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Abstract

Monitoring the behavior of potential output helps policymakers implement appropriate policies in response to an economic crisis. In the short-run, estimates of the output gap can guide the timing of the implementation and withdrawal of stimulus measures. In the medium- to long-term, these estimates can also provide the basis for gauging productive potential and, hence, guide policies to support sustainable, non-inflationary output growth. In this paper, we investigate the post-crisis behavior of potential output in emerging East Asian economies by employing the Markov-switching model to account for structural breaks. Results show that after the 1997/98 Asian financial crisis, potential output in Hong Kong, China; the Republic of Korea (Korea); Singapore; and Malaysia reverted to levels consistent with trends prior to the crisis. While there were permanent drops in potential output for both Thailand and Indonesia, growth rates returned to pre-crisis trends. The People's Republic of China (PRC); Taipei,China; and the Philippines are special cases as explained in the report. Econometric estimates of a simple growth model show that the differences among the patterns of post-crisis recovery can be attributed to the investment-to-gross-domestic-product (GDP) ratio; macroeconomic policies; exchange rate behavior; and productivity, which is proxied by the level of technological activity. These results can be used to guide policy in the aftermath of the 2008 global financial crisis.

Keywords: Potential output, Markov-switching model, structural break, global crisis, East Asia

JEL Classification: C3, E32

1. Introduction

Potential output is defined as the level of output consistent with price stability or, alternatively, the trend level of output around which the economy fluctuates over the business cycle. Deviations of actual from potential output lead to output gaps. The output gap is one of the main components of price determination based on the Phillips Curve and is often used as an argument in monetary policy reaction functions. As such, it is an important consideration in an inflation-targeting framework.

Potential output can also be a useful indicator for policymakers in adopting appropriate measures in response to an economic crisis. The main issue is to what extent a particular crisis has an impact on potential output. To illustrate, a crisis can have three possible impacts on potential output depending on the nature of the economic downturn and subsequent policy responses (Figure 1). Scenario 1 shows that potential output will revert to the level that was determined by its trend prior to the crisis. This implies that actual output growth will experience a jump when the economy returns to its path prior to the crisis. Meanwhile, output growth in Scenario 2 will only return to its pre-crisis trend, but potential output will be at a lower level. The worst case scenario is depicted as Scenario 3 in which output expansion will slow down even after the crisis dissipates.

Knowledge of the cyclical position—based on estimates of potential output and the position of gross domestic product (GDP) in relation to its potential (i.e., the output gap)—is a key element in monetary and fiscal frameworks. First, the level of GDP relative to its potential has important implications for inflationary pressures in the economy. Consequently, the output gap is one of the main factors in monetary policy decisions, such as in the Taylor rule or the inflation-targeting framework. Second, the size and sign of the output gap provides a good indicator of an economy's cyclical position, which is an important element in the estimation of the structural fiscal balance. The structural fiscal balance is conceptually a non-cyclical component of the fiscal balance and an important gauge for assessing the fiscal stance.

Accordingly, it is important to be able to accurately decompose an economic downturn into a change in potential output and a change in the output gap. A change in output can be decomposed into a permanent (y^P) and a transitory component (z), such that:

$$\Delta y_t = \Delta y_t^P + \Delta z_t$$

where y^P and z correspond to potential output and the output gap, respectively. For example, during a recession, if the change in y^P is dominant, then a restrictive monetary policy is called for. However, if it turns out that the transitory component is more prominent, then a restrictive monetary policy can choke off the recovery. It should be noted that real shocks (e.g., a rise in productivity due to new technology) are usually manifested in changes in y^P, while nominal shocks (e.g., an increase in the money supply) tend to affect the transitory component.

The major implication is that potential output should be estimated fairly accurately in order that appropriate policies can be implemented in response to a particular crisis. The second part of the paper presents various methodologies to estimate potential output, with emphasis on accounting for structural breaks in the data. The second section also includes a review of some applications in Asian countries. The third section of the paper discusses the various channels by which a financial crisis can affect potential output. In addition, policy responses are highlighted and empirical studies focusing on the 1997/98 Asian financial crisis are reviewed in this section. The fourth section deals with empirical results of the present study. These are the basis for policy recommendations in response to the 2008 crisis, which are outlined in the last section.

2. Estimating Potential Output

Methodologies to estimate potential output and the output gap can be classified into three major categories. The first are statistical or atheoretical approaches, where actual data on output are used to construct an estimate of potential output. On the other hand, structural approaches apply economic theory to estimate potential output. Typically, data on employment and the capital stock are used to construct a production function. Given assumptions about the full-time equivalent of employment, productivity, and utilization of capital stock, measures of potential output can be estimated. However, this method cannot be applied to many developing countries due to the lack of required data.

In this section, we will focus on the atheoretical approach, discussing the strengths and weaknesses of a few common methodologies employed in our empirical analyses.

2.1 Atheoretical Approach

The most popular atheoretical approach is that suggested by Hodrick and Prescott (1997). The Hodrick-Prescott (HP) filter[1] has a time-varying trend and estimates the potential component of output by minimizing the loss function, specified as follows:

$$L = \sum_{t=1}^{n}(y_t - y_t^T)^2 + \lambda \cdot \sum_{t=2}^{n-1}(\Delta y_{t+1}^T - \Delta y_t^T)^2$$

where λ is the smoothing weight on potential output growth and n is the sample size.[2]

The main advantage of the HP filter is that it produces an output gap that is stationary and allows the trend to follow a stochastic process. One disadvantage though is that the

[1] Filtering refers to a procedure by which a value is decomposed into two or more ex ante unknown quantities. The decomposition is based on set criteria.

[2] Burns and Mitchell (1946) suggested that the cyclical components of the business cycle fall within a particular range of duration (typically between 1.5 and 8 years). The band pass filter extracts components of a time series within this range of periodicities, while filtering out components at lower and higher frequencies. Two popular methods employing this filter are the Baxter–King (1999) filter and the Christiano–Fitzgerald (CF) (2003) filter. In this report, the CF variant of the filter was used. The method is also atheoretical and has properties similar to the HP filter.

selection of the smoothing weight is arbitrary, which matters to the actual results.[3] The HP filter is also sensitive to new data, which is the uncertainty associated with statistical revisions. It is useful to distinguish the latter from the uncertainty due to data revisions, which arise when historical GDP figures are changed. Studies have shown that the effect of statistical revisions is of an order of magnitude more important than published data revisions.[4]

Another atheoretical approach is what is called the unobservable components method (UC). Typically, output is decomposed into a permanent (y^P) and a transitory component (*z*), such that:

$$y_t = y_t^P + z_t$$

where y^P and z correspond to potential output and the output gap, respectively. Permanent output is assumed to follow a random walk with drift:

$$y_t^P = \mu^y + y_{t-1}^P + \varepsilon_t^y$$

where μ^y is a drift term and $\varepsilon_t^y \sim N(0, \sigma_y^2)$. The output gap is assumed to follow an AR(2) process:

$$z_t = \phi_1 z_{t-1} + \phi_2 z_{t-2} + \varepsilon_t^z$$

where $\varepsilon_t^z \sim N(0, \sigma_z^2)$ and the stationary conditions hold. Estimates of the parameters of the model and the unobserved state variables can be obtained through a maximum likelihood procedure using the Kalman filter. This approach has advantages and disadvantages similar to the HP filter.

The Beveridge and Nelson decomposition is yet another atheoretical method where the changes in output are modeled as an ARMA (p,q) process,

$$\phi(L)(\Delta y_t - \mu) = \theta(L)\varepsilon_t .$$

Standing at time t, the expectation of y_{t+k} conditional on data through t is

$$\hat{y}_t(k) = y_t + \sum_{j=1}^{k} \hat{\Delta y}_t(j) .$$

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3 Hodrick and Prescott recommend a value of 1600 for quarterly data, which is based on the relative size of the variances of the shocks to permanent and transitory components of output. Changing the weight affects how responsive potential output is to movements in actual output. For example, as the smoothing factor approaches infinity, the loss function is minimized by penalizing changes in potential output growth, which is done by making potential output growth a constant, i.e. a linear time trend. Hence the time-trend method is a special case of the HP filter.

4 An assertion that is also contained in the 1999 Orphanides and van Norden study.

The permanent or trend component of y_t is

$$y_t^p = y_t + \lim_{k\to\infty}\left[\sum_{j=1}^{k}\Delta\hat{y}_t(j) - k\mu\right]$$

The second term of the equation's right hand side, which captures the momentum contained in y_t at time t, was interpreted by Beveridge and Nelson (1981) as the cyclical component of the series. In this paper, this method is applied using the Newbold (1990) implementation of the Beveridge–Nelson (BN) decomposition.[5]

The UC method usually results in a smooth trend and large cycle. This is because the UC method (e.g., Clark 1987) forces the innovations in the trend and the cycle to be uncorrelated. When this restriction is relaxed, meaning that the covariance between the trend and the cycle innovations are not restricted to zero, the (unrestricted) unobserved components model results to a univariate representation and a trend-cycle decomposition that is identical to the BN decomposition (Morley et al., 2003). Hence, in this study the BN decomposition is estimated instead of the (restricted) unobserved components method.

2.2 Accounting for Structural Breaks

A common disadvantage of the atheoretical methodologies is that they do not account for structural breaks in the time series. Model instability and structural breaks from one sub-period to another is an important consideration that needs to be taken into account. Early methods (e.g., Chow 1960) dealt with the issue by dating the parameter shifts in cases where the changes are known—or are determined—by the researcher. Later methods incorporated strategies for detecting parameter switches when the dates of the turning points are unknown, In these methods, the structural change is modeled endogenously. The most popular of these is Hamilton's (1989) Markov-switching (MS) model, which allows for the probability of the shift to depend explicitly on the regime that is in effect (Kim and Nelson, 1999a provide an exposition of these models).

In MS models, since the evolution of the variable capturing the changes in the regime, $S_t,\ t = 1,2,...,T,$ is not known, it needs to be estimated—as an unobserved variable—together with the parameters of the model. These Markov regime-switching models can be applied to account for both shocks to potential output and breaks from a trend that lead to unusually large contractions. Hamilton (1989) developed a method to analyze economic fluctuations as the outcome switches from one state to another, with the change in state being governed by an unobserved first-order Markov process.[6] Lam

[5] Unlike the HP filter that imposes smoothness in the trend *a priori*, both the BN decomposition and the unobserved components method "let the data speak for themselves" (Morley et al., 2003). However, it is well-known that the BN decomposition results in a decomposition where much of the GDP variation is in the trend component, while the temporary component is small.

[6] Potential output is specified as:

(1990) extended the original Hamilton model to enable the modeling of processes whose autoregressive component need not have a unit root. Meanwhile, Kim (1994) reworked Lam's specification using state space techniques enabling the application of a Kalman filter.

The generalized Hamilton model assumes that the MS occurs in the permanent part of output but not in the cyclical component. It thus assumes that recessions have a permanent impact on real GDP. Another set of models that attempts to capture business cycle asymmetry, albeit using a fundamentally different approach from Hamilton's model, assumes that recessions are transitory "plucks" from output. That is, recessions are those episodes when output is disturbed by negative temporary shocks, but that following a recession, a rapid recovery phase—labeled as the bounce-back or peak-reversion effect—ensues. This is the model advocated by Friedman (1964, 1993), and formalized in the MS framework by Kim and Nelson (1999b).

A body of empirical work followed either of these types of business cycle asymmetry models (Hamilton- and Friedman-types) separately. Kim and Piger (2002) generalize these business cycle models by adopting a unified framework capable of capturing both types of asymmetry together and therefore allows for a distinction to be made between each type of asymmetry and an evaluation of which of the two types is significant. Similar to Stock and Watson (1989, 1991, 1993), Kim and Piger adopted a multivariate framework, but incorporated MS in their framework. In their model, output and investment (but not consumption) are affected by shocks to the common stochastic trend, a common transitory portion, and transitory shocks that are idiosyncratic in nature.

Kim and Piger (2002) applied their model to cointegrated data and assumed that both types of asymmetry are propelled by the same state variable. This implies that each recession is forced to contain both permanent and transitory common factors. A related approach was utilized by Kim and Murray (2002) using non-cointegrated data, this time utilizing two different state variables to capture the Hamilton-type and the Friedman-type asymmetries, with the state variables' duration and timing permitted to vary across recessions. This allows for the possibility that recessions can emanate from more than one source, either as a change in the common transitory component or a shift in the common permanent component. Otherwise stated, this approach permits one to isolate whether a particular recession is driven by a regime change in the permanent component or in the transitory component.

Kim and Piger (2002), and Kim and Murray (2002), therefore, improve upon Hamilton (1989), Lam (1990), and Kim (1994) in that unlike the latter group, the former's methods

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a. $y_t^P = \mu_0 + y_{t-1}^P + \mu_1 s_t + \varepsilon_t^y$

Potential output is a random walk with a drift that evolves according to a two-state Markov process. The binary variable s_t represents either a high- or a low-growth state of the economy in period *t*. The probability that state *j* follows state *i* is given by the transition probabilities,

b. $p_{ij} = \Pr(s_t = j | s_{t-1} = i)$ where $\sum_j p_{ij} = 1$ and i, j = 0,1.

are able to capture the peak-reversion feature that the Hamilton model is unable to capture. Moreover, their methods are more general, in that using specific coefficients in their equations can reproduce the results of the Hamilton model.

In estimating business cycle co-movement and asymmetry in the context of Asian economies, it would be better to use Kim and Piger (2002), with its one state variable, rather than the more complex, two-state approach adopted in Kim and Murray (2002).[7] The reason is that unlike the United States (US), for which these business cycle methods were originally developed, Asian economies in general have fewer episodes of boom and bust cycles. Most of the economies we studied have only about one or two episodes of recessions at the most. Thus, for Asian economies, it would be more difficult to obtain the averaging required to estimate the state probabilities for the computer algorithm to converge.

3. Impact of Financial Crises on Potential Output in Asia

3.1 Theory and Policy Responses

There are various channels through which the crisis can impact potential output. First, a crisis discourages firms from investing in capital as a fall in demand and worsening economic outlook increase uncertainty over the returns on investment. Moreover, a financial crisis tends to worsen funding conditions for firms' new investment due to higher risk premia, tighter lending standards, and higher real costs of capital due to limited credit. Second, a crisis weakens the labor market situation. Especially when the labor market is rigid, a temporary reduction in employment could become persistent even as economic conditions improve. Third, a crisis may lead to a drop in productivity due to decreased capital spending. For instance, a reduction in research and development (R&D) spending can lower total factor productivity.

Policy responses and private restructuring efforts following a crisis also influence the trajectory of output. Policy responses to cushion the impact of an economic downturn can sometimes have long-term effects. For example, an increase in public spending, which is used to build physical and social infrastructure, may help boost potential output. On the other hand, stabilization policies could introduce distortions in markets, thus creating long-term side effects. A financial crisis also provides impetus for reforms and corporate restructuring. Successful implementation of structural reforms and corporate restructuring can enhance productivity, thus eventually lifting potential output even higher than its original path. Since the crisis impacts productivity beyond the short-term, thus the impact on potential growth remains highly uncertain. For example, Japan suffered substantial and persistently widening output losses following the banking crisis of the 1990s. On the other hand, Mexico and Norway, which also suffered through crisis

[7] The method by Kim and Piger (2002) would hold a better chance of having the probability estimates converge than that by Kim and Murray (2002). This advice was given by Professor Chang-Jin Kim in a phone conversation on 16 November 2009. Unfortunately, the algorithm generously provided by Professor Jeremy Piger would not converge when applied to data from East Asian economies. The algorithm can be provided upon request.

in the 1990s, eventually achieved and even exceeded the levels of output that pre-crisis growth trends had suggested (Haugh et al., 2009).

A priori, the impact of a crisis on potential output is uncertain. Hence, it is important to investigate the sources of a decline in output following a crisis. It is very difficult to determine the path of potential output in the event of a crisis. However, identifying the sources of the output loss—for example, a temporary rise in the unemployment rate or a decline in productivity—has important implications for the output gap and the appropriate policy responses. If the output loss is largely associated with the output gap—a temporary deviation from potential output—stabilization policies would be sufficient. However, if the loss is induced from a change in potential output, the appropriate policy response would require more fundamental reforms that can address structural problems (Cerra and Saxena, 2005).

In addition, a financial crisis can change potential output through indirect effects. Indeed, crises usually trigger policy responses from public authorities to cushion against the economic downturn. Stabilization policies can sometimes have long-term effects. On the one hand, investment in infrastructure is likely to boost potential output. On the other hand, some policies can be detrimental to long-term growth when they introduce distortions or encourage excessive risk-taking. At the same time, temporary fiscal measures can lead to a permanent increase in government size and debt levels, which in turn will have negative effects on growth. Finally, the impact of policies depends on the nature and design of the specific measures. Financial crises can also foster the implementation of structural reforms that can enhance potential output by moderating political opposition to reforms.

3.2 Evidence from Earlier Crises

Many studies looked into the impact of financial crises, including the effect of the 1997/98 financial crisis on potential output in Asia. Past experience shows that financial crises tend to cause substantial and persistent output losses, although there are significant country variations. The patterns of medium-term output performance following financial crisis have attracted much attention recently. Several studies have examined the medium-term behavior of output in the crisis-affected countries. Some stylized facts about crisis-driven recessions have emerged.

- Financial crises, especially those involving a banking crisis, tend to have a negative and persistent effect on potential output. Furceri and Mourougane (2009) estimate that financial crises lower potential output by between 1.5% and 2.4% on average for the economies of the Organisation for Economic Co-operation and Development (OECD). The magnitude of the effect increases with the severity of the crisis. Abiad, Balakrishnan, Brooks, Leigh, and Tytell (2009) also found that output tends to be depressed substantially and persistently following banking crises after investigating 88 banking crises that occurred over the past 4 decades across a wide range of economies. Their finding was based on a comparison in each economy between the medium-term level of output[8] and the level it would have reached if it had adhered to the pre-crisis trend.

- Following financial crises, output does not return to its original trend path over the medium-term on average. Growth does, however, eventually return to its pre-crisis rate for most economies, suggesting that the pattern of medium-term output performance following a financial crisis is best described by Scenario 2 in Figure 1.

- The depressed output path tends to result from long-lasting reductions of roughly equal proportion to the employment rate, the capital-to-labor ratio, and total factor productivity (Abiad et al., 2009).

- Initial conditions and policy responses have a strong influence on the size of the output loss. What happens to short-term output is also a good predictor of the medium-term outcome. Interestingly, post-crisis output losses are not significantly related with the level of income.

In Asia, one of the first cross-country estimates of the output gap in the aftermath of the 1997/98 crisis was undertaken by Bautista (2003). By applying the generalized Hamilton model as modified by Lam (1990) and Kim (1994), he addressed the problem created by structural breaks. One interesting result was that the stochastic output gap estimates obtained from the modified Hamilton model were on average smaller than estimates of the linear–quadratic output gap. The reason is that shocks to potential output partly account for the fluctuations in GDP. This is clear evidence that the 1997/98 crisis had an adverse impact on potential output. The downturn in the Philippines and Thailand, however, could not be classified as recessions and instead appeared as slowdowns. Rather, the different experiences of each country could likely be attributed to different policy responses as well as their initial conditions.

A similar approach was applied by Cerra and Saxena (2005), but with the asymmetry also applied to the output gap. They used a two-common-factor model with regime switching in each of the factors. Real GDP, investment, and private consumption were used to identify the common transitory and stochastic trends. Their results indicate some amount of permanent output loss in all six economies that were part of the study. The recovery phase is predominantly characterized by a return to the normal growth rate of an expansion, rather than a higher-than-normal growth rate. This is akin to Scenario 2 of Figure 1. Thus, the level of output is permanently lower than its initial trend path.

Cerra and Saxena also determined that the impact of the 1997/98 crisis was milder in the Philippines, a result that is consistent with Bautista. The cumulative output loss in the Philippines for the period 1997–1999 was only 1.5%, compared to 22.3% in Indonesia, 10.3% in the Republic of Korea (Korea), and 19.0% in Malaysia. Unfortunately, Thailand was not included in the study due to lack of data.

[8] The medium-term is defined as 7 years after the crisis in this paper.

4. Empirical Results

4.1 Results from Atheoretical Methods

Three relatively simple atheoretical methods were initially applied to determine the variation in the empirical results. The economies that were included in the estimation are the People's Republic of China (PRC); Hong Kong, China; India; Indonesia; Japan; Korea; Malaysia; Philippines; Singapore; Taipei,China; and Thailand. In addition, estimates were applied to the US and aggregate Europe.[9] The data used are described in the appendix. The end-point problem of the HP filter is addressed by extending the data up to the fourth quarter of 2010 by applying ADB forecasts. The results are summarized in Tables 1-3.

All three methods—HP, band pass (BP)–CF, and BN—suggest a noticeable drop in the potential output growth for (i) the countries affected by the 1997/98 Asian financial countries (e.g., Malaysia, Indonesia, Thailand); and (ii) all regions and countries (with the possible exception of the PRC, Indonesia, and India) for the 2008/09 global crisis. In general, among the three methods used, the BN decomposition registers the largest reduction in potential GDP growth during both crisis periods. This result is expected because, as previously explained, the BN methodology results in a decomposition in which much of the GDP variation is in the trend and stochastic component.

For the 1997/98 crisis, all three methods suggest a large and substantial reduction in potential output growth for Indonesia and Thailand; a relatively large potential output growth reduction for Malaysia; Korea; and Hong Kong, China; and a relatively small but noticeable potential output growth decline for Singapore; Taipei,China; and Japan. The results are not surprising given that Indonesia and Thailand are known to have suffered the most from the 1997/98 crisis.

For the 2008/09 crisis, Singapore registers the largest potential output growth reduction using the HP filter and BN decompositions methods, and second largest potential output growth reduction using the BP–CF method. This can be explained by Singapore's large dependence on exports and foreign capital flows. All three methods likewise registered no (or negligible) potential growth reductions for the PRC, Indonesia, and India. The reasons behind the results for the PRC and India include the PRC's injection of a large fiscal stimulus package into the economy and India's lower level of export dependency compared to the East Asian economies.

4.2 Accounting for Structural Breaks Using Markov Switching

To account for structural breaks, the Markov switching model as a generalized Hamilton model and modified by Lam (1990) and Kim (1994) was applied to nine East Asian

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9 Includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and United Kingdom.

economies.[10] The resulting level of potential output is then compared to the estimates obtained from the HP filter. This is shown in Figures 2a–2i. Generally the results from the MS regime methodology and the HP filter do not deviate significantly from each other. However, there are distinct differences.

The MS results are more jagged, which is to be expected since the methodology is sensitive to breaks in the data and the HP is a smoothing procedure. In only one economy is the difference between the two estimates relatively large: Malaysia. The authors unfortunately cannot offer a credible reason for this. Figure 2d shows that from 1984 to 1991 the HP estimates were consistently below the MS estimates, while the reverse is true from 1991 to 2007.

The difference between the two methodologies shows up more clearly in the estimates of the output gap in Figures 3a to 3i. Except for Malaysia and Singapore, the output gap estimates for MS are smaller than those from the HP filter. This is to be expected since in the MS methodology the switch in regimes is loaded into the potential component of output. Another consequence of this bias in loading is that the output gap for the MS methodology becomes positive after the 1997/98 crisis for many key economies including Indonesia, Malaysia, Singapore, Thailand, and Korea. This counterintuitive result implies that the crisis caused a fall in potential output that was larger than the fall in actual output. The weakness in the original MS methodology was supposed to have been addressed by the algorithm of Kim and Piger (2002), and Kim and Murray (2002).

5. Post-Crisis Trends in Potential Output

5.1 Explaining Behavior of Potential Output

For the purposes of this study, it is important to determine whether or not estimated potential outputs—using both the MS and HP methods—for the nine economies will follow the same general pattern after the 1997/98 crisis. To determine the applicable scenario among Scenarios 1, 2, and 3, the trend of potential output immediately prior to the 1997/98 crisis was estimated from data obtained from the MS method. A simple linear trend was estimated—mostly based on the period from the first quarter of 1990 to the second quarter of 1997—and extended. This is shown as a black dashed line in the graphs.[11]

While it is still too early to tell how the 2008/09 crisis will affect medium-term output performance, the path of potential output following the 1997/98 crisis can provide valuable insights. Output declined for most economies in emerging East Asia[12] in the wake of the 1997/98 crisis. While the causes and impacts of the crisis are well

[10] We are grateful to Carlos C. Bautista for providing us a copy of the GAUSS algorithm to estimate potential output using this method. The algorithm can be provided upon request.

[11] A similar analysis will result if the trend is based on the HP estimate of potential output.

[12] Throughout this paper, emerging East Asia refers to nine selected economies of developing Asia: the PRC; Hong Kong, China; Indonesia; Korea; Malaysia; the Philippines; Singapore; Taipei,China; and Thailand.

documented, an extensive analysis of the recovery process is still limited. In particular, the behavior of potential output over an extended period of time has not been adequately studied for emerging East Asian economies. Of particular interest is which scenario in Figure 1—Scenario 1, Scenario 2, or Scenario 3—materialized for each economy. The different outcomes can be traced to the set of policies implemented to cope with the crisis.

The patterns of post-1997/98 crisis recoveries differ significantly across borders, particularly between three groups of economies. The first group comprises Singapore; Hong Kong, China; Korea; and Malaysia. The second group includes Indonesia and Thailand; and the third group covers the PRC; Philippines; and Taipei,China. The first group generally follows Scenario 1 and the second and third groups follow Scenario 2. Among the third group, potential output did not seem to be affected by the 1997/98 crisis and eventually exceeded levels consistent with pre-crisis trends.

In Hong Kong, China; Korea; Singapore; and Malaysia, the levels of potential output reverted to levels consistent with pre-crisis trends after an initial drop in the wake of the crisis. Hong Kong, China experienced the largest fall and longest recovery period at about 10 years. The absence of currency flexibility may have contributed to this situation. Unlike the other economies, Hong Kong, China saw the Hong Kong dollar appreciate in real effective terms in 1997 and 1998. The real effective exchange rate of the Hong Kong dollar did not return to its 1996 level until 2003.

Greater openness seemed to be one of the major factors that allowed this group to ride out the crisis. According to some studies,[13] sharp currency depreciations were one of the main contributors to the quick recovery of economies in the region as the resulting increase in exports helped economies to emerge from the crisis. This export orientation also helped maintain the pace of technological progress as measured by total factor productivity (TFP). Estimates confirm that TFP growth collapsed during the crisis, but has since reverted to earlier trends. Other estimates show that Korea; Singapore; and Taipei,China had a higher level of TFP than the ASEAN-4 economies[14] did many years after the 1997/98 crisis.[15] Data from the United Nations Conference on Trade and Development (UNCTAD) show that the first group of economies referenced above—plus Taipei,China—have a higher index of technological activity (Table 4). This technological advantage helped the newly industrialized economies (NIEs)[16] and Malaysia to return to a level of potential output that is consistent with their pre-crisis trend.

In the case of Indonesia and Thailand, the 1997/98 crisis shifted the potential output path downward from the pre-crisis trend level, although growth eventually recovered to the pre-crisis rate. The impact of financial crises on the level of potential output tends to be long-lasting for these two countries. Abiad et al. (2009) find that the path of output

[13] Park and Lee (2002).

[14] ASEAN-4 comprises Indonesia, Malaysia, Philippines, and Thailand.

[15] APO (2004) as cited by ADB (2007) reports estimated TFP growth until 2000. Kidsom (2008) shows that in 2004 the level of TFP of the NIEs was higher than that of ASEAN-4.

[16] NIEs includes Hong Kong, China; Republic of Korea; Singapore; and Taipei,China.

tends to be depressed substantially and persistently following the crisis as a result of reductions in the employment rate, capital-to-labor ratio, and TFP in roughly equal proportions after analyzing 88 cases of financial crises over the past 4 decades. They also argue that "capital and employment tend to suffer enduring losses relative to the pre-crisis trends." In emerging East Asia, Park and Lee (2002) and ADB (2007) find that the main cause of the decline in potential output was the sharp contraction in investment and lower capital accumulation afterwards. Some argue that the drop in investment and capital stock in the pre-crisis period might be overestimated if an investment boom preceded the crisis and as a result investment was at unsustainable levels prior to the crisis. Nevertheless, the crisis seems to have reduced incentives to invest in capital and thus slowed capital accumulation.[17]

The output path in the PRC; Taipei,China; and the Philippines seem fairly unaffected by the 1997/98 crisis, albeit for the reasons that are completely different. The PRC's strong growth momentum continued with its relatively closed economic and financial systems unaffected by the crisis. Prior to the 1997/98 crisis, the PRC boasted huge foreign reserves, low external debt, and sound economic fundamentals, which allowed it to ride out and counter speculative attacks against its currency. Also, the slow pace of financial liberalization meant there was little opportunity for foreign speculators to tap the domestic capital market. This lessened the magnitude of uncontrolled capital movement. In the Philippines, potential output languished in the 1980s and the momentum of its economic recovery in the 1990s seems to have overcome the adverse impacts of the 1997/98 crisis (Figure 2h). In fact, the level of potential output at a certain point during the 1997/98 crisis is estimated to have exceeded the level consistent with the pre-crisis trend. Moreover, the Philippines did not benefit as much from pre-crisis capital inflows compared with other East Asian economies and therefore was not as severely affected by the abrupt withdrawal of capital from the region.

Apart from its technological advantage, Taipei,China's relatively good performance immediately after the 1997/98 crisis is attributed to several factors similar to those present in the PRC at the time of the crisis. For one, the Taipei,China's huge foreign reserves, low external debt, and sound economic fundamentals allowed it to withstand speculative attacks against its currency. Also as in the PRC, the slow pace of financial liberalization meant there was little opportunity for foreign speculators to tap the domestic capital market. This lessened the magnitude of uncontrolled capital movement. In addition, Taipei,China adopted a moderately loose monetary policy that kept the price range within reasonable levels.

Strictly speaking, Taipei,China belongs to the first group since the economy experienced a recession in 2001 and Figure 2i depicts a Scenario 1 pattern. The recession was brought about by the downturn in the global electronics market, increase in the number of bad loans in the financial sector, and continued migration of Taipei,China's manufacturers to the PRC to take advantage of cheaper costs for land and labor. However, since the fall in potential output was mild and not related to the 1997/98 crisis, Taipei,China is included in the third group.

[17] Furceri and Mourougane (2009).

Differences in initial conditions, country-specific reasons, and policy responses exerted significant influence on the patterns of post-crisis recovery. The cross-country comparison of post-crisis recoveries suggests three important elements contribute to a healthy recovery. First are the initial conditions. Economies with relatively sound economic fundamentals stand a better chance in dealing with a shock. Second, continued openness and currency flexibility allowed some economies to tap external demand when domestic demand slackened. Luckily, a favorable external environment during the 1997/98 crisis helped the region in the recovery process. Third, swift policy responses to mitigate the initial crisis impact proved beneficial not only in the short-term, but also later in the medium- to long-term, by minimizing disruptions in asset allocation, such as a rise in unemployment and a deterioration in capital stock. Finally, the crisis prompted corporate restructuring and structural reforms in many emerging East Asian economies. Their medium-term output performances reflect the success of these reforms.

5.2 Econometric Evidence

A simple growth model was estimated to provide econometric evidence for the arguments in the previous section (Appendix 1). The results indicate that the investment-to-GDP ratio exerts a positive and significant impact on per capita growth of potential output. Policy variables represented by government consumption and money supply also affect the dependent variable significantly.

The significant impact of the growth rate of major industrialized economies implies that greater openness and a favorable global economy support the expansion of potential output. However, the impact of the real effective exchange rate is ambiguous as explained in Appendix 1. The econometric results, however, do not refute the need for a depreciation that will restore external balance.

An interesting result is the positive and significant impact of the level of technological activity in the random-effects version of the econometric results. While the variable is insignificant in the fixed-effects model, the study presents enough evidence to support policies that enhance an economy's technological capability.

6. Implications for Responses to the 2008/09 Crisis

6.1 Output Gap, Exit Strategies, and Medium-Term Policies

Output losses associated with crises are significant, but appropriate policy responses can shape the post-crisis recovery and help contain medium-term output losses. The forecast-adjusted simple HP filtered estimates and the MS estimates suggest a drop in potential output growth for emerging East Asian economies.[18] Consistent with earlier

[18] The output gaps derived from HP estimates are used for the analysis in this section. The MS output gaps are relatively small and have a counterintuitive sign particularly after the 1997/98 crisis. As explained earlier, this is because the switch in regimes is loaded into the potential component of output.

studies, potential output is likely to have been reduced by the 2008/09 crisis. However, the drop was generally milder during this crisis compared to the 1997/98 crisis. The previous crisis experience also shows large variations in the post-crisis recovery patterns of individual economies. The key challenge for policymakers is therefore to implement policies that will close the output gap and at the same time stem the decline in potential output.

Policy adjustments at the macroeconomic level are an integral part of the recovery process. A critical difference between the 1997/98 crisis and the 2008/09 crisis is the size and promptness of monetary and fiscal responses. Short-run monetary and fiscal policy stimuli proved effective in dealing with immediate crisis effects in 2008/09.[19] Output gaps (Figures 3a to 3i) show that many economies reached their troughs in the first quarter of 2009, only one quarter after the crisis created negative output gaps. This can be attributed to timely and sizeable policy support. In contrast, during the 1997/98 crisis, the output gaps were largely negative for nearly 2 years from the first quarter of 1998. Recent studies also find that short-run expansionary macroeconomic policies are positively correlated with smaller output and growth losses (Abiad et al., 2009).

While expansionary macroeconomic policies have been moderately successful in narrowing the negative output gap, careful monitoring of the output gaps is important to avoid risks of mistimed exits. In the wake of the recent crisis, the first order of business was to design and implement fiscal stimulus packages, and to loosen monetary policy. The swift policy responses have been moderately successful as GDP growth for East Asian economies was generally higher in the second and third quarters of 2009 compared with the first quarter. However, fiscal policy has to be consolidated and monetary policy has to be tightened in due time otherwise the recovery will be snuffed by inflationary pressures. Output gaps can be a useful guide in timing an exit strategy. For the majority of the region's economies, the forecast-adjusted, simple HP-filtered estimates suggest that output gaps remain negative. Although a declining trend is detected, the negative output gap suggests that any talk of exit strategies is still premature. The exceptions to this are the PRC and Indonesia, where output gaps are turning positive.

The region's policymakers need to look into instituting more structural measures designed to counter the permanent effects of a crisis on output. It is important for policymakers to be able to determine whether the downturn in GDP during crisis years is associated more with the cyclical components or a reduction in the potential output. Cyclical downturns might be countered with fiscal and monetary countercyclical policy. On the other hand, a permanent reduction in potential output growth is better addressed with more structural changes (such as policies to reduce the structural rate of unemployment). The estimated results using the forecast-adjusted, simple HP-filter and the MS methodology suggest that for some countries and regions, both the 1997/98 and 2008/09 crises reduced potential output growth. Therefore, future crises are likely to once again lead either to Scenario 2 or Scenario 3, rather than Scenario 1. For economies that did experience a Scenario-1-type pattern, the importance of productivity-retaining measures was underscored. This again makes further structural reforms a

[19] This is also supported by the econometric evidence presented in Appendix 1.

priority. An exit strategy from the stimulus measures and a shift to policies that focus more on medium-term economic growth is, therefore, very important.

A major policy consideration is how to lift potential output to minimize medium-term output losses while sustaining a recovery's momentum. A crisis provides incentives and catalysts for structural reforms. Economies that have seized the opportunity were often able to grow faster and achieve higher potential output even after a crisis. Although necessary structural reforms are country-specific, many of these structural policies are medium-term in nature (e.g., education and R&D). Hence, there should be investment programs in the pipeline as the stimulus measures are withdrawn. Additional key actions that can contribute to national economic recovery include the strengthening of the banking sector and financial markets, control of inflation, and timely provision of fiscal stimuli. Measures to reduce unemployment have also been largely successful, although larger numbers of workers are employed in the informal sector in many developing countries.

6.2 Regional Rebalancing

Since a favorable external environment is crucial to the full recovery of potential output and the timing of recovery of industrialized economies is uncertain, rebalancing the sources of growth toward greater domestic and regional demand is important. In this context, it is important to distinguish between rebalancing at the regional level and rebalancing at the national level (or domestic level) and how these two processes relate to each other. A framework as shown in Figure 4 should be developed as the basis for appropriate policies.

Some experts have noted that Asia's outward-oriented development model does not need to be overhauled. Rather, what will be required is an adjustment in net exports and some shift toward production for Asian demand. In other words, the main thrust of regional rebalancing should be an increase in intra-regional trade and investment among East Asian economies, but with more of the final exports going to economies in the region instead of the US and Western Europe. In order to facilitate this transition, some economies have to import more from their neighbors, which implies increasing their domestic spending (consumption and investment). Hence, rebalancing will lead to an increase in the level of potential output.

The strategy of coordinating regional and domestic rebalancing will allow the economies of East Asia to retain their outward orientation and overcome the threat of protectionism. As indicated earlier, openness was crucial for the NIEs in maintaining their technological edge. The relatively stable real effective exchange rates of the nine economies of emerging East Asia, largely due to the absence of disruptions in the balance sheets of the financial and corporate sectors, will also contribute to maintaining an outward orientation.

7. Appendix

Appendix 1: Econometric Model and Empirical Results

Model

To guide policymakers and provide econometric evidence for the arguments laid out in the text, a simple growth model is estimated. Instead of actual gross domestic product (GDP) growth being the dependent variable, the per capita growth rate of potential output is used. The estimated model is as follows:

$$GR_{it} = f\left(\frac{I}{GDP}_{i,t-k}, \widehat{GC}_{i,t-l}, \widehat{REER}_{i,t-m}, \widehat{MS}_{i,t-n}, GR_{US_{JAP_{EU}}}, GDP_{i,0}, TA_{it}\right)$$

GR_{it} is per capita growth rate of economy i at time t, $\frac{I}{GDP}_{i,t-k}$ is the investment-GDP ratio of economy i lagged k periods; $\widehat{GC}_{i,t-l}$ is government consumption growth y-o-y in real terms for economy i lagged l periods; $\widehat{REER}_{i,t-m}$ is the year-on-year (y-o-y) percentage in the real effective exchange rate for economy i lagged m periods, with positive value indicating an appreciation; $\widehat{MS}_{i,t-n}$ is y-o-y money supply growth in real terms for economy i lagged n periods; $GR_{US_{JAP_{EU}}}$ is the weighted average of the y-o-y real GDP growth rate of the United States (US), Japan, and Europe, with weights fixed at 42%, 14%, and 44%, respectively; $GDP_{i,0}$ is the per capita income of economy i in 1990 in PPP$; and TA_{it} is the level of technological activity for economy i as reported in Table 4, with the 1995 figure being applied to 1990–1999 and the 2001 figure being applied to 2000–2009.

The growth model is patterned after Park and Lee (2002) since the economy's behavior after the 1997/98 crisis is of interest in this study. The investment-to-GDP ratio indicates the rate at which the capital stock is augmented. Data on the latter variable is not available for all economies hence I/GDP is used instead. Differences in initial conditions could affect future growth rates and also the pattern of adjustment to a crisis. In growth theory, an economy with a lower initial per capita GDP is in a more favorable position for future growth. The fundamental idea is that the gap in existing capital and technology between the current and steady-state levels provides an opportunity for "catching up" via high rates of capital accumulation as well as diffusion of technology from more advanced economies. This is the rationale for the variable GDP_0.

Meanwhile, macroeconomic and structural reform policies implemented by the government for crisis management can influence the behavior of both actual and potential output. Fiscal policy can shore up domestic demand while monetary policy usually plays a crucial role in determining consumption and investment. While the major concern of policymakers would be short-term output growth, implementing appropriate stimulus measures has repercussions on medium- and long-term output growth. For example, if government does not compensate for a sharp drop in private sector demand, there may be a permanent loss of employment.

An important variable in the adjustment process is the exchange rate. The large real exchange rate depreciation in many economies of East Asia after the 1997/98 financial crisis restored their external balance. This helped facilitate a quick recovery in their respective economies. The favorable global environment at the time of the 1997/98 crisis also supported the current account balance through sustained export demand.

Given the importance of technology in endogenous growth models, a variable representing technological activity is included in the model. Unfortunately, there is no measure of technological capability at the country level on a regular basis (Archibugi and Coco, 2005). What is used in the econometric model is a technological activity index reported by the United Nations Conference on Trade and Development (UNCTAD), but only for 2 years. The rankings of the level of technological activity, however, reflect the degree of recovery of the nine economies from the 1997/98 crisis.

Estimation procedure

Since a combination of time series and cross section data is used, a traditional fixed-effects model was estimated in order to determine the optimal number of lags. After this, the possibility of improving the estimation to account for non-stationary and heterogeneous behavior was considered. This was done by using the mean-group estimator of Pesaran and Smith (1995) and Pesaran, Shin, and Smith (1998), which involves assuming that given the dependent variable Y and explanatory variables Xs, there is a short-run and long-run behavior of the cointegrating variables:

$$\Delta y_{it} = \phi * (y_{i,t-1} - \beta x_{i,t}) + \sum_{j=1}^{p} \alpha_j \Delta y_{i,t-j} + \sum_{j=1}^{q} \gamma_j \Delta x_{i,t-j} + \varepsilon_{it}$$

Where ϕ is the error correction speed of adjustment parameter to be estimated; β is a k x 1 vector of parameters; α and γ are parameters to be estimated; x_{it} is a (1 x k) vector of covariates; and ε_{it} is the error term.

The model was estimated using Stata, but results indicated that the log likelihood function was non-concave. One possible reason was that the dependent variable—per capita growth of potential output—or some or all of the covariates are stationary. This was a logical deduction since many of these variables are percent changes, thereby inherently involving differencing. Panel unit root tests developed by Im–Pesaran–Shin confirmed this.

This outcome ruled out the Pesaran–Smith model. Instead, improvements on the fixed effects model were obtained by testing for cross-sectional dependence, i.e., whether the residuals from the fixed effects model are correlated across entities. The test results indicate the presence of cross sectional dependence and following Hoechle (2007), adjustments are applied by estimating the model with Driscoll–Kraay standard errors. The results are shown in Table A.1.

Meanwhile, a standard random-effects model was estimated using generalized least squares taking into account heteroscedasticity and contemporaneous correlation among the variables. The results are shown in Table A.2. Estimates from a random-effects model are generally more efficient than those from a fixed-effects model. However, the latter always yields consistent estimates. Moreover, since choice of the economies in the study is pre-determined, the fixed-effects model is theoretically more appropriate.

Data

Quarterly real GDP data series for the nine emerging East Asian economies, Japan, US, and aggregate Europe were constructed for the period from 1980 to 2010. Data from 1980Q1 to 2009Q2 were sourced from Oxford Economics. Figures from 2009Q3 to 2010Q4 were derived from the quarterly pattern of Oxford Economics forecasts using the annual GDP growth rate forecasts from the Asian Development Outlook Update 2009. Data for the emerging East Asian economies on real private consumption (from 1980–2010), real total fixed investment (from 1980–2010), government consumption expenditures in current prices (from 1980–2009), and money supply (M2 and M3, from 1980–2009) were also sourced from Oxford Economics.[20] All data not seasonally adjusted at the source were adjusted using Eviews 6, X12 Census method. Money supply and government consumption were deflated using consumer price index (CPI) data obtained from Oxford Economics.[21]

Population data used in the model was from the World Economic Outlook Database October 2009 and the Technology Activity Index for 1995 and 2001 was taken from the UNCTAD World Investment Report 2005. Data on the real effective exchange rate was sourced from Bloomberg with the exception of PRC data, which was obtained from the International Monetary Fund's (IMF) International Finance Statistics database.

Results

Estimated coefficients generally conform to expectations and those that do are statistically significant. The main difference from the fixed-effects model (Table A.1) and the random-effects model (Table A.2) is the sign and significance of initial GDP and the variable representing technological activity. These two variables carry the correct sign and are significant in the random-effects model.

The investment-to-GDP ratio is significant when it is lagged one and four periods. The coefficient of the former carries the expected positive sign, while the variable lagged four periods negatively affects growth of per capita GDP, a counter-intuitive result. The combined coefficients, however, yields a net positive impact, confirming the role of investment in driving potential output.

[20] However, M3 data for Indonesia and Taipei,China are missing while figures for the Philippines from 1982Q1 to 1986Q3 were estimated based on data from the Central Bank of the Philippines.

[21] CPI data for the nine emerging East Asia economies were obtained from Oxford Economics, with the exception of data for Hong Kong, China, which was downloaded from CEIC.

The policy variables are also significant, with the fixed-effects model showing significant coefficients for government consumption and money supply when they are lagged two periods. In the case of random-effects, government consumption lagged one period is also significant. This conforms to conventional wisdom that fiscal policy—while normally longer to design and implement—has a quicker impact on economic activity.

The only problematic variable is the real effective exchange rate (REER). The expected sign is negative since an undervalued currency is more supportive of economic growth. The coefficient of the percentage change of REER is negative and significant when the variable is lagged four periods. However, it is positive and significant when lagged one and two periods. Moreover, combining the coefficients yields a net positive value. Most likely the time period involved does not capture the long-term dynamics of exchange rate behavior and economic growth. Another possible reason is that the percentage change in REER does not capture the degree of over-valuation or under-valuation of a particular currency, which is the important concept in explaining economic growth.

Meanwhile, the combined economic growth of industrialized economies yields a positive and significant coefficient. The dummy variable representing the 1997/98 crisis and its aftermath carries a negative coefficient. As mentioned earlier, the fixed-effects model and random-effects model yield contrasting results for the technology variable and the variable representing initial conditions. Nevertheless, this is an indication that both variables are important in explaining the behavior of potential output.

Figure 1: Possible Impacts of a Crisis on Outputs

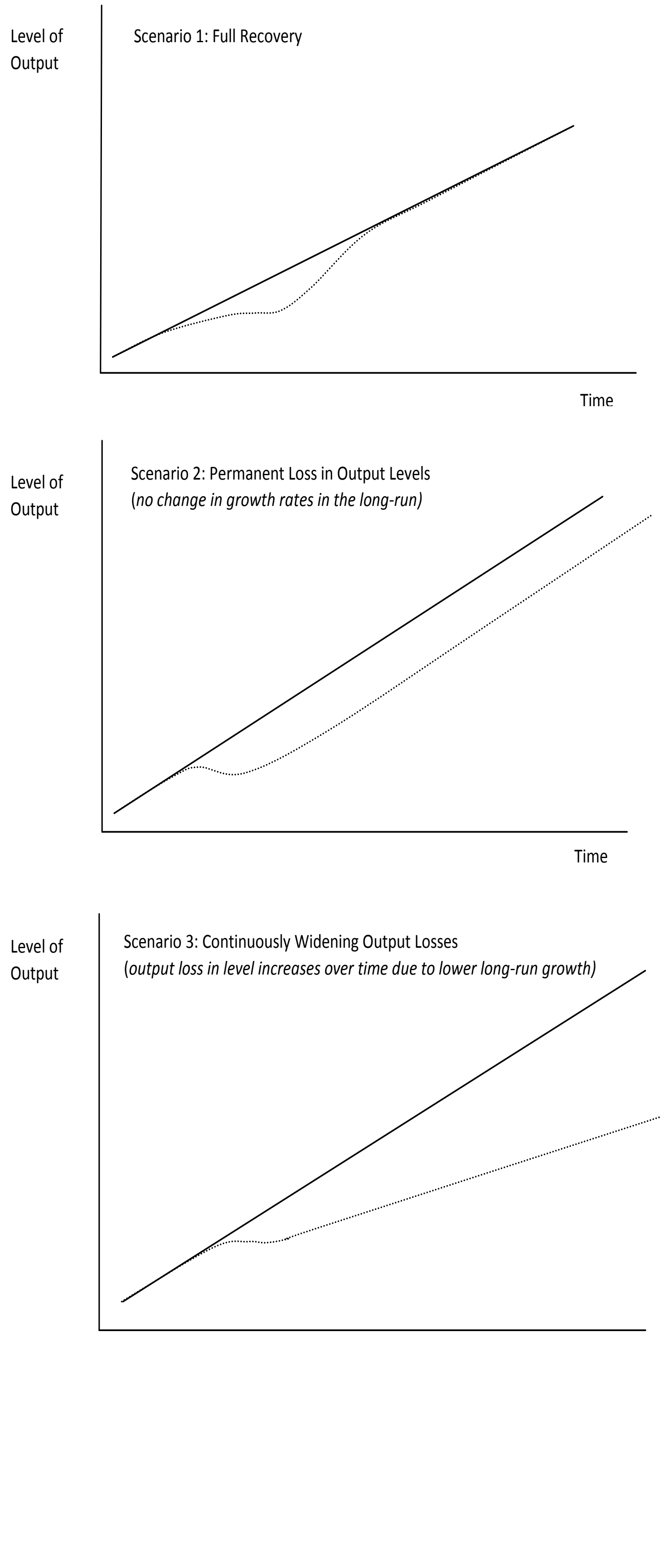


Table 1: Potential Output Growth Rates[1] (using HP filter)

	1985Q1–1989Q4	1990Q1–1994Q4	1995Q1–1997Q2	1997Q3–1999Q4	**1997/98 crisis reduction in potential growth**	2000Q1–2004Q4	2005Q1–2007Q4	2008Q1–2009Q2	**2008/09 crisis reduction in potential growth**
	(1)	(2)	(3)	(4)	**(5)=[ave(1:3)]-(4)**	(6)	(7)	(8)	**(9)=[ave(6:7)]-(8)**
China, People's Republic of	9.6	10.7	10.2	8.5	**1.7**	9.4	10.8	9.7	**0.2**
Hong Kong, China	7.4	5.3	3.0	1.7	**3.9**	4.0	5.1	2.7	**1.7**
India	5.4	5.5	6.3	5.8	**-0.3**	6.5	8.4	7.6	**-0.4**
Indonesia	7.2	8.1	4.1	0.4	**6.5**	3.5	5.7	5.5	**-1.2**
Korea, Republic of	9.3	7.8	5.5	4.3	**3.7**	5.0	3.9	2.5	**2.1**
Malaysia	5.9	9.6	6.9	3.8	**3.7**	4.9	5.0	3.3	**1.7**
Philippines	1.8	2.9	3.8	3.4	**-0.8**	4.5	5.1	4.1	**0.6**
Singapore	7.1	9.2	7.5	5.1	**2.9**	5.1	5.6	2.6	**2.7**
Taipei,China	9.0	7.4	6.3	5.0	**2.8**	3.9	3.4	1.2	**2.5**
Thailand	9.2	9.1	3.5	0.5	**7.5**	4.3	4.4	2.3	**2.0**
Europe[2]	2.9	1.9	2.3	2.7	**-0.4**	2.2	1.5	0.2	**1.7**
Japan	4.9	2.5	1.0	0.6	**2.6**	1.3	1.1	-0.5	**1.7**
United States	3.5	2.6	3.7	3.9	**-0.7**	2.9	2.0	0.8	**1.8**

[1] Each period uses average year-on-year growth rates.
[2] Includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and United Kingdom.
Source: OREI staff calculations using gross domestic product (GDP) figures from Oxford Economics and forecast GDP growth rates from ADB's *Asian Development Outlook Update 2009*.

Table 2: Potential Output Growth Rates[1] (using BN decomposition)

	1985Q1–1989Q4	1990Q1–1994Q4	1995Q1–1997Q2	1997Q3–1999Q4	**1997/98 crisis reduction in potential growth**	2000Q1–2004Q4	2005Q1–2007Q4	2008Q1–2009Q2	**2008/09 crisis reduction in potential growth**
	(1)	(2)	(3)	(4)	**(5)=[ave(1:3)]-(4)**	(6)	(7)	(8)	**(9)=[ave(6:7)]-(8)**
China, People's Republic of	11.6	6.6	10.1	8.2	**1.1**	7.8	9.9	12.0	**-3.4**
Hong Kong, China	7.2	5.5	3.8	-0.7	**6.5**	4.4	6.8	0.3	**5.0**
India	5.5	4.8	7.2	5.8	**-0.3**	5.9	9.3	7.1	**0.0**
Indonesia	6.5	8.1	7.5	-4.2	**11.5**	4.5	5.9	5.6	**-0.6**
Korea, Republic of	9.1	7.8	7.6	1.7	**6.6**	5.5	4.7	0.8	**4.4**
Malaysia	4.7	9.2	9.7	0.7	**6.8**	5.6	5.6	2.7	**3.0**
Philippines	2.8	1.9	5.3	2.1	**0.8**	4.7	5.8	2.9	**2.3**
Singapore	6.4	9.1	7.9	4.2	**3.6**	5.0	7.8	-1.2	**7.3**
Taipei,China	9.0	7.0	6.5	5.4	**2.2**	3.7	4.6	-0.9	**4.9**
Thailand	8.6	9.0	7.0	-3.5	**12.0**	5.1	4.9	1.5	**3.5**
Europe[2]	3.0	1.6	2.3	2.7	**-0.4**	2.2	2.5	0.6	**1.7**
Japan	5.1	2.3	2.3	-0.7	**4.1**	1.5	2.0	-2.4	**4.1**
United States	3.8	2.3	3.4	4.5	**-1.4**	2.7	2.6	-0.1	**2.7**

[1] Each period uses average year-on-year growth rates.
[2] Includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and United Kingdom.
Source: OREI staff calculations using gross domestic product (GDP) figures from Oxford Economics and forecast GDP growth rates from ADB's *Asian Development Outlook Update 2009*.

Table 3: Potential Output Growth Rates[1]
(using Band Pass-Christiano Fitzgerald method)

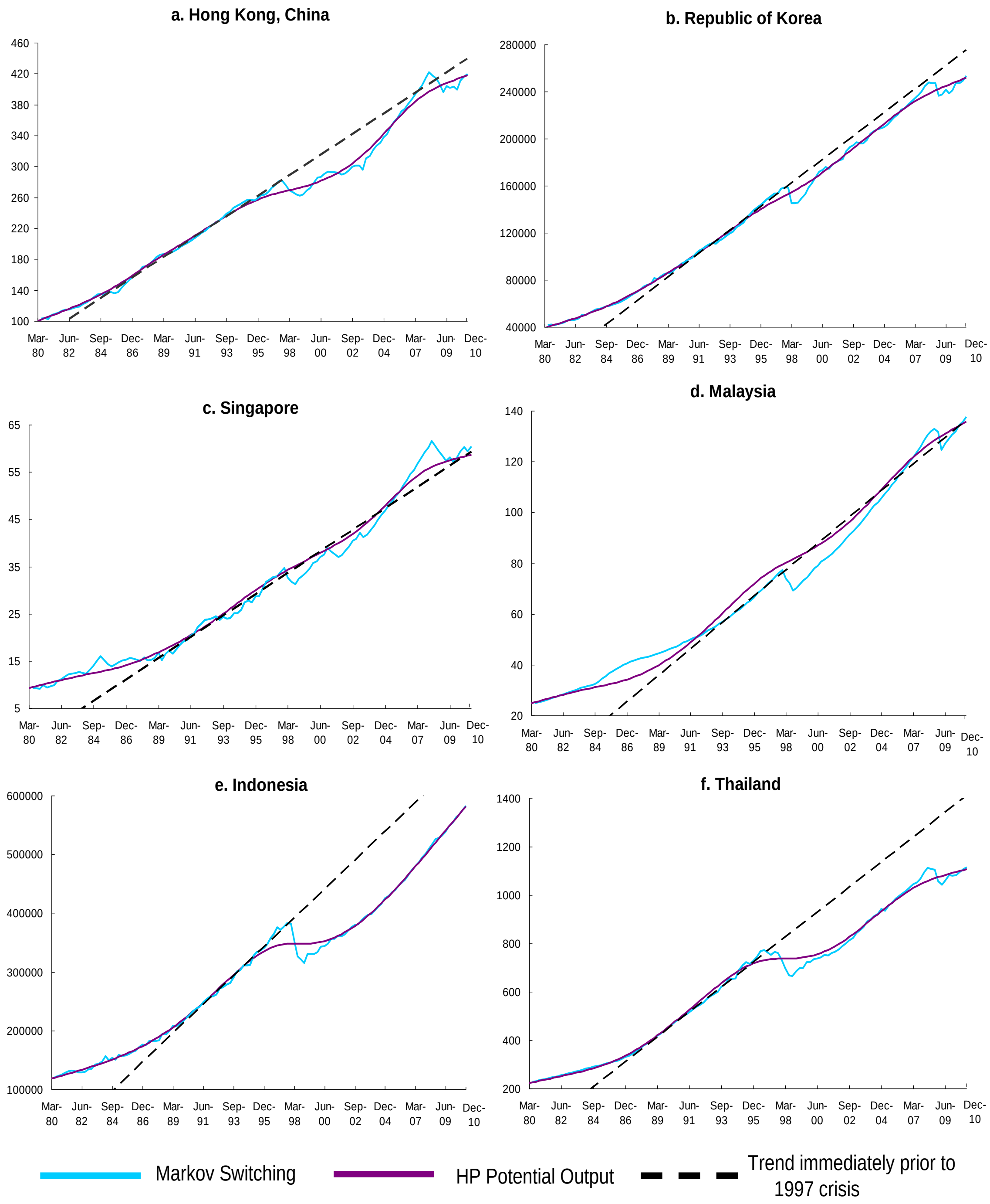
	1985Q1–1989Q4	1990Q1–1994Q4	1995Q1–1997Q2	1997Q3–1999Q4	**1997/1998 crisis reduction in potential growth**	2000Q1–2004Q4	2005Q1–2007Q4	2008Q1–2009Q2	**2008/2009 crisis reduction in potential growth**
	(1)	(2)	(3)	(4)	**(5)=[ave(1:3)]-(4)**	(6)	(7)	(8)	**(9)=[ave(6:7)]-(8)**
China, People's Republic of	9.3	10.6	11.1	8.4	**1.8**	8.9	11.5	9.8	**0.1**
Hong Kong, China	7.8	5.2	3.7	1.0	**5.0**	4.1	5.4	2.5	**2.0**
India	6.7	4.5	7.4	5.9	**0.1**	6.0	9.1	7.8	**-0.7**
Indonesia	6.7	8.8	4.0	0.0	**7.0**	3.5	6.1	5.1	**-0.6**
Korea, Republic of	9.4	8.0	5.4	3.9	**4.1**	5.3	3.7	2.4	**2.2**
Malaysia	5.3	10.2	7.0	3.2	**4.4**	4.9	5.3	2.9	**2.2**
Philippines	2.0	2.7	4.0	3.9	**-1.2**	4.1	5.8	3.9	**0.9**
Singapore	7.3	9.0	8.6	4.4	**3.8**	4.9	6.0	2.8	**2.5**
Taipei,China	9.8	6.8	7.5	4.5	**3.6**	3.8	3.7	1.3	**2.5**
Thailand	8.7	10.0	3.3	-0.6	**8.7**	4.8	4.4	1.5	**3.2**
Europe[2]	3.4	1.5	2.7	2.8	**-0.4**	2.2	1.6	0.2	**1.7**
Japan	5.4	2.3	1.0	0.4	**2.9**	1.4	1.2	-0.6	**2.0**
United States	4.0	2.2	4.4	3.8	**-0.5**	2.9	2.0	0.7	**1.9**

[1] Each period uses average year-on-year growth rates.

[2] Includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden Switzerland and United Kingdom.

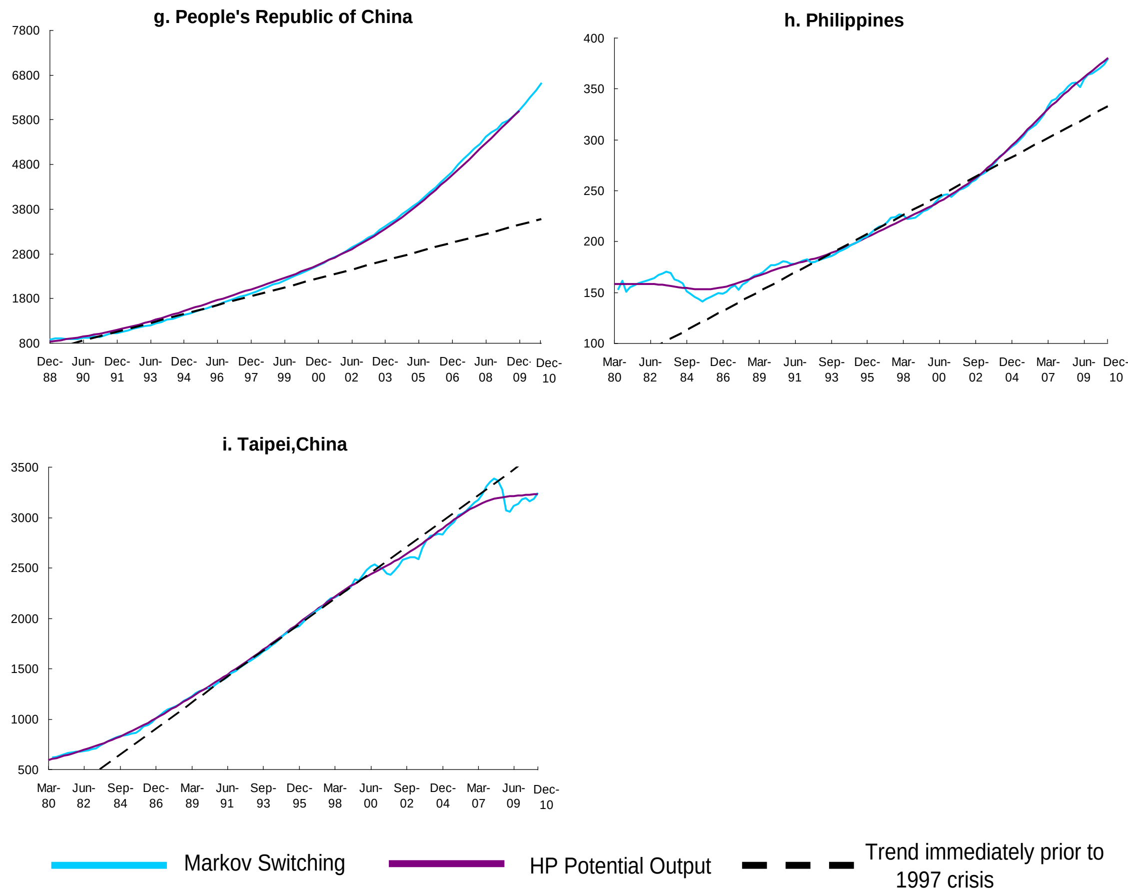
Source: OREI staff calculations using gross domestic product (GDP) figures from Oxford Economics and forecast GDP growth rates from ADB's *Asian Development Outlook Update 2009*.

Figure 2: Potential Output (local currency, billion)



Source: Authors calculations using gross domestic product (GDP) data sourced from Oxford Economics and forecast GDP growth rates from the *Asian Development Outlook 2009 Update.*

Figure 2: ***continued***



Source: Authors calculations using gross domestic product (GDP) data sourced from Oxford Economics and forecast GDP growth rates from the *Asian Development Outlook 2009 Update.*

Figure 3: Output Gap

Figure 3: *continued*

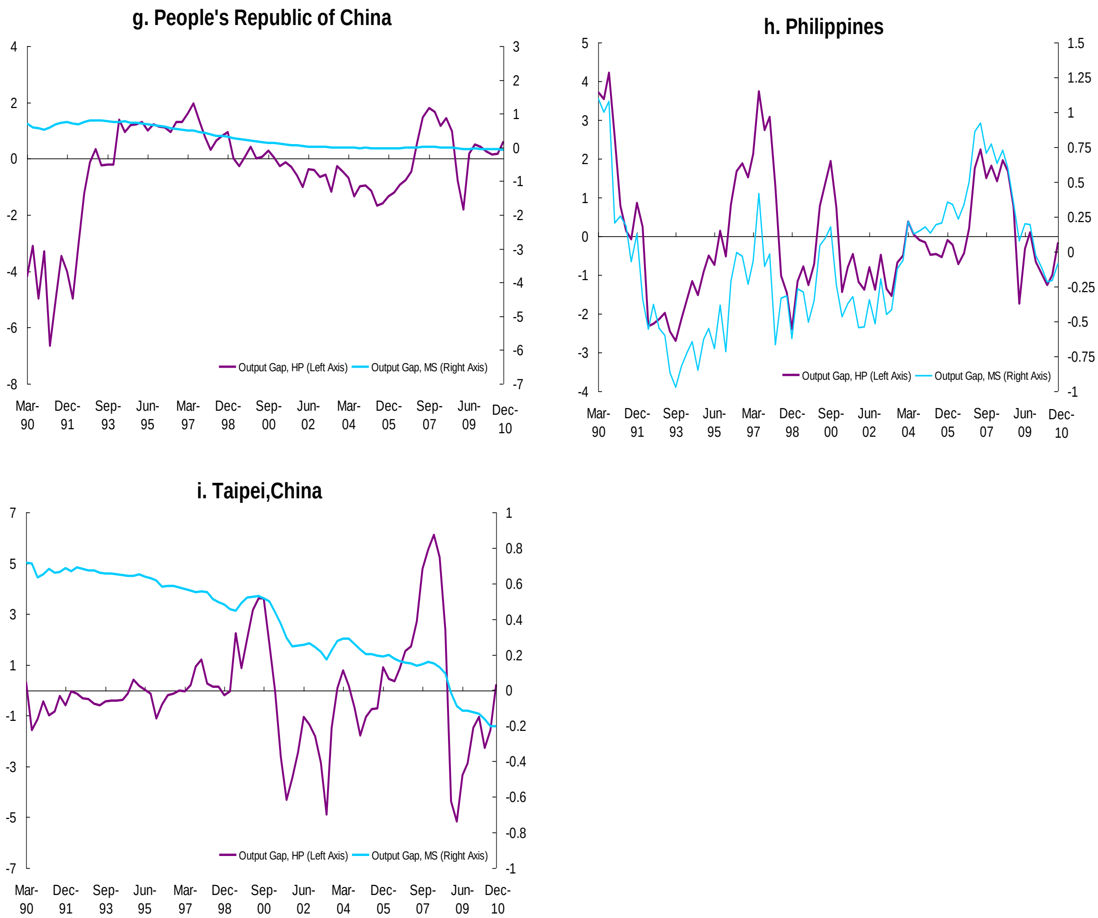


Figure 4: Linking Regional and Domestic Rebalancing

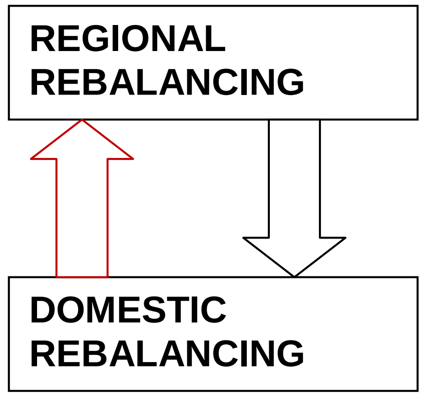


Table 4: Technological Activity Index

	Rank (out of 117 countries)	Country	1995 Index	Rank (out of 117 countries)	Country	2001 Index
High Innovation	3	Japan	0.949	5	Japan	0.935
	10	Taipei,China	0.89	7	Taipei,China	0.902
	18	Singapore	0.803	12	Singapore	0.875
	24	Korea, Republic of	0.762	20	Korea, Republic of	0.812
Medium-high Innovation	37	Hong Kong, China	0.613	33	Hong Kong, China	0.632
	61	Malaysia	0.401	55	Malaysia	0.446
	63	China, People's Republic of	0.39	58	China, People's Republic of	0.417
	67	Thailand	0.34	61	Thailand	0.361
	76	Philippines	0.264	80	Philippines	0.265
	85	Indonesia	0.203			
Low Innovation				93	Indonesia	0.175

Source: UNCTAD. World Investment Report, 2005

Note: Each component of the Index has equal weights, the Index value being the simple average of the normalized value of the three variables: R&D manpower, patents in the United States and scientific journal articles.

Table A.1: Regression with Driscoll–Kraay Standard Errors

Pesaran's test of cross sectional independence = 8.664, Pr = 0.0000

Average absolute value of the off-diagonal elements = 0.223
Time period: 1990.1 to 2009.2
Number of obs = 702
Method: Fixed-effects regression
Group variable (i): country
maximum lag: 3

Number of groups = 9
F(16, 8) = 106.12
Prob > F = 0.0000
within R-squared = 0.5020

gr_opc	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
$I/GDP_{i,t-1}$	44.30594	11.34307	3.91	0.005	18.14877	70.46311
$I/GDP_{i,t-2}$	1.766473	13.11754	0.13	0.896	-28.48262	32.01557
$I/GDP_{i,t-3}$	-11.73668	11.00396	-1.07	0.317	-37.11184	13.63849
$I/GDP_{i,t-4}$	-35.71371	9.817551	-3.64	0.007	-58.35303	-13.0744
$\widehat{REER}_{i,t-1}$	0.0493613	0.0185593	2.66	0.029	0.0065636	0.0921591
$\widehat{REER}_{i,t-2}$	0.0566701	0.0151829	3.73	0.006	0.0216583	0.0916819
$\widehat{REER}_{i,t-3}$	-0.0057716	0.0137737	-0.42	0.686	-0.0375339	0.0259906
$\widehat{REER}_{i,t-4}$	-0.0312023	0.0091777	-3.40	0.009	-0.0523661	-0.0100386
$\widehat{MS}_{i,t-1}$	0.0277273	0.0337377	0.82	0.435	-0.050072	0.1055266
$\widehat{MS}_{i,t-2}$	0.1160739	0.0331892	3.50	0.008	0.0395395	0.1926083
$\widehat{GC}_{i,t-1}$	0.0204435	0.0176002	1.16	0.279	-0.0201426	0.0610297
$\widehat{GC}_{i,t-2}$	0.0430097	0.0188366	2.28	0.052	-0.0004276	0.086447
GR_US_JAP_EU	0.7960337	0.1319575	6.03	0.000	0.4917391	1.100328
TA_{it}	-1.138649	12.81787	-0.09	0.931	-30.6967	28.4194
$GDP_{i,0}$	0.0004438	0.0014232	0.31	0.763	-0.0028381	0.0037257
crisis	-4.0994	1.146849	-3.57	0.007	-6.744039	-1.45476
_cons	(omitted)					

Table A.2: Cross-sectional Time-Series FGLS Regression, Random Effects

Coefficients: generalized least squares
Panels: heteroskedastic
Correlation: no autocorrelation
Pesaran's test of cross sectional independence = 10.209, Pr = 0.0000

Estimated covariances =	9	Number of obs =	702
Estimated autocorrelations =	0	Number of groups =	9
Estimated coefficients =	17	Time periods =	78
		Wald chi2(16) =	965.06
		Prob > chi2 =	0.0000

gr_opc	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
$I/GDP_{i,t-1}$	60.89181	9.454518	6.44	0	42.36129	79.42232
$I/GDP_{i,t-2}$	3.132636	13.37797	0.23	0.815	-23.0877	29.35297
$I/GDP_{i,t-3}$	-16.2035	13.39094		0.226	-42.44925	10.04225
$I/GDP_{i,t-4}$	-39.66735	9.476735	-4.19	0	-58.24141	-21.09329
$\widehat{REER}_{i,t-1}$	0.0527876	0.0142222	3.71	0	0.0249126	0.0806627
$\widehat{REER}_{i,t-2}$	0.0505705	0.0175188	2.89	0.004	0.0162344	0.0849067
$\widehat{REER}_{i,t-3}$	-0.0029573	0.0170837	-0.17	0.863	-0.0364407	0.0305262
$\widehat{REER}_{i,t-4}$	-0.0319757	0.0141286	-2.26	0.024	-0.0596672	-0.0042842
$\widehat{MS}_{i,t-1}$	0.0343035	0.0311144	1.1	0.27	-0.0266796	0.0952866
$\widehat{MS}_{i,t-2}$	0.0914888	0.0314566	2.91	0.004	0.0298349	0.1531427
$\widehat{GC}_{i,t-1}$	0.0383344	0.0164303	2.33	0.02	0.0061316	0.0705373
$\widehat{GC}_{i,t-2}$	0.054322	0.0163228	3.33	0.001	0.0223298	0.0863142
GR_US_JAP_EU	0.7037246	0.0744424	9.45	0	0.5578202	0.8496289
TA_{it}	3.414927	0.723703	4.72	0	1.996495	4.833358
$GDP_{i,0}$	-0.0001203	0.0000401	-3	0.003	-0.0001989	-0.0000417
crisis	-3.624811	0.3724092	-9.73	0	-4.35472	-2.894902
_cons	-2.149762	0.4873421	-4.41	0	-3.104935	-1.194589

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