0.000)	-0.387 (0.000)	-0.201 (0.000)	-0.172 (0.000)	0.365 (0.000)				0.774 (0.000)	0.0009 (0.0000)
JPN	0.671 (0.000)	-0.211 (0.000)		-0.084 (0.032)		0.186 (0.000)				0.0009 (0.0000)
DEU	0.671 (0.000)	-0.211 (0.000)	-0.231 (0.000)	-0.084 (0.032)	0.365 (0.000)		0.468 (0.000)	-0.263 (0.000)	0.289 (0.000)	0.0012 (0.0000)
FRA	0.156 (0.001)	-0.387 (0.000)	-0.231 (0.000)	-0.084 (0.032)	0.365 (0.000)	0.186 (0.000)		-0.263 (0.000)		0.0009 (0.0000)
ITA	0.156 (0.001)	-0.387 (0.000)	-0.231 (0.000)	-0.172 (0.000)	0.365 (0.000)					0.0012 (0.0000)
GBR	0.671 (0.000)	-0.387 (0.000)	-0.201 (0.000)	-0.172 (0.000)		0.186 (0.000)				0.0015 (0.0000)
CAN	0.465 (0.000)	-0.211 (0.000)		-0.084 (0.032)		0.186 (0.000)			0.289 (0.000)	0.0012 (0.0000)
					1995-2006					
USA	0.697 (0.000)	-0.189 (0.008)	-0.201 (0.000)		0.365 (0.000)				0.774 (0.000)	0.0007 (0.0000)
JPN	0.671 (0.000)	-0.211 (0.000)				0.186 (0.000)				0.0007 (0.0000)
DEU	0.671 (0.000)	-0.211 (0.000)	-0.231 (0.000)		0.365 (0.000)		0.468 (0.000)	-0.263 (0.000)	0.289 (0.000)	0.0010 (0.0000)
FRA	0.464 (0.000)	-0.189 (0.008)	-0.231 (0.000)		0.365 (0.000)	0.186 (0.000)		-0.263 (0.000)	0.302 (0.005)	0.0007 (0.0000)
ITA	0.464 (0.000)	-0.189 (0.008)	-0.231 (0.000)		0.365 (0.000)					0.0010 (0.0000)
GBR	0.671 (0.000)	-0.189 (0.008)	-0.201 (0.000)			0.186 (0.000)			0.302 (0.005)	0.0007 (0.0000)
CAN	0.697 (0.000)	-0.211 (0.000)				0.186 (0.000)			0.289 (0.000)	0.0010 (0.0000)

Notes: The parameters γ_{1i} and δ_{1i} through δ_{4i} were not significant for any country in either subsample. The numbers in parenthesis are the *p*-values of exclusion restrictions on the coefficients. The estimated system of equations is:

$$\Delta\pi_{it} = (\alpha_i + \varphi_i D)\pi_{it}^{5Y} - (\alpha_i + \varphi_i D)\pi_{it-1} + \sum_{j=1}^{3}(\beta_{ji} + \rho_{ji} D)\Delta\pi_{it-j} + \sum_{j=0}^{4}(\gamma_{ji} + \psi_{ji} D) MGS_{it-j}^{SH}\left(\pi_{it-j}^{MGS} - \pi_{it-j}^{ULC}\right)$$
$$+ \sum_{j=0}^{4}(\delta_{ji} + \omega_{ji} D) MNW_{it-j}^{SH}\left(\pi_{it-j}^{MNW} - \pi_{it-j}^{ULC}\right) + (\theta_i + \nu_i D) UGAP_{it-1}$$

Table 30. **Phillips curve estimates -- GAPHP**

	α_i	β_{1i}	β_{2i}	β_{3i}	γ_{0i}	γ_{2i}	γ_{3i}	γ_{4i}	δ_{0i}	θ_i
					1980-94					
USA	0.323	-0.445	-0.281	-0.225	0.391				0.747	0.0007
	(0.204)	(0.000)	(0.000)	(0.000)	(0.000)				(0.000)	(0.0000)
JPN	0.459	-0.244		-0.094		0.148				0.0007
	(0.000)	(0.000)		(0.021)		(0.000)				(0.0000)
DEU	0.459	-0.244	-0.263	-0.094	0.391		0.460	-0.272	0.314	0.0007
	(0.000)	(0.000)	(0.000)	(0.021)	(0.000)		(0.000)	(0.000)	(0.000)	(0.0000)
FRA	0.059	-0.445	-0.263	-0.094	0.391	0.148		-0.272		0.0007
	(0.000)	(0.000)	(0.000)	(0.021)	(0.000)	(0.000)		(0.000)		(0.0000)
ITA	0.059	-0.445	-0.263	-0.225	0.391					0.0007
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)					(0.0000)
GBR	0.459	-0.445	-0.281	-0.225		0.148				0.0022
	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)				(0.0000)
CAN	0.323	-0.244		-0.094		0.148			0.314	0.0007
	(0.204)	(0.000)		(0.021)		(0.000)			(0.000)	(0.0000)
					1995-2006					
USA	0.690	-0.256	-0.281		0.391				0.747	0.0005
	(0.000)	(0.001)	(0.000)		(0.000)				(0.000)	(0.0000)
JPN	0.582	-0.244				0.148				0.0005
	(0.000)	(0.000)				(0.000)				(0.0000)
DEU	0.582	-0.244	-0.263		0.391		0.460	-0.272	0.314	0.0005
	(0.000)	(0.000)	(0.000)		(0.000)		(0.000)	(0.000)	(0.000)	(0.0000)
FRA	0.375	-0.256	-0.263		0.391	0.148		-0.272	0.311	0.0005
	(0.001)	(0.001)	(0.000)		(0.000)	(0.000)		(0.000)	(0.004)	(0.0000)
ITA	0.375	-0.256	-0.263		0.391					0.0005
	(0.001)	(0.001)	(0.000)		(0.000)					(0.0000)
GBR	0.582	-0.256	-0.281			0.148			0.311	0.0005
	(0.000)	(0.001)	(0.000)			(0.000)			(0.004)	(0.0000)
CAN	0.690	-0.244				0.148			0.314	0.0005
	(0.000)	(0.000)				(0.000)			(0.000)	(0.0000)

Notes: The parameters γ_{1i} and δ_{1i} through δ_{4i} were not significant for any country in either subsample. The numbers in parenthesis are the *p*-values of exclusion restrictions on the coefficients. The estimated system of equations is:

$$\Delta\pi_{it} = (\alpha_i + \varphi_i D)\pi_{it}^{5Y} - (\alpha_i + \varphi_i D)\pi_{it-1} + \sum_{j=1}^{3}(\beta_{ji} + \rho_{ji} D)\Delta\pi_{it-j} + \sum_{j=0}^{4}(\gamma_{ji} + \psi_{ji} D) MGS_{it-j}^{SH}\left(\pi_{it-j}^{MGS} - \pi_{it-j}^{ULC}\right)$$

$$+ \sum_{j=0}^{4}(\delta_{ji} + \omega_{ji} D) MNW_{it-j}^{SH}\left(\pi_{it-j}^{MNW} - \pi_{it-j}^{ULC}\right) + (\theta_i + \nu_i D) GAPHP_{it-1}$$

Table 31. **Phillips curve estimates -- UGAPHP**

	α_i	β_{1i}	β_{2i}	β_{3i}	γ_{0i}	γ_{2i}	γ_{3i}	γ_{4i}	δ_{0i}	θ_i
					1980-94					
USA	0.374	-0.413	-0.235	-0.204	0.368				0.770	0.0014
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)				(0.000)	(0.0000)
JPN	0.546	-0.267		-0.096		0.208				0.0014
	(0.000)	(0.000)		(0.018)		(0.000)				(0.0000)
DEU	0.546	-0.267	-0.259	-0.096	0.368		0.490	-0.270	0.294	0.0019
	(0.000)	(0.000)	(0.000)	(0.018)	(0.000)		(0.000)	(0.000)	(0.000)	(0.0000)
FRA	0.070	-0.413	-0.259	-0.096	0.368	0.208		-0.270		0.0014
	(0.134)	(0.000)	(0.000)	(0.018)	(0.000)	(0.000)		(0.000)		(0.0000)
ITA	0.070	-0.413	-0.259	-0.204	0.368					0.0019
	(0.134)	(0.000)	(0.000)	(0.000)	(0.000)					(0.0000)
GBR	0.546	-0.413	-0.235	-0.204		0.208				0.0034
	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)				(0.0000)
CAN	0.374	-0.267		-0.096		0.208			0.294	0.0019
	(0.000)	(0.000)		(0.018)		(0.000)			(0.000)	(0.0000)
					1995-2006					
USA	0.665	-0.235	-0.235		0.368				0.770	0.0007
	(0.000)	(0.002)	(0.000)		(0.000)				(0.000)	(0.0265)
JPN	0.546	-0.267				0.208				0.0007
	(0.000)	(0.000)				(0.000)				(0.0265)
DEU	0.546	-0.267	-0.259		0.368		0.490	-0.270	0.294	0.0012
	(0.000)	(0.000)	(0.000)		(0.000)		(0.000)	(0.000)	(0.000)	(0.0005)
FRA	0.365	-0.235	-0.259		0.368	0.208		-0.270	0.305	0.0007
	(0.001)	(0.002)	(0.000)		(0.000)	(0.000)		(0.000)	(0.006)	(0.0265)
ITA	0.365	-0.235	-0.259		0.368					0.0012
	(0.001)	(0.002)	(0.000)		(0.000)					(0.0005)
GBR	0.546	-0.235	-0.235			0.208			0.305	0.0007
	(0.000)	(0.002)	(0.000)			(0.000)			(0.006)	(0.0265)
CAN	0.665	-0.267				0.208			0.294	0.0012
	(0.000)	(0.000)				(0.000)			(0.000)	(0.0005)

Notes: The parameters γ_{1i} and δ_{1i} through δ_{4i} were not significant for any country in either subsample. The numbers in parenthesis are the *p*-values of exclusion restrictions on the coefficients. The estimated system of equations is

$$\Delta\pi_{it} = (\alpha_i + \varphi_i D)\pi_{it}^{5Y} - (\alpha_i + \varphi_i D)\pi_{it-1} + \sum_{j=1}^{3}(\beta_{ji} + \rho_{ji} D)\Delta\pi_{it-j} + \sum_{j=0}^{4}(\gamma_{ji} + \psi_{ji} D)MGS_{it-j}^{SH}\left(\pi_{it-j}^{MGS} - \pi_{it-j}^{ULC}\right)$$

$$+ \sum_{j=0}^{4}(\delta_{ji} + \omega_{ji} D)MNW_{it-j}^{SH}\left(\pi_{it-j}^{MNW} - \pi_{it-j}^{ULC}\right) + (\theta_i + \nu_i D)UGAPHP_{it-1}$$

Table 32. **Phillips curve estimates -- CAP**

	α_i	β_{1i}	β_{2i}	β_{3i}	γ_{0i}	γ_{2i}	γ_{3i}	γ_{4i}	δ_{0i}	θ_i
					1980-94					
USA	0.231	-0.484	-0.264	-0.194	0.382				0.762	0.0001
	(0.880)	(0.003)	(0.000)	(0.000)	(0.000)				(0.000)	(0.0032)
JPN	0.375	-0.316		-0.119		0.148				0.0001
	(0.000)	(0.000)		(0.004)		(0.001)				(0.0032)
DEU	0.375	-0.316	-0.309	-0.119	0.382		0.431	-0.272	0.302	0.0003
	(0.000)	(0.000)	(0.000)	(0.004)	(0.000)		(0.001)	(0.000)	(0.000)	(0.0000)
FRA	0.012	-0.484	-0.309	-0.119	0.382	0.148		-0.272		0.0001
	(0.000)	(0.003)	(0.000)	(0.004)	(0.000)	(0.001)		(0.000)		(0.0032)
ITA	0.012	-0.484	-0.309	-0.194	0.382					0.0003
	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)					(0.0000)
GBR	0.375	-0.484	-0.264	-0.194		0.148				0.0003
	(0.000)	(0.003)	(0.000)	(0.000)		(0.001)				(0.0000)
CAN	0.231	-0.316		-0.119		0.148			0.302	0.0003
	(0.880)	(0.000)		(0.004)		(0.001)			(0.000)	(0.0000)
					1995-2006					
USA	0.592	-0.293	-0.264		0.382				0.762	0.0001
	(0.000)	(0.000)	(0.000)		(0.000)				(0.000)	(0.0002)
JPN	0.489	-0.316				0.148				0.0001
	(0.000)	(0.000)				(0.001)				(0.0002)
DEU	0.489	-0.316	-0.309		0.382		0.431	-0.272	0.302	0.0001
	(0.000)	(0.000)	(0.000)		(0.000)		(0.001)	(0.000)	(0.000)	(0.0002)
FRA	0.297	-0.293	-0.309		0.382	0.148		-0.272	0.304	0.0001
	(0.005)	(0.000)	(0.000)		(0.000)	(0.001)		(0.000)	(0.006)	(0.0002)
ITA	0.297	-0.293	-0.309		0.382					0.0001
	(0.005)	(0.000)	(0.000)		(0.000)					(0.0002)
GBR	0.489	-0.293	-0.264			0.148			0.304	0.0001
	(0.000)	(0.000)	(0.000)			(0.001)			(0.006)	(0.0002)
CAN	0.592	-0.316				0.148			0.302	0.0001
	(0.000)	(0.000)				(0.001)			(0.000)	(0.0002)

Notes: The parameters γ_{1i} and δ_{1i} through δ_{4i} were not significant for any country in either subsample. The numbers in parenthesis are the *p*-values of exclusion restrictions on the coefficients. The estimated system of equations is:

$$\Delta\pi_{it} = (\alpha_i + \varphi_i D)\pi_{it}^{5Y} - (\alpha_i + \varphi_i D)\pi_{it-1} + \sum_{j=1}^{3}(\beta_{ji} + \rho_{ji} D)\Delta\pi_{it-j} + \sum_{j=0}^{4}(\gamma_{ji} + \psi_{ji} D) MGS_{it-j}^{SH}\left(\pi_{it-j}^{MGS} - \pi_{it-j}^{ULC}\right)$$

$$+ \sum_{j=0}^{4}(\delta_{ji} + \omega_{ji} D) MNW_{it-j}^{SH}\left(\pi_{it-j}^{MNW} - \pi_{it-j}^{ULC}\right) + (\theta_i + \nu_i D) CAP_{it-1}$$

Table 33. **Inflationary impact of a rise in the gap (deviation from baseline)**

Annual inflation in per cent

	USA	JPN	DEU	FRA	ITA	GBR	CAN
	1980-94						
GAP	0.31	0.30	0.39	0.39	0.55	0.66	0.52
UGAP	0.47	0.45	0.58	0.60	0.82	0.72	0.74
GAPHP	0.39	0.41	0.38	0.49	0.49	1.15	0.47
UGAPHP	0.78	0.76	0.96	0.99	1.34	1.76	1.22
CAP	0.06	0.06	0.19	0.07	0.24	0.18	0.23
	1995-2006						
GAP	0.14	0.16	0.26	0.18	0.32	0.15	0.27
UGAP	0.33	0.34	0.48	0.38	0.58	0.33	0.50
GAPHP	0.25	0.28	0.27	0.31	0.32	0.27	0.26
UGAPHP	0.35	0.39	0.62	0.43	0.74	0.38	0.61
CAP	0.03	0.04	0.04	0.04	0.04	0.04	0.04

Notes: The simulation exercise assumes that the business cycle measure rises by 1 percentage point for four consecutive quarters.

Table 34. **Phillips curve estimates -- GAP components**

	α_i	β_{1i}	β_{2i}	β_{3i}	γ_{0i}	γ_{2i}	γ_{3i}	γ_{4i}	δ_{0i}	κ_i	η_i	σ_i	ζ_i
							1980-94						
United States	0.576	-0.327	-0.192	-0.161	0.363				0.762	0.014	0.162		0.095
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)				(0.000)	(0.012)	(0.000)		(0.000)
Japan	0.784	-0.157		-0.086		0.216				0.014		0.102	0.095
	(0.000)	(0.000)		(0.026)		(0.000)				(0.012)		(0.000)	(0.000)
Germany	0.784	-0.157	-0.205	-0.086	0.363		0.559	-0.240	0.324	0.014	0.162		0.095
	(0.000)	(0.000)	(0.000)	(0.026)	(0.000)		(0.000)	(0.001)	(0.000)	(0.012)	(0.000)		(0.000)
France	0.262	-0.327	-0.205	-0.086	0.363	0.216		-0.240		0.014		0.102	0.095
	(0.000)	(0.000)	(0.000)	(0.026)	(0.000)	(0.000)		(0.001)		(0.012)		(0.000)	(0.000)
Italy	0.262	-0.327	-0.205	-0.161	0.363					0.014		0.102	0.095
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)					(0.012)		(0.000)	(0.000)
United Kingdom	0.784	-0.327	-0.192	-0.161		0.216				0.014	0.162	0.102	0.095
	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)				(0.012)	(0.000)	(0.000)	(0.000)
Canada	0.576	-0.157		-0.086		0.216			0.324	0.014	0.162		0.095
	(0.000)	(0.000)		(0.026)		(0.000)			(0.000)	(0.012)	(0.000)		(0.000)
							1995 – 2006						
United States	0.755	-0.149	-0.192		0.363				0.762	0.014			0.058
	(0.000)	(0.034)	(0.000)		(0.000)				(0.000)	(0.012)			(0.000)
Japan	0.784	-0.157				0.216				0.014			0.058
	(0.000)	(0.000)				(0.000)				(0.012)			(0.000)
Germany	0.784	-0.157	-0.205		0.363		0.559	-0.240	0.324	0.014			0.058
	(0.000)	(0.000)	(0.000)		(0.000)		(0.000)	(0.001)	(0.000)	(0.012)			(0.000)
France	0.509	-0.149	-0.205		0.363	0.216		-0.240	0.320	0.014			0.058
	(0.000)	(0.034)	(0.000)		(0.000)	(0.000)		(0.001)	(0.004)	(0.012)			(0.000)
Italy	0.509	-0.149	-0.205		0.363					0.014			0.058
	(0.000)	(0.034)	(0.000)		(0.000)					(0.012)			(0.000)
United Kingdom	0.784	-0.149	-0.192			0.216			0.320	0.014			0.058
	(0.000)	0.034	(0.000)			(0.000)			(0.004)	(0.012)			(0.000)
Canada	0.755	-0.157				0.216			0.324	0.014			0.058
	(0.000)	(0.000)				(0.000)			(0.000)	(0.012)			(0.000)

Notes: The parameters γ_{1i} and δ_{1i} through δ_{4i} were not significant for any country in either subsample. The numbers in parenthesis are the *p*-values of exclusion restrictions on the coefficients. The estimated system of equations equation is:

$$\Delta\pi_{it} = (\alpha_i + \varphi_i D)\pi_{it}^{5Y} - (\alpha_i + \varphi_i D)\pi_{it-1} + \sum_{j=1}^{3}(\beta_{ji} + \rho_{ji} D)\Delta\pi_{it-j} + \sum_{j=0}^{4}(\gamma_{ji} + \psi_{ji} D)MGS_{it-j}^{SH}\left(\pi_{it-j}^{MGS} - \pi_{it-j}^{ULC}\right) + \sum_{j=0}^{4}(\delta_{ji} + \omega_{ji} D)MNW_{it-j}^{SH}\left(\pi_{it-j}^{MNW} - \pi_{it-j}^{ULC}\right)$$

$$+ (\kappa_i + \vartheta_i D)\ln\left(\frac{TFP_{it-1}}{TFPTR_{it-1}}\right) + (\eta_i + \mu_i D)\ln\left(\frac{LFPR_{it-1}}{LFPRTR_{it-1}}\right) + (\sigma_i + \tau_i D)\ln\left(\frac{HRS_{it-1}}{HRS_{it-1}}\right) + (\zeta_i + \xi_i D)\ln\left(\frac{1 - UNR_{it-1}/100}{1 - NAIRU_{it-1}/100}\right).$$

Table 35. **Accuracy of inflation forecasts (Root Mean Squared Error)**

		CAN	DEU	FRA	GBR	ITA	JPN	USA
Model	Data	1-year-ahead forecast						
Phillips-curve model with GAP	RT	0.45	0.78	0.62	0.74	0.60	0.73	0.85
	RT/EO81	0.42	0.62	0.42	0.72	0.53	0.69	0.54
	EO81	0.47	0.62	0.38	0.47	0.54	0.54	0.50
Phillips-curve model with UGAP	RT	0.59	0.84	0.52	0.60	0.59	0.83	0.89
	RT/EO81	0.57	0.71	0.37	0.56	1.00	0.77	0.55
	EO81	0.62	0.74	0.41	0.46	0.68	0.54	0.55
Phillips-curve model with CAP	RT	0.50	0.71	0.38	0.78	0.48	0.87	0.90
	RT/EO81	0.49	0.78	0.34	0.75	0.75	0.83	0.59
	EO81	0.56	1.00	0.62	0.52	0.86	0.46	0.56
Inflation model	RT	0.51	0.75	0.40	0.81	0.45	0.62	0.80
	RT/EO81	0.50	0.82	0.35	0.78	0.66	0.60	0.51
	EO81	0.59	1.06	0.61	0.58	0.77	0.33	0.51
AR-process	RT	0.69	0.77	0.34	0.87	0.54	0.79	1.13
EO projections	RT	0.31	0.60	0.35	0.36	0.45	0.46	0.89
		2-year-ahead forecast						
Phillips-curve model with GAP	RT	0.27	0.87	0.90	1.03	0.75	0.84	1.04
	RT/EO81	0.29	0.36	0.43	0.98	0.34	0.67	0.44
	EO81	0.50	0.54	0.53	0.52	0.23	0.55	0.42
Phillips-curve model with UGAP	RT	0.47	0.99	0.62	0.86	0.49	1.05	1.18
	RT/EO81	0.56	0.51	0.40	0.77	1.10	0.75	0.42
	EO81	0.47	0.46	0.44	0.38	0.71	0.51	0.46
Phillips-curve model with CAP	RT	0.39	0.25	0.46	1.11	0.44	1.06	1.09
	RT/EO81	0.61	0.97	0.67	0.97	0.94	0.78	0.44
	EO81	0.54	1.45	1.08	0.59	1.13	0.33	0.48
Inflation model	RT	0.27	0.31	0.47	1.11	0.39	0.67	0.95
	RT/EO81	0.30	0.96	0.66	0.96	0.77	0.46	0.41
	EO81	0.31	1.57	1.02	0.61	0.98	0.19	0.44
AR-process	RT	0.75	0.45	0.59	1.07	0.53	0.78	1.19
EO projections	RT	0.57	0.68	0.78	0.40	0.33	0.54	1.27

Notes: Forecast accuracy is judged against the inflation data published in the spring-2007 issue of the *OECD Economic Outlook*. In the RT specifications both the estimation and the forecast are based on real time data. In the RT/EO81 specifications the estimation is based on real time data whereas the forecasts of the RHS-variables are based on the growth rates published in EO81. The EO81 specifications use data from EO81 for both the estimation and the forecast.

Table 36. **Revisions to estimates of the CABB and CAPB**

Per cent of GDP

	t vs. *t*+4		*t*+1 vs. *t*+4		*t* vs. *t*+4		*t*+1 vs. *t*+4	
	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean
	Revisions to the level of the CABB				Revisions to the change of the CABB			
USA	2.55	0.92	0.85	0.54	1.87	0.88	0.72	0.32
JPN	3.06	1.03	1.59	0.88	1.65	0.91	1.20	0.56
DEU	2.37	1.04	1.41	0.75	0.71	0.34	0.68	0.25
FRA	1.43	0.63	0.83	0.31	1.18	0.41	0.65	0.23
ITA	3.26	1.52	2.84	1.23	1.36	0.60	1.77	0.55
GBR	2.21	1.07	1.09	0.58	1.34	0.65	0.73	0.31
CAN	1.62	0.93	1.71	1.09	1.45	0.84	1.08	0.43
AUS	1.49	0.51	1.34	0.58	2.50	0.82	1.98	0.70
AUT	1.01	0.54	1.00	0.51	1.47	0.58	0.80	0.41
BEL	1.29	0.72	1.56	0.51	1.25	0.65	1.01	0.47
DNK	1.95	0.97	1.62	0.65	0.94	0.41	0.78	0.42
FIN	3.35	1.41	2.12	0.71	2.68	0.78	2.63	0.79
GRC	5.26	2.37	3.83	1.37	1.27	0.72	0.94	0.52
IRL	3.35	1.74	1.38	0.63	2.94	1.22	1.44	0.71
NLD	3.45	1.67	2.11	1.19	1.16	0.72	0.78	0.36
NZL	4.24	1.74	3.55	1.23	1.19	0.61	0.85	0.52
NOR	2.66	1.53	2.44	1.01	1.60	0.94	1.78	0.92
PRT	3.87	1.41	2.48	1.14	1.57	0.73	1.36	0.49
ESP	0.71	0.35	1.25	0.50	1.05	0.50	0.92	0.32
SWE	3.22	1.68	2.80	0.96	2.27	0.93	3.30	0.78
	Revisions to the level of the CAPB				Revisions to the change of the CAPB			
USA	0.71	0.47	2.46	1.22	0.59	0.28	1.84	0.81
JPN	1.42	0.75	2.72	0.96	1.23	0.51	1.61	0.82
DEU	1.37	0.76	2.76	1.11	0.76	0.29	0.89	0.30
FRA	0.78	0.38	1.71	0.77	0.72	0.25	1.17	0.42
ITA	2.78	1.58	4.00	1.87	1.70	0.50	1.05	0.32
GBR	0.86	0.53	1.95	0.96	0.72	0.29	1.30	0.69
CAN	2.05	1.24	2.15	1.37	0.89	0.48	1.51	0.56
AUS	1.27	0.57	1.35	0.67	2.02	0.61	2.67	0.73
AUT	1.47	0.70	1.20	0.72	1.29	0.66	1.40	0.62
BEL	1.62	0.59	1.09	0.69	0.90	0.38	1.03	0.61
DNK	1.42	0.53	1.75	0.77	0.88	0.39	1.05	0.44
FIN	2.18	0.67	3.15	1.32	2.45	0.74	2.48	0.71
GRC	3.30	1.67	5.35	2.43	2.02	0.70	1.43	0.64
IRL	1.31	0.49	3.10	1.49	1.01	0.67	3.64	1.26
NLD	2.56	1.28	3.41	1.73	1.08	0.40	1.10	0.58
NZL	3.19	1.43	3.86	1.74	1.77	0.75	1.20	0.73
NOR	5.88	1.90	6.48	2.37	1.72	1.01	1.88	1.08
PRT	2.40	1.18	3.80	1.55	0.67	0.33	1.46	0.76
ESP	1.52	0.62	0.86	0.49	0.90	0.26	0.86	0.41
SWE	4.24	1.58	3.30	1.92	3.44	0.86	1.79	0.96

Notes: CABB = cyclically adjusted budget balance, CAPB = cyclically-adjusted primary balance. The columns labelled *t vs. t*+4 (*t*+1 vs. *t*+4) refer to the total revision made between *t* and *t*+4 (*t*+1 and *t*+4), where 'max' is the maximum absolute revision and 'mean' the mean absolute revision observed during the sample period. The sample period is 1997 to 2003 for the revision between at *t* and *t*+4 and 1996 to 2006 for the revision between *t*+1 and *t*+4. No results are reported for Switzerland due to lacking data.

Table 37. **Correlation analysis -- cyclically-adjusted primary balance**

	Initial outturn estimate (*t*+1) vs. final outturn estimate (*t*+4)	Current-year prediction vs. initial outturn estimate (*t*+1)	Current-year prediction vs. final outturn estimate (*t*+4)	1-year-ahead prediction vs. initial outturn estimate (*t*+1)	1-year-ahead prediction vs. final outturn estimate (*t*+4)
United States	0.97*	0.90*	0.75*	0.52	-0.18
	(0.08)	(0.14)	(0.29)	(0.32)	(0.49)
Japan	0.84*	0.70*	0.91*	0.18	0.49
	(0.19)	(0.23)	(0.19)	(0.37)	(0.44)
Germany	0.83*	0.60*	0.35	0.08	-0.27
	(0.20)	(0.25)	(0.42)	(0.38)	(0.48)
France	0.89*	0.61*	0.35	-0.27	-0.72*
	(0.16)	(0.25)	(0.42)	(0.36)	(0.35)
Italy	0.68*	0.91*	0.50	0.81*	-0.48
	(0.26)	(0.13)	(0.39)	(0.22)	(0.44)
United Kingdom	0.96*	0.93*	0.84*	0.79*	0.43
	(0.09)	(0.12)	(0.24)	(0.23)	(0.45)
Canada	0.94*	0.96*	0.91*	0.91*	0.79*
	(0.12)	(0.09)	(0.19)	(0.15)	(0.30)
Australia	0.63*	0.66*	0.35	0.40	0.11
	(0.27)	(0.27)	(0.42)	(0.32)	(0.50)
Austria	0.61*	0.13	0.54	0.68*	0.46
	(0.28)	(0.35)	(0.38)	(0.26)	(0.44)
Belgium	-0.34	0.89*	0.09	0.70*	-0.24
	(0.33)	(0.16)	(0.45)	(0.25)	(0.48)
Denmark	0.80*	-0.12	0.44	-0.62*	0.15
	(0.21)	(0.35)	(0.40)	(0.28)	(0.49)
Finland	0.94*	0.79*	0.57	0.51*	0.24
	(0.12)	(0.22)	(0.37)	(0.30)	(0.49)
Greece	0.92*	0.89*	0.51	0.70*	-0.18
	(0.14)	(0.16)	(0.39)	(0.25)	(0.49)
Ireland	0.97*	0.55	0.66*	-0.07	-0.04
	(0.08)	(0.30)	(0.33)	(0.35)	(0.50)
Netherlands	0.57	0.21	-0.53	-0.08	-0.41
	(0.29)	(0.35)	(0.38)	(0.35)	(0.46)
New Zealand	0.27	0.65*	-0.05	0.42	-0.62
	(0.39)	(0.31)	(0.41)	(0.37)	(0.32)
Norway	0.79*	0.70*	0.72*	0.68*	0.19
	(0.22)	(0.25)	(0.31)	(0.26)	(0.49)
Portugal	0.76*	0.74*	0.00	0.30	-0.03
	(0.23)	(0.24)	(0.45)	(0.34)	(0.50)
Spain	0.34	0.69*	0.12	0.24	0.47
	(0.33)	(0.26)	(0.44)	(0.34)	(0.44)
Sweden	0.75*	0.79*	0.33	0.59*	0.12
	(0.23)	(0.22)	(0.42)	(0.29)	(0.50)

Notes: Standard errors in parentheses. An asterisk denotes significance at the 5% level. The sample period is 1996 to 2003 for the correlation between the outturn estimates at *t*+1 and *t*+4, 1997 to 2006 (1997 to 2003) for the correlation between the current-year prediction and the outturn estimate at *t*+1 (*t*+4), and 1998 to 2006 (1998 to 2003) for the correlation between the 1-year-ahead prediction and the outturn estimate at *t*+1 (*t*+4). No results are reported for Switzerland due to lacking data.

Table 38. **Test for efficiency and unbiasedness, cyclically-adjusted primary balance**

	(a)			(b)			(c)			(d)			(e)		
	α	*β*	Wald	*α*	*β*	Wald	*α*	*β*	Wald	*α*	*β*	Wald	*α*	*β*	Wald
USA	0.00	0.93	0.73	0.00	0.88	0.70	0.00	0.85	0.86	0.00	0.61	0.57	0.02	-0.41	0.36
	(0.00)	(0.09)		(0.00)	(0.15)		(0.01)	(0.33)		(0.01)	(0.38)		(0.03)	(1.13)	
JPN	-0.02	0.64	0.03	-0.02	0.58	0.13	-0.03	0.50	0.00	-0.04	0.11	0.00	-0.05	0.15	0.00
	(0.01)	(0.17)		(0.01)	(0.21)		(0.00)	(0.10)		(0.01)	(0.23)		(0.01)	(0.13)	
DEU	-0.01	1.00	0.10	0.00	0.87	0.95	0.00	0.77	0.36	0.01	0.18	0.52	0.02	-0.92	0.14
	(0.00)	(0.27)		(0.00)	(0.41)		(0.01)	(0.92)		(0.01)	(0.79)		(0.02)	(1.66)	
FRA	0.00	1.10	0.86	0.00	0.87	0.81	0.00	0.68	0.83	0.01	-0.50	0.05	0.02	-1.86	0.00
	(0.00)	(0.24)		(0.00)	(0.40)		(0.01)	(0.81)		(0.01)	(0.66)		(0.01)	(0.89)	
ITA	-0.02	1.12	0.22	0.00	1.03	0.83	-0.02	1.19	0.24	0.00	0.97	0.79	0.10	-1.45	0.00
	(0.02)	(0.49)		(0.01)	(0.16)		(0.05)	(0.92)		(0.01)	(0.26)		(0.07)	(1.31)	
GBR	0.00	1.12	0.34	0.00	1.12	0.75	-0.01	1.54	0.45	0.00	1.03	0.96	0.00	0.97	0.98
	(0.00)	(0.12)		(0.00)	(0.16)		(0.01)	(0.45)		(0.01)	(0.30)		(0.02)	(1.01)	
CAN	-0.02	1.07	0.00	-0.01	1.10	0.65	-0.02	1.21	0.00	-0.01	1.06	0.68	-0.03	1.30	0.00
	(0.01)	(0.15)		(0.01)	(0.11)		(0.01)	(0.25)		(0.01)	(0.18)		(0.03)	(0.50)	
AUS	0.01	0.70	0.38	0.01	0.79	0.46	0.01	0.48	0.34	0.01	0.58	0.29	0.01	0.42	0.55
	(0.01)	(0.35)		(0.01)	(0.32)		(0.01)	(0.58)		(0.01)	(0.50)		(0.03)	(1.94)	
AUT	0.00	0.95	0.51	0.02	0.09	0.00	0.00	0.97	0.47	0.01	0.34	0.00	0.00	0.53	0.38
	(0.01)	(0.50)		(0.00)	(0.23)		(0.01)	(0.68)		(0.00)	(0.14)		(0.01)	(0.51)	
BEL	0.13	-1.06	0.12	0.01	0.78	0.27	0.05	0.23	0.53	0.03	0.56	0.04	0.09	-0.38	0.19
	(0.08)	(1.21)		(0.01)	(0.14)		(0.08)	(1.18)		(0.01)	(0.21)		(0.05)	(0.76)	
DNK	0.00	0.95	0.40	0.05	-0.19	0.04	0.00	0.79	0.36	0.06	-0.76	0.00	0.02	0.34	0.41
	(0.01)	(0.29)		(0.02)	(0.55)		(0.03)	(0.72)		(0.01)	(0.36)		(0.04)	(1.11)	
FIN	0.01	0.72	0.01	0.01	0.88	0.26	0.03	0.48	0.08	0.03	0.50	0.07	0.04	0.20	0.06
	(0.00)	(0.10)		(0.01)	(0.24)		(0.01)	(0.31)		(0.01)	(0.32)		(0.02)	(0.41)	
GRC	-0.04	1.39	0.00	-0.01	1.13	0.23	-0.04	1.24	0.13	-0.02	1.11	0.22	0.08	-0.65	0.11
	(0.01)	(0.25)		(0.01)	(0.20)		(0.06)	(0.95)		(0.02)	(0.43)		(0.11)	(1.79)	
IRL	0.00	1.11	0.12	0.01	0.56	0.25	0.00	0.88	0.96	0.01	-0.06	0.00	0.01	-0.06	0.20
	(0.00)	(0.11)		(0.01)	(0.30)		(0.01)	(0.44)		(0.01)	(0.32)		(0.02)	(0.76)	
NLD	0.00	0.82	0.23	0.02	0.31	0.29	0.05	-1.46	0.01	0.03	-0.09	0.03	0.03	-0.79	0.03
	(0.01)	(0.49)		(0.01)	(0.52)		(0.03)	(1.03)		(0.01)	(0.46)		(0.02)	(0.88)	
NZL	0.02	0.31	0.25	0.01	0.62	0.20	0.02	-0.06	0.09	0.01	0.54	0.19	0.03	-0.90	0.00
	(0.01)	(0.44)		(0.01)	(0.26)		(0.01)	(0.58)		(0.01)	(0.44)		(0.01)	(0.57)	
NOR	-0.01	1.21	0.07	-0.01	0.93	0.37	-0.02	1.32	0.05	-0.02	0.89	0.08	-0.04	0.49	0.13
	(0.01)	(0.38)		(0.01)	(0.33)		(0.02)	(0.56)		(0.01)	(0.36)		(0.03)	(1.27)	
PRT	-0.02	1.56	0.00	0.00	0.87	0.78	0.00	0.01	0.01	0.00	0.35	0.07	0.00	-0.11	0.00
	(0.01)	(0.54)		(0.00)	(0.28)		(0.02)	(1.13)		(0.01)	(0.43)		(0.03)	(1.87)	
ESP	0.00	0.66	0.07	0.00	0.86	0.84	0.02	0.12	0.01	0.02	0.33	0.35	0.01	0.38	0.00
	(0.02)	(0.75)		(0.01)	(0.32)		(0.01)	(0.44)		(0.01)	(0.50)		(0.01)	(0.36)	
SWE	0.01	0.56	0.01	0.01	0.97	0.26	0.01	0.50	0.48	0.01	0.83	0.54	0.02	0.29	0.47
	(0.01)	(0.20)		(0.01)	(0.27)		(0.03)	(0.64)		(0.01)	(0.43)		(0.05)	(1.21)	
All			0.00			0.07			0.00			0.00			0.00

Notes: Specification (a): $B^*_{t|t+4} = \alpha + \beta B^*_{t|t+1} + \varepsilon_t$, specification (b): $B^*_{t|t+1} = \alpha + \beta B^*_{t|t} + \varepsilon_t$, specification (c): $B^*_{t|t+4} = \alpha + \beta B^*_{t|t} + \varepsilon_t$, specification (d): $B^*_{t|t+1} = \alpha + \beta B^*_{t|t-1} + \varepsilon_t$, specification (e): $B^*_{t|t+4} = \alpha + \beta B^*_{t|t-1} + \varepsilon_t$, where B^* = GDP share of cyclically-adjusted primary balance. The columns labelled "Wald" show the *p*-values of Wald tests of the joint hypothesis $\alpha = 0$ and $\beta = 1$. The row labelled "All" shows the *p*-values of the same test applied to all 20 countries jointly. Switzerland is excluded from the analysis due to lacking data. The numbers in parentheses denote the standard errors of the estimated parameters. The sample period is 1996 to 2003 for specification (a), 1997 to 2006 for specification (b), 1997 to 2003 for specification (c), 1998 to 2006 for specification (d), and 1998 to 2003 for specification (e).

Table 39. **Sign of the cyclically-adjusted primary balance**

		Initial outturn estimate (*t*+1)		Correct decisions (% of total)	Prob-ability	Final outturn estimate (*t*+1)		Correct decisions (% of total)	Prob-ability
		-	+			-	+		
1-year-ahead projection	-	24	4	91%	0.000	12	1	83%	0.000
	+	13	141			20	87		
Current-year projection	-	30	3	95%	0.000	16	0	87%	0.000
	+	8	163			18	106		
Initial outturn estimate	-					24	1	91%	0.000
	+					13	123		

Notes: The 2x2 tables display the number of occurrences of the four possible combinations of positive and negative values of the primary balance. The row labelled "probability" shows the probabilities that the observed frequencies are random. The sample period is 1997 to 2006 (1997 to 2003) when comparing the current-year projection with the outturn estimate at *t*+1 (*t*+4), 1998 to 2006 (1998 to 2003) when comparing the 1-year-ahead projection with the outturn estimate at *t*+1 (*t*+4), and 1996 to 2003 when comparing the outturn estimate at *t*+1 with the outturn estimate at *t*+4.

Table 40. **Predicted and actual change of the cyclically-adjusted primary balance**

		Initial outturn estimate (*t*+1)		Correct decisions (% of total)	Prob-ability	Final outturn estimate (*t*+4)		Correct decisions (% of total)	Prob-ability
		down	up			down	up		
1-year-ahead projection	down	58	46	60%	0.007	47	22	61%	0.055
	up	27	51			25	26		
Current-year projection	down	73	41	73%	0.000	57	18	75%	0.000
	up	14	76			17	48		
Initial outturn estimate	down					60	11	83%	0.000
	up					16	74		

Notes: The 2x2 tables display the number of occurrences of the four possible combinations of upward and downward movements in the primary balance. The row labelled "probability" shows the probabilities that the observed frequencies are random. The sample period is 1997 to 2006 (1997 to 2003) when comparing the current-year projection with the outturn estimate at *t*+1 (*t*+4), 1998 to 2006 (1998 to 2003) when comparing the 1-year-ahead projection with the outturn estimate at *t*+1 (*t*+4), and 1996 to 2003 when comparing the outturn estimate at *t*+1 with the outturn estimate at *t*+4.

Table 41. **Test for efficiency and unbiasedness, change in the cyclically-adjusted primary balance**

	(a)			(b)			(c)			(d)			(e)		
	α	β	Wald	α	β	Wald	α	β	Wald	α	β	Wald	α	β	Wald
USA	0.001	1.01	0.80	0.003	1.86	0.07	0.001	1.53	0.65	-0.004	2.08	0.31	-0.003	2.55	0.38
	(0.001)	(0.10)		(0.003)	(0.38)		(0.005)	(0.61)		(0.004)	(0.85)		(0.006)	(1.60)	
JPN	-0.002	0.99	0.28	0.002	1.77	0.00	0.000	1.82	0.00	0.002	2.55	0.06	-0.002	2.87	0.06
	(0.001)	(0.09)		(0.002)	(0.24)		(0.002)	(0.25)		(0.003)	(0.66)		(0.004)	(0.85)	
DEU	0.001	1.29	0.12	-0.001	1.01	0.83	-0.002	1.08	0.77	-0.001	1.25	0.91	-0.005	-1.08	0.12
	(0.001)	(0.14)		(0.001)	(0.31)		(0.002)	(0.65)		(0.002)	(0.93)		(0.002)	(1.35)	
FRA	-0.002	1.11	0.27	0.002	0.73	0.28	-0.001	1.09	0.72	0.002	0.71	0.48	-0.002	1.21	0.60
	(0.001)	(0.22)		(0.002)	(0.30)		(0.002)	(0.31)		(0.002)	(0.37)		(0.002)	(0.41)	
ITA	-0.003	0.97	0.54	0.001	0.92	0.26	-0.003	1.01	0.34	0.001	0.80	0.13	-0.005	0.71	0.09
	(0.003)	(0.28)		(0.001)	(0.09)		(0.002)	(0.17)		(0.002)	(0.31)		(0.002)	(0.53)	
GBR	-0.001	0.90	0.81	0.004	0.92	0.60	-0.002	0.72	0.72	0.004	-0.05	0.73	-0.004	-0.25	0.14
	(0.003)	(0.24)		(0.004)	(0.53)		(0.004)	(0.42)		(0.007)	(1.32)		(0.007)	(1.09)	
CAN	-0.004	1.22	0.08	0.005	1.24	0.00	0.003	1.41	0.59	0.005	1.87	0.07	-0.001	1.84	0.13
	(0.002)	(0.17)		(0.002)	(0.27)		(0.003)	(0.47)		(0.002)	(0.70)		(0.002)	(0.65)	
AUS	0.000	0.99	1.00	0.001	0.70	0.45	-0.001	0.43	0.73	0.001	1.24	0.66	-0.003	1.84	0.49
	(0.004)	(0.55)		(0.002)	(0.31)		(0.005)	(0.87)		(0.002)	(0.45)		(0.004)	(0.89)	
AUT	0.002	1.06	0.75	0.000	0.90	0.91	0.000	1.86	0.21	0.000	0.16	0.45	0.002	0.88	0.90
	(0.003)	(0.31)		(0.001)	(0.24)		(0.003)	(0.54)		(0.002)	(0.69)		(0.006)	(1.96)	
BEL	-0.001	1.28	0.86	0.001	1.06	0.67	0.000	0.18	0.87	-0.001	0.28	0.08	-0.001	-0.03	0.50
	(0.002)	(0.58)		(0.001)	(0.23)		(0.003)	(1.60)		(0.003)	(0.52)		(0.006)	(1.40)	
DNK	0.001	0.72	0.10	0.003	0.71	0.43	-0.001	0.95	0.85	0.008	2.56	0.13	0.004	3.05	0.02
	(0.001)	(0.13)		(0.004)	(0.37)		(0.003)	(0.38)		(0.004)	(1.05)		(0.002)	(0.80)	
FIN	-0.004	0.69	0.01	0.009	1.41	0.01	0.004	1.05	0.65	0.005	1.10	0.63	0.002	0.47	0.98
	(0.003)	(0.16)		(0.003)	(0.34)		(0.004)	(0.46)		(0.006)	(1.26)		(0.008)	(3.04)	
GRC	0.002	0.82	0.69	-0.003	1.10	0.65	-0.004	1.82	0.31	0.001	1.68	0.89	-0.008	-2.61	0.17
	(0.004)	(0.37)		(0.003)	(0.35)		(0.003)	(0.78)		(0.005)	(1.44)		(0.005)	(1.98)	
IRL	0.000	0.92	0.90	-0.001	-0.06	0.54	-0.002	2.49	0.66	0.002	-1.60	0.00	0.000	-1.65	0.00
	(0.003)	(0.18)		(0.007)	(1.07)		(0.008)	(2.41)		(0.005)	(0.63)		(0.006)	(0.61)	
NLD	-0.001	1.29	0.63	0.005	0.96	0.01	-0.002	0.11	0.26	0.004	0.33	0.10	-0.003	0.27	0.28
	(0.002)	(0.33)		(0.002)	(0.27)		(0.003)	(0.57)		(0.003)	(0.50)		(0.003)	(0.46)	
NZL	-0.002	0.47	0.31	-0.004	0.45	0.24	-0.002	0.55	0.53	-0.005	0.43	0.23	-0.003	1.15	0.78
	(0.004)	(0.40)		(0.003)	(0.34)		(0.004)	(0.41)		(0.003)	(1.07)		(0.005)	(1.51)	
NOR	-0.003	0.69	0.65	-0.002	1.59	0.18	-0.001	3.77	0.02	-0.003	1.46	0.04	-0.004	2.10	0.31
	(0.004)	(0.43)		(0.002)	(0.67)		(0.004)	(1.14)		(0.002)	(0.44)		(0.005)	(1.27)	
PRT	-0.001	1.03	0.80	0.002	1.11	0.56	-0.001	0.95	0.99	0.001	1.57	0.91	0.000	2.53	0.46
	(0.002)	(0.19)		(0.002)	(0.25)		(0.004)	(1.08)		(0.005)	(1.80)		(0.004)	(1.24)	
ESP	-0.002	1.05	0.66	0.002	1.03	0.28	0.002	0.75	0.65	0.002	1.79	0.25	0.002	1.07	0.79
	(0.002)	(0.19)		(0.001)	(0.38)		(0.002)	(0.55)		(0.002)	(0.99)		(0.002)	(1.37)	
SWE	-0.003	0.94	0.76	0.009	0.78	0.01	0.004	0.85	0.58	0.004	2.43	0.03	-0.004	2.10	0.39
	(0.006)	(0.24)		(0.004)	(0.22)		(0.005)	(0.27)		(0.003)	(0.58)		(0.006)	(0.92)	
All			0.54			0.00			0.51			0.00			0.00

Notes: Specification (a): $\Delta B^*_{t|t+4} = \alpha + \beta\ \Delta B^*_{t|t+1} + \varepsilon_t$, specification (b): $\Delta B^*_{t|t+1} = \alpha + \beta\ \Delta B^*_{t|t} + \varepsilon_t$, specification (c): $\Delta B^*_{t|t+4} = \alpha + \beta\ \Delta B^*_{t|t} + \varepsilon_t$, specification (d): $\Delta B^*_{t|t+1} = \alpha + \beta\ \Delta B^*_{t|t-1} + \varepsilon_t$, specification (e): $\Delta B^*_{t|t+4} = \alpha + \beta\ \Delta B^*_{t|t-1} + \varepsilon_t$, where ΔB^* = change in the GDP share of the cyclically-adjusted primary balance. The columns labelled "Wald" show the *p*-values of Wald tests of the joint hypothesis $\alpha = 0$ and $\beta = 1$. The row labelled "All" shows the *p*-values of the same test applied to all 20 countries jointly. Switzerland is excluded from the analysis due to lacking data. The numbers in parentheses denote the standard errors of the estimated parameters. The sample period is 1996 to 2003 for specification (a), 1997 to 2006 for specification (b), 1997 to 2003 for specification (c), 1998 to 2006 for specification (d), and 1998 to 2003 for specification (e).

Table 42. **Revisions to the cyclically-adjusted primary balance -- regression results**

	t+4 vs. *t*+1			*t*+4 vs. *t*	
Specification	(1)	(2)	(3)	(4)	(5)
Revision to *GAP*[1]	-0.51	-0.51	-0.31	-0.46	-0.53
	(0.07)	(0.06)	(0.11)	(0.12)	(0.06)
Revision to *B*[1]		0.73	0.30		0.82
		(0.08)	(0.28)		(0.04)
Revision to UGAP[1]			0.63		
			(0.13)		
Number of observations	160	160	80	140	140
S.E. of regression	0.93	0.72	0.77	1.48	0.76
Implied impact of GAP revision on *B**[2]	-0.51	-0.51	-0.31	-0.49	-0.57

1. In specifications (1) to (3) the variable is defined as the revision between *t*+1 and *t*+4 and in specifications (4) and (5) it is defined as the revision between *t+4* and *t*. 2) Mean absolute revision to GAP observed during sample period multiplied by the coefficient on the GAP revision; per cent of GDP.

2. Dependent variable: GDP share of the cyclically-adjusted primary balance. *B* = GDP share of the primary balance, *B** = GDP share of the cyclically-adjusted primary balance. The numbers in parenthesis denote the standard errors of the estimated parameters. The sample period is and 1996 to 2003 for specifications (1) and (2), 2001 to 2003 for specification (3) and 1997 to 2003 for specifications (4) and (5).

Table 43. **Revisions to revenues and disbursements**

	Average revision		Average absolute revision	
	Disbursements	Receipts	Disbursements	Receipts
United States	0.11	0.64	0.45	0.94
Japan	0.04	0.05	0.32	0.83
Euro area	-0.02	-0.08	0.34	0.34
France	0.10	-0.05	0.32	0.37
Germany	-0.27	-0.25	0.27	0.61
Italy	0.31	0.20	0.45	1.34
United Kingdom	0.59	0.07	0.67	0.49
Canada	0.03	-0.25	0.19	0.45
Australia	-0.30	0.01	0.68	0.29
Austria	-0.16	-0.07	0.46	0.68
Belgium	0.22	-0.39	0.64	0.61
Switzerland	-1.07	0.34	1.07	0.34
Denmark	-0.36	0.64	1.05	0.78
Spain	-0.01	0.27	0.77	0.84
Finland	-0.34	-0.14	0.75	0.67
Greece	-0.98	-2.71	3.36	3.29
Ireland	0.09	1.36	0.95	1.36
Netherlands	0.04	0.31	0.94	0.98
Norway	-1.04	-0.87	1.32	1.45
New Zealand	-0.11	1.06	3.15	4.67
Portugal	0.35	0.15	1.00	0.58
Sweden	-0.91	-0.14	1.17	0.58

Notes: The revision is defined as the difference between the current-year-projection and the initial data outturn at time *t*+1. The sample period is limited to 2003 to 2006 due to methodological changes that took place between 2002 and 2003.

Table 44. **Output/unemployment gap uncertainty and the cyclically-adjusted budget balance**

Percentage points

	Level of the budget balance		Change in the budget balance	
	Scenario 1 (mean absolute revision)	Scenario 2 (maximum absolute revision)	Scenario 1 (mean absolute revision)	Scenario 2 (maximum absolute revision)
United States	0.25	0.79	0.17	0.51
Japan	0.58	1.21	0.26	0.89
Germany	0.45	1.19	0.21	0.40
France	0.14	0.44	0.22	0.33
Italy	0.87	1.67	0.20	0.48
United Kingdom	0.31	0.77	0.21	0.45
Canada	0.27	0.60	0.21	0.60
Australia	0.30	0.54	0.22	0.45
Austria	0.41	0.82	0.27	0.55
Belgium	0.35	1.06	0.30	0.65
Denmark	0.63	1.19	0.39	0.79
Finland	0.50	1.51	0.35	1.00
Greece	0.26	0.59	0.15	0.41
Ireland	0.55	1.18	0.69	1.25
Netherlands	0.39	0.68	0.35	0.77
New Zealand	0.31	0.55	0.36	1.01
Norway	0.31	0.54	0.23	0.64
Portugal	0.54	0.98	0.19	0.48
Spain	0.31	0.70	0.17	0.48
Sweden	0.48	0.95	0.36	0.86
Switzerland	0.41	0.88	0.21	0.43

Notes: The left panel of the table shows the revision in the GDP share of the cyclically adjusted budget balance resulting from a given change in GAP and UGAP. The size of the change in GAP and UGAP is equal to the mean and the maximum absolute revision of GAP and UGAP observed during the period 1995 to 2003 for the current-year-prediction versus the final data outturn at *t*+4. The right panel of the table shows the revision to the year-on-year change in the GDP share of the cyclically adjusted budget balance resulting from a given change in ΔGAP and ΔUGAP. The size of the change in ΔGAP and ΔUGAP is equal to the mean and the maximum absolute revision of ΔGAP and ΔUGAP observed during the period 1995 to 2003 for the current-year-prediction versus the final data outturn at *t*+4.

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