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Abstract: The paper uses capital and labor utilization rates to derive estimates of the Japanese output gap and potential output. Two techniques are used. The first uses the cyclical indicators to adjust potential output estimates derived from a Hodrick-Prescott filter over the most recent period when such estimates are generally considered to be unreliable. The second estimates equilibrium levels of the cyclical indicators and uses an Okun's Law-type relationship to derive output gaps and potential output. The second method is also applied to the components of potential output to derive a third estimate. These methods suggest that the current Japanese output gap is considerably larger than a simple Hodrick-Prescott filter would suggest.

Keywords: potential output, output gap

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The Use of Cyclical Indicators in Estimating the Output Gap in Japan

I. Introduction

Potential output growth and the output gap are key determinants of inflationary pressures in an economy. They thus have important implications for macroeconomic policy. However, they are also inherently difficult to estimate with precision. In general, the key task is to separate the cyclical component from the underlying trend. This becomes more difficult during longer cycles. For Japan, a decade of slack growth has thus resulted in more than the usual degree of uncertainty in estimating potential and the corresponding gap.

Estimates of potential output are usually derived either by smoothing actual output, or by estimating the potential level of the inputs- -labor, capital, and total factor productivity (or some combination)- - and using a production function to determine the corresponding level of potential output. Smoothing techniques such as the Hodrick-Prescott filter attempt to disentangle the cycle from the trend by assuming that the level of potential output can be approximated by drawing a trend line--with the trend rate of growth allowed to change only slowly--through the actual data. The technique is clearly less satisfactory near the beginning and end of the sample, but it will still usually provide reasonable estimates as long as the endpoint is not far from the trend. However, it is well-known that such estimates will be biased downward at the end of the sample if the economy is in a cyclical downturn, and biased upward if the economy is in a boom period. Estimation of potential output using a production function relies on a larger set of information, including the capital stock, which has a much less pronounced cyclical component. However, the other inputs, labor and total factor productivity, generally show significant cyclical variation.

Other approaches to estimation of potential output are more ad hoc, as in the use of an Okun's law relationship that relates the unemployment gap to the output gap. This requires an estimate of the NAIRU in order to calculate the unemployment gap. The methods explored in this paper have some similarities to this type of approach, as they represent an attempt to use the information embodied in other cyclical indicators to shed some light on the amount of slack currently available in the Japanese economy. Two methods are used. The first assumes that the "true" level of potential output can be measured by estimating potential output with an HP filter, as long as enough time has passed so that new data do not significantly affect the earlier estimate of potential. The other cyclical indicators are then used to refine the most recent estimates of potential, as described in more detail in the following section.

The second approach instead uses the other cyclical indicators to derive an alternate measure of the output gap. This involves first estimating the elasticity of changes in output to changes in the other indicators, then estimating the output gap by applying these coefficients to the deviations in the cyclical indicators from the equilibrium levels. The latter are determined using Phillips curve-type equations. This approach is described more fully in the third section.

The results from both methods suggest that the latest HP filter estimates are understating the amount of slack currently existing in the Japanese economy, although they differ in their estimate of the size. The unadjusted HP filter suggests that the output gap is currently slightly negative (actual output about ¼ below potential), whereas the refined HP filter estimate indicates that the gap is about -1½ percent. The gap calculated using the indicators directly is about -2 percent in the most recent period. The methods also give different estimates of the current rate of potential output growth. These are contrasted in Section IV.

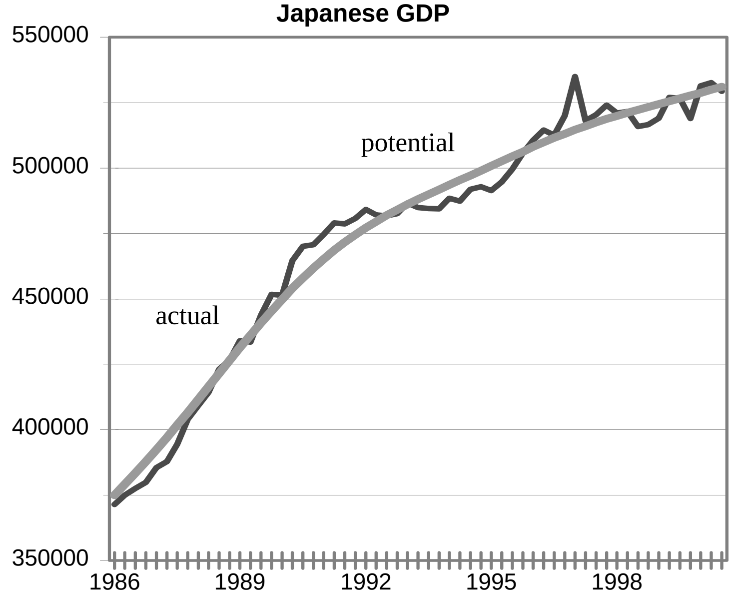
The primary conclusion of the paper, which is discussed in Section V, is that the cyclical indicators do contain information that is useful in assessing the current level of potential. These methods might also be applied to measuring other "unobserved" equilibrium variables, such as NAIRUs.

Section II: Use of Cyclical Indicators to Refine Filtered Output Gap Measures

The purpose of this approach is to try to mitigate the "endpoint" problem associated with the HP filter. It focuses only on this particular shortcoming of the HP filter procedure. It thus assumes that the potential series obtained using the filter is the true one, once enough data has been added to the end of the sample that the series is nearly impervious to further additions.

The possible importance of the endpoint problem is illustrated in Chart 1, where an estimate of Japanese potential output derived using an HP filter through the end of the sample (2000:Q3) suggests that trend output is about equal to actual output in the last period for which GDP data are available, implying an output gap that is close to zero.

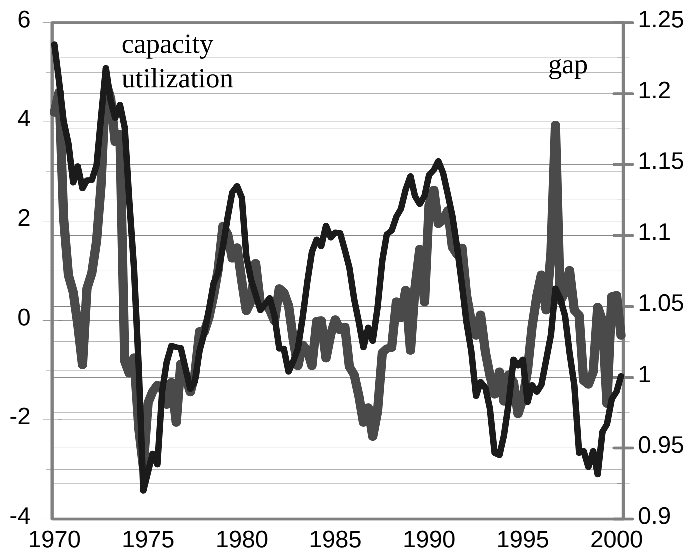
Chart 1
Japanese GDP

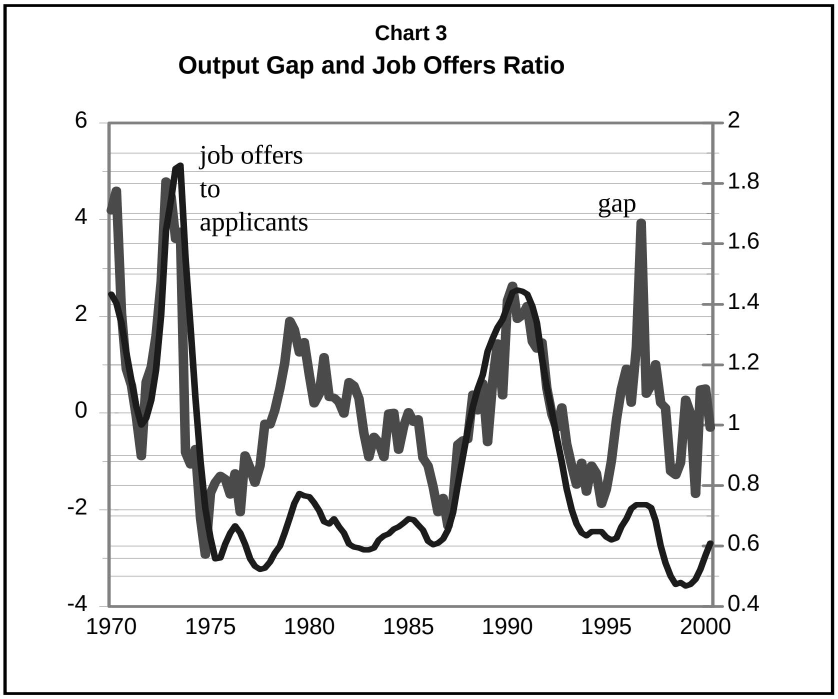


The output gap derived as the difference between the actual and potential series shown in chart 1 is plotted separately against the capacity utilization rate (a measure of slack in capital resources) and the job-offers-to-applicants ratio (a measure of labor market slack) in charts 2 and 3 below. Although the estimated output gap is close to zero at the end of the sample, the other indicators both appear to be below their long-run averages, suggesting that some degree of economic slack remains.

Chart 2

Output Gap and Capacity Utilization

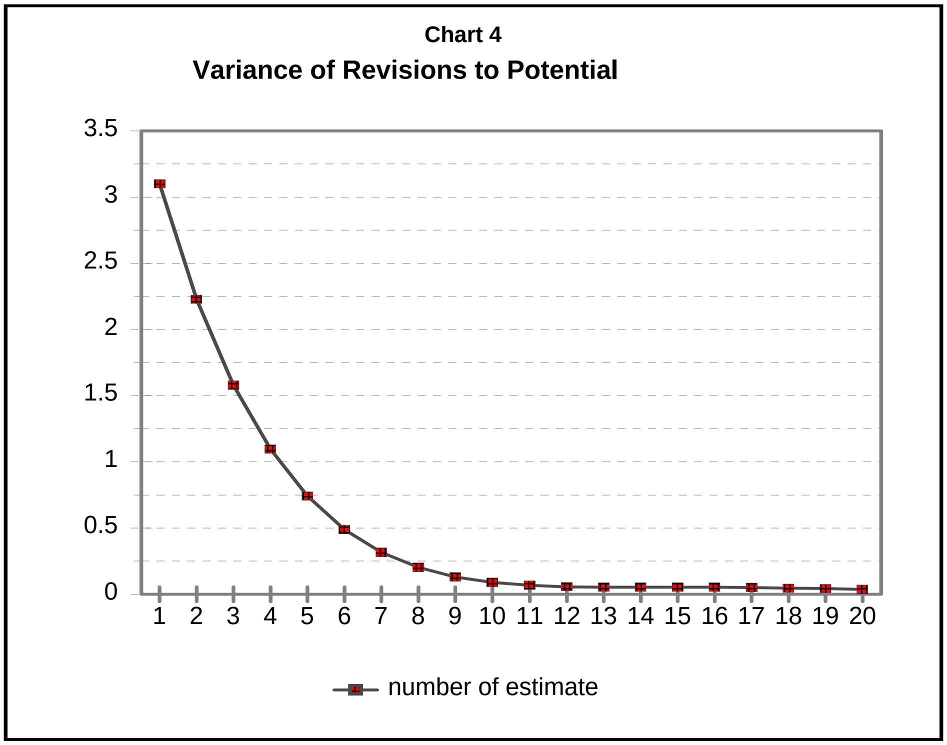




The question is how to use the information contained in the other cyclical indicators to refine the output gap measure near the end of the sample. In the approach taken here, the first step was to make an empirical determination of how far prior to the end of the sample the endpoint problem is indeed a problem, in other words, at what point do the filtered estimates no longer show notable changes as the sample is lengthened. The next step is to see whether the revisions to potential during this period can be predicted using other cyclical indicators. For instance, if it is generally the case that the HP filter underestimates potential output during a recession, the extent to which the estimates will later be revised up may be systematically related to cyclical variables like the capacity utilization rate and/or the labor vacancy rate.

Although it is difficult to make a precise determination of how far prior to the end of the sample estimated potential is sensitive to extending the endpoint, since this will likely vary from one sample to another, the sensitivity of the estimates over the subsequent five-year period was tested by calculating successive series for potential with an HP filter while moving the endpoint forward through the end of the data sample. Specifically, a set of 20 time series, each beginning in 1970:Q1, was created. The first series consists of the first estimate of potential for 1970:Q1, the first estimate for 1970:Q2, up through the first estimate for 2000:Q3, the last data point in the sample. The second series consists of the second estimate for each quarter, up through 2000:Q2. The last series extends through 1995:Q4, the last quarter for which there is a twentieth estimate. A second set of twenty series was then created by taking the percentage differences between these series and the most recent estimate of potential for the corresponding time period. These series measure the size of the difference, in percentage terms, between the first, second, third, etc., estimates of potential and the “final” estimate (proxied by the most recent estimate, through 2000:Q3). The expectation would be that the variance of these differences would decline as more data is added to the end of the sample. The criteria used here to judge how far back the endpoint problem is a problem is when this variance reaches an acceptably small level. This of course requires a definition of “acceptably small”, which is admittedly arbitrary.

Chart 4 shows the variance over the period 1970-1995 of the percentage difference between each of these series and the latest series. The size of the variance of the revision drops off to less than a quarter of a percentage point by the time the sample extends two years (8 quarters) beyond the quarter in question. Adding another year’s worth of data reduces the variance to less than one-tenth of one percent, but adding a fourth year makes little further difference. It is assumed here that less than one-tenth of one percent is an “acceptably small” level, so the sensitivity of the revisions to the other cyclical indicators is estimated for the most recent three-year period.



The relationship between the revisions at each stage and the cyclical indicators was estimated with a simple equation of the form:

(1) $$rev_i = \alpha * vac + \beta * cap + \gamma * rev_i(-1) + \varepsilon$$

where rev_i is the difference between the ith estimate of potential and the "final" series, with i = 1,2,...12. Vac and cap are the two cyclical indicators, the labor vacancy rate and the capacity utilization rate, respectively. The variables used in the equation are de-meaned. The lagged dependent variable is included because the revisions are highly correlated over time. Both α and β are expected to be negative, as we would expect upward revisions to potential as more data are added during a cyclical downturn, and vice versa. The results of this estimation are shown in the table below.

Both cyclical indicators are significant in the equations for the revisions to the first and second estimates of potential. For the other periods, the equations were estimated with both indicators and also with each separately. (These two indicators are obviously highly correlated, making joint estimation of the coefficients difficult for some periods.)   For the revisions to the fourth through the eighth estimates the capacity utilization rate is significant, but the labor vacancy rate is not. The vacancy rate is significant, however, when the capacity utilization rate is not included. For the ninth through the twelfth revisions neither indicator is significant either together or alone.

The equations were used to calculate two estimates of potential. For the first, a strict standard for significance of the coefficient estimates is applied: both indicators are used only for the first and second periods, the capacity utilization rate is used for periods 3 through 8, and the equations for periods 9 through12 use only the lagged dependent variable. For the second estimate, a looser standard for coefficient significance was applied to provide more continuity between period estimates. In this case, the same equations as before are used for periods 1 and 2, but the equations that include both indicators were also used for period 3 through 5, where the vacancy rate is correctly signed in the aggregate equation and is significant when used alone. Using this approach, the coefficient on the vacancy rate diminishes gradually and is very small for period 5. The equations for period 6 through 12 include just the capacity utilization rate, the coefficient for which also drops off gradually.

Variable / estimate #	Coefficient Estimates for Cylical Indicator Equations[1]			Sample period 1973:Q4-1997:Q3
	Vacancy rate	Cap. Util.	Lagged Dep.	
1st	-.359(-2.59)*	-1.97(-3.21)*	.921(51.81)*	R^2 .980
2nd	-.265(-2.03)$^{+}$	-1.35(-2.40)*	.904(44.55)*	R^2 .973
3rd	-.178(-1.55)	-1.15(-2.37)*	.906(40.87)*	R^2 .968
	-.371(-4.44)*		.889(41.80)*	.966
		-1.69(-4.86)*	.926(51.24)*	.967
4th	-.102(-1.03)	-.942(-2.26)$^{+}$	.913(38.25)*	R^2 .963
	-.254(-3.43)*		.899(38.16)*	.961
		-1.23(-4.04)*	.927(47.05)*	.962
5th	-.026(-.308)	-.809(-2.29)+	.923(36.57)*	R^2 .957
	-.150(-2.35)*		.912(35.97)*	.958
		-.880(-3.32)*	.927(43.47)*	.958
6th	.003(.044)	-.610(-2.10)$^{+}$	.935(36.54)*	R^2 .954
	-.086(-1.66)		.929(35.88)*	.952
		-.602(-2.71)*	.934(41.57)*	.954
7th	-.002(-.047)	-.398(-1.71)$^{+}$	.946(37.99)*	R^2 .954
	-.058(-1.44)		.944(37.57)*	.953
		-.405(-2.26)$^{+}$	.946(41.51)*	.954
8th	.006(.148)	-.290(-1.55)	.955(39.77)*	R^2 .954
	-.033(-1.07)		.956(39.51)*	.953
		-.273(-1.89)$^{+}$	.954(41.88)*	.954
9th	.006(.199)	-.192(-1.28)	.962(42.51)*	R^2 .956
	-.019(-.810)		.964(42.53)*	.956
		-.173(-1.51)	.961(43.52)*	.956
10th	.005(.188)	-.139(-1.14)	.968(46.25)*	R^2 .961
	-.014(-.741)		.970(46.51)*	.960
		-.124(-1.35)	.968(46.64)*	.961
11th	-.000(-.002)	-.094(-.955)	.974(51.95)*	R^2 .968
	-.013(-.859)		.977(52.46)*	.967
		-.095(-1.29)	.974(52.24)*	.968
12th	-.008(-.492)	-.052(-.622)	.981(58.47)*	R^2 .974
	-.015(-1.24)		.982(59.22)*	.974
		-.080(-1.30)	.980(58.94)*	.974

1. t-statistics in parentheses +significant at the 5 percent level * significant at the 1 percent level

The alternative series for potential were calculated step-by-step by first taking the predicted value from the equation for the twelfth revision to 1997:Q4 and adding it to the most recent estimate to obtain a prediction for the revised level of potential for 1997:Q4. The predicted value for the lagged term for the next equation is derived as the difference between this predicted level of potential and the previous estimate. This process continues sequentially up through the most recent time period. The difference between the two estimates of potential turns out to be negligible, so just the first (the stricter standard) was used in the comparison with the other estimates.

As shown in chart 5 below, the adjusted series suggests both a higher level and a higher growth rate than the HP filter series (growth rates for the different methods are compared in section 3 below). The resulting output gaps are shown in chart 6. The adjusted estimate shows a gap that is about 1 percent larger than that derived from the unadjusted HP filter series in the most recent period.

The next section looks instead at a more direct way of using the other indicators of slack to derive an output gap measure.

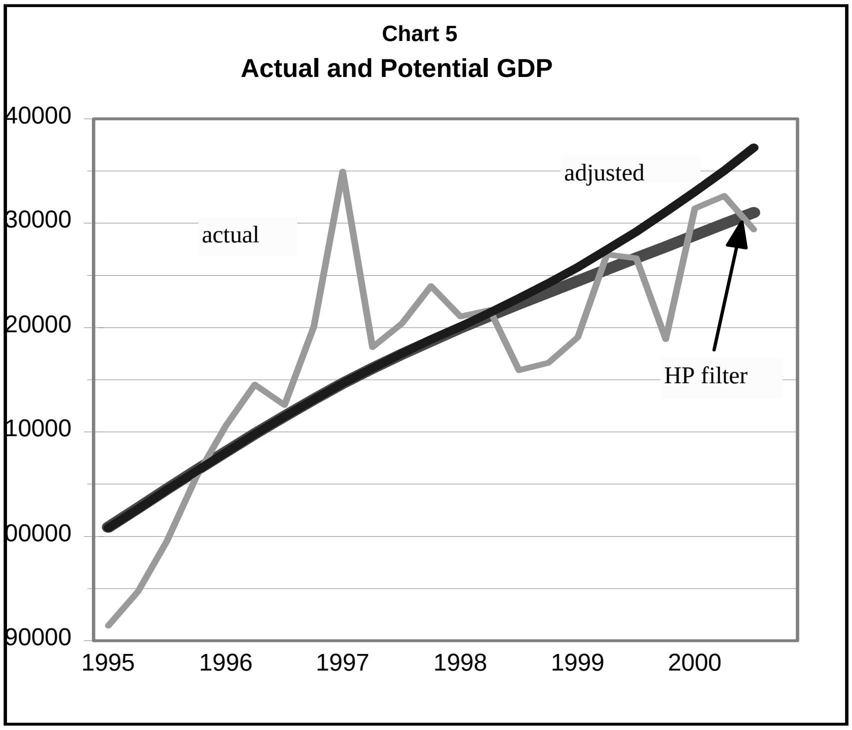


Chart 5
Actual and Potential GDP
40000
30000
20000
10000
00000
90000
1995
1996
1997
1998
1999
2000
adjusted
actual
HP filter

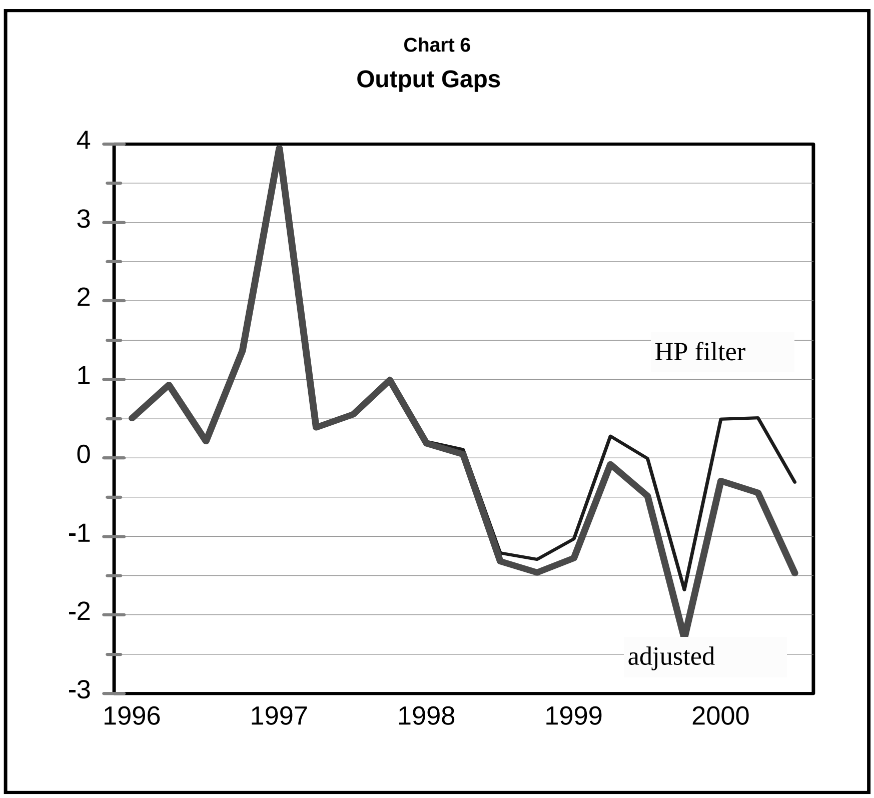


Chart 6
Output Gaps
4
3
2
1
0
-1
-2
-3
1996
1997
1998
1999
2000
HP filter
adjusted

III: Use of Cyclical Indicators to Calculate Alternative Measure of the Output Gap

In contrast to the previous method, which attempted to use historical relationships between measured output gaps and other cyclical indicators to refine the most recent estimates of the gap, this approach builds on the idea that the other indicators are themselves proxies for other measures of the gap. The method involves first estimating the sensitivity of changes in output to changes in the other cyclical indicators, then estimating equilibrium levels of the other indicators in a Phillips-curve framework, and finally combining this information into an alternative measure of the output gap.

The method is thus quite similar to estimation of the output gap using Okun's law, which relates changes in GDP to changes in the unemployment rate. In that case, the output gap is presumed to equal the Okun's law coefficient multiplied by the gap between the actual unemployment rate and the NAIRU. Use of Okun's Law is complicated for Japan by the fact that the unemployment rate is not stationary over the estimation period, suggesting that the NAIRU probably is not either. The other cyclical indicators, in contrast, do appear to be stationary over this period.[1]

Assuming a Cobb-Douglas production function for the economy, i.e.,

(2) $$Y = T K^{\alpha} L^{(1-\alpha)}$$

where Y is output, T is total factor productivity, K is capital services, and L is labor hours worked, which can be written in log form (lower-case letters denoting natural logs) as:

(3) $$y = t + \alpha * k + (1-\alpha) * l ,$$

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[1] The relevant ADF statistic for the unemployment rate for the period 1974-2000 is -.95. For the vacancy rate it is -3.24, and for the capacity utilization rate it is -4.49.

the output gap can then be expressed as:

(4) $$(y - y^p) = (t - t^p) + \alpha * (k - k^p) + (1-\alpha) * (l - l^p)$$

where the p superscript denotes the potential level.

The output gap is thus a weighted average of the gaps between the actual and potential amounts of capital services and hours worked, respectively, added to the gap between actual and potential productivity. If production inputs were adjusted instantaneously, the productivity gap might be expected to be close to zero for the entire economy (abstracting from scale effects). However, in reality production might be less efficient at a lower level of utilization, or there might be some labor hoarding. If we assume (similar to an Okun's law approach) that the productivity gap is roughly proportional to the capital and labor gaps, the above equation can be rewritten as:

(5) $$(y - y^p) = a * (k - k^p) + b * (l - l^p),$$

where a and b include any impact on productivity that is related to the level of resource utilization. They thus do not necessarily have to sum to 1.

The construction of an alternative measure of the output gap thus requires estimates of a, b, k^p, and l^p . The above equation is used to estimate a and b. To derive an estimable equation, the potential output term is moved to the right-hand side. The equation is also differenced because the log of GDP is not stationary, but the difference is.[2] This produces the relationship:

(6) $$\Delta y_t = a\, \Delta(k_t - k_t^{\,p}) + b\Delta(l_t - l_t^{\,p}) + \Delta y_t^{\,p} + \varepsilon_t$$

which relates the percentage change in real output to changes in the gaps between actual and

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[2] The relevant ADF statistic for the log of real GDP for the period 1974-2000 is -1.33. For the change in the log of real GDP it is -4.04.

potential capital services and labor hours. These are proxied by the capacity utilization rate and the job-offers-to-applicants ratio (labor vacancy rate), respectively.

The equation was estimated over the period 1974:Q3-2000:Q3. The change in potential output was approximated by a constant, a linear time trend and time trends to the ½ and ⅓ powers.[3] Two lags of the dependent variable were also included to whiten the residuals. The results are shown in the table below for both the estimated equation and the static long-run solution.

Results from Output Change Regression[1] (estimation period 1974:Q3 - 2000:Q3)		
Variable	Estimated Equation	Long Run Solution
1st lag of GDP growth	-.389 (-4.192)*	
2nd lag of GDP growth	-.330 (-3.830)*	
Constant	1.244 (2.966)*	.724 (3.018)*
Trend	-.009 (-3.044)*	-.005 (-3.100)*
$(\text{Trend})^{1/2}$	.609 (2.960)*	.354 (3.010)*
$(\text{Trend})^{1/3}$	-1.375 (-2.944)*	-.800 (-2.994)*
Capacity Utilization	.074 (1.664)+	.043 (1.641)
Vacancy Rate (lagged one period)	.092 (4.135)*	.054 (4.605)*
R^2	.384	
DW	1.94	

1. t-statistics are shown in parentheses. +significant at 5 percent level. * significant at 1 percent level.

All of the variables are significant in the estimated equation, although the capacity utilization rate is only marginally significant at the 5 percent level. However, this is again largely

[3] The time trend variables are similar to those used by Bayoumi (2000), although his equations were estimated in level rather than first difference form.

a result of the high degree of correlation between the two cyclical indicators. When the vacancy rate is excluded the capacity utilization rate is highly significant and the coefficient estimate approximately doubles.

The estimate of a, the sensitivity of the change in the output gap to changes in the capacity utilization rate, is .043. The estimate of b, the sensitivity of the change in the output gap to the change in the labor vacancy rate, is .054.

The next step in constructing alternative measures of the output gap is to estimate the equilibrium levels of the vacancy and capacity utilization rates. This was done using Phillips-curve type equations of the form:

(7) $$\Pi = A\ L(\Pi_{-t}) + B(L)\ Z_t + C + D * (CYC - CYC^*) + \nu_t$$

where the coefficients on the lagged inflation terms (a proxy for inflation expectations) are constrained to sum to one. Z_t represents other factors that may influence inflation in the short run, such as changes in import prices and/or the value added tax. The cyclical indicator is either the capacity utilization or the vacancy rate. CYC* is defined as the value of the indicator that is consistent with no change in inflation in the absence of temporary shocks, i.e.:

(8) $$CYC^* = -C / D.$$

The results from the estimation of this equation, using the capacity utilization rate and the labor vacancy rate (separately) are shown in table 4 below. In both equations the cyclical indicator is significant and the resulting equilibrium value appears to be plausible in the sense that periods where the indicator is below the equilibrium value generally correspond to periods where inflation is declining and vice versa (see charts 7 and 8 below).

Phillips Curve Equations[1] (estimation period 1974:1-2000:3)			
		Labor Vacancy Rate	Capacity Utilization Rate
Inflation	1st lag	.265 (2.98)*	.277 (3.25)*
	2nd lag	.164 (1.82)+	.137 (1.67)*
	3rd lag	.306 (3.43)*	.314 (3.93)*
	4th lag	.365#	.273#
Dummy for VAT change[2]		.004 (2.18)+	.004 (2.27)+
	1st lag	-.001#	-.001#
	2nd lag	-.001#	-.001#
	3rd lag	-.002#	-.002#
	4th lag	-.002#	-.001#
Percent change in import prices		.044 (3.80)*	.043 (3.80)*
Constant		-.005 (-2.33)+	-.006 (-2.871)*
CYC		.006 (2.08)+	.006 (2.790)*
R^2		.78	.79
SEE		.0074	.0072
CYC*		1.064	.92

1. t-statistics are shown in parentheses. + significant at 5 percent level. * significant at 1 percent level.
2. The dummy variable is equal to 3 in 1989:Q2, when a 3% VAT was imposed, and to 2 in 1997:Q2, when the tax was raised to 2 percent. The lagged variables are included under the assumption that the impact on measured inflation is temporary and should not affect inflation expectations. The lagged coefficients are constrained to offset the arithmetic impact on the lagged inflation terms of the increase.
coefficient is constrained.

Chart 7

Vacancy Rate and Inflation*

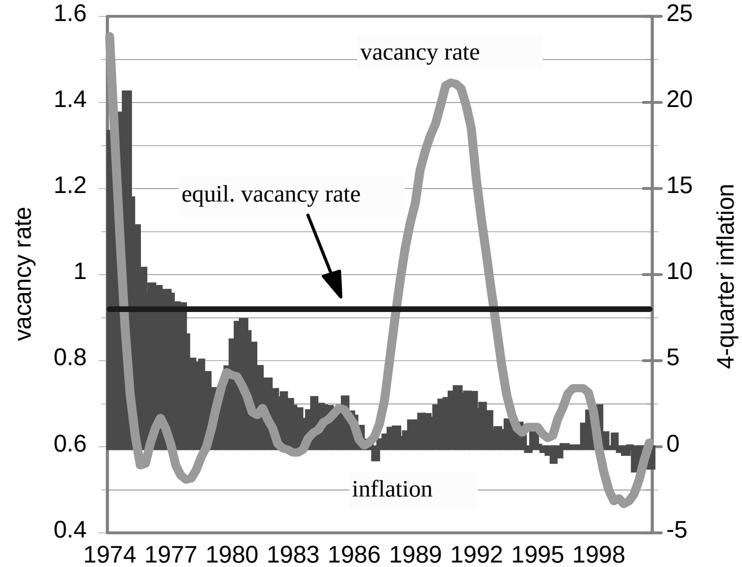
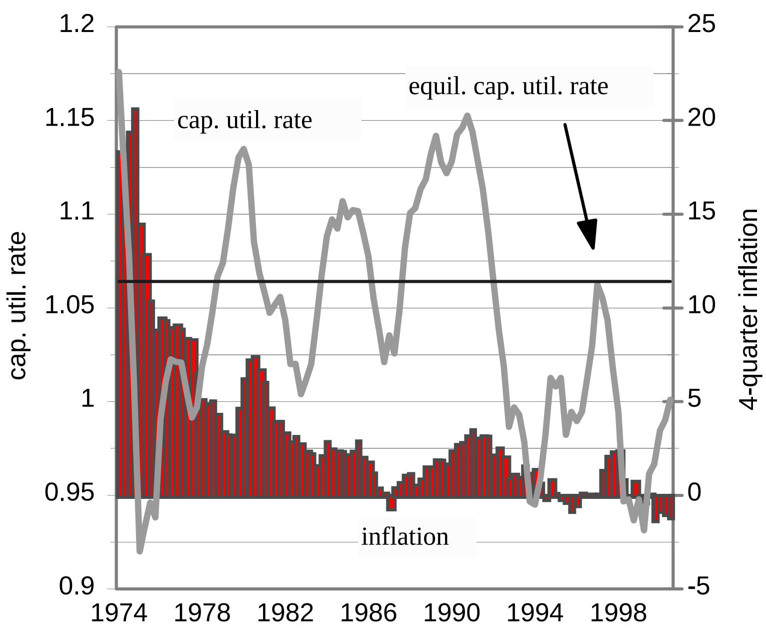


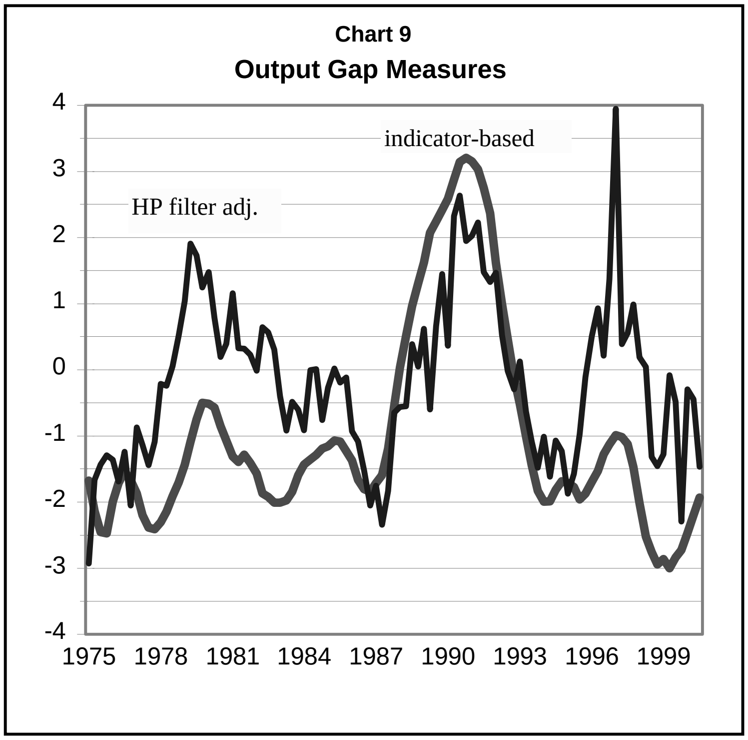
Chart 8

Capacity Utilization and Inflation*



*the inflation series removes the effect of the VAT increases in 1989 and 1997.

The alternative measure of the output gap is constructed by multiplying the estimated coefficients in the above table by the deviations of the indicator series from their equilibrium levels. The series constructed using these two indicators is shown in Chart 8,along with the estimates from the HP filter, refined using the cyclical indicators as described in the previous section. The values for the most recent period are shown in the table below.



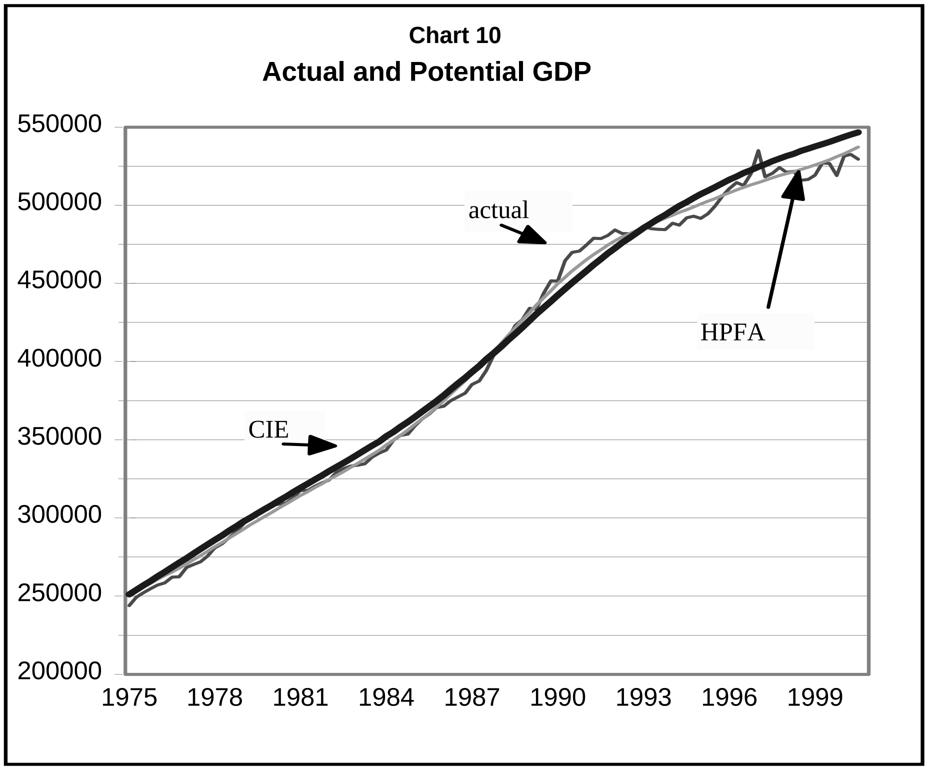
The constructed series suggests a somewhat larger output gap in the current period than the refined HP filter estimate. The constructed measure also shows considerably more slack in the economy for most of the period, although it suggests that the economy was more overheated during the bubble period than the other measure indicates.

Output Gap Measures			
	HP Filter	HP Filter (adjusted)	Indicator-Based
1998:Q1	.21	.18	-2.02
1998:Q2	.11	.05	-2.53
1998:Q3	-1.21	-1.31	-2.75
1998:Q4	-1.29	-1.46	-2.94
1999:Q1	-1.03	-1.28	-2.86
1999:Q2	.28	-.08	-3.00
1999:Q3	.00	-.48	-2.84
1999:Q4	-1.68	-2.30	-2.73
2000:Q1	.49	-.30	-2.47
2000:Q2	.51	-.45	-2.20
2000:Q3	-.31	-1.46	-1.93

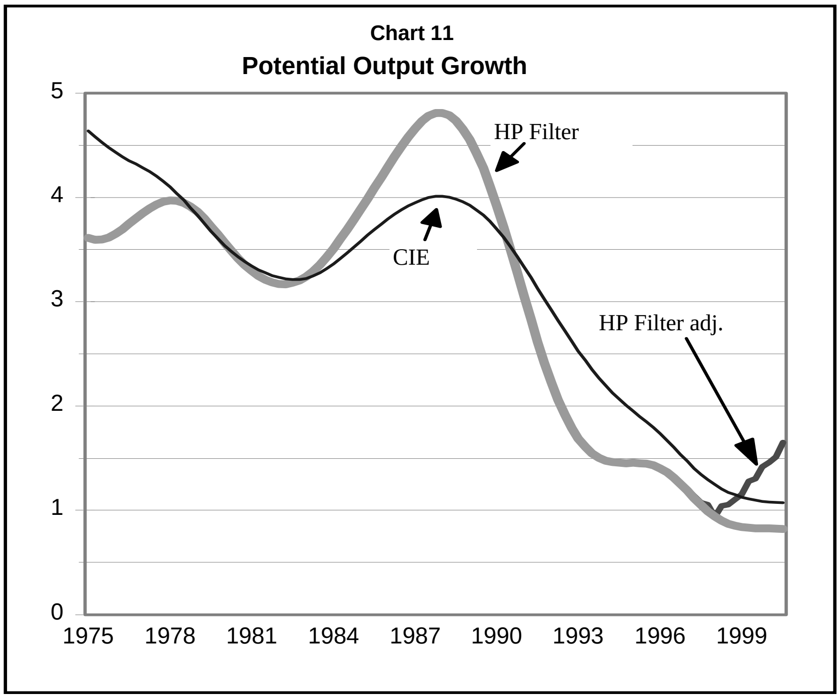
IV. Implications for Potential Output Growth

A series for the level of potential output that corresponds to the output gap derived in the previous section can be calculated using the actual output series. However, because the output gap series is relatively smooth, the resulting potential series is excessively noisy, reflecting the volatility in the actual GDP series. This issue is addressed by using the HP filter to smooth the potential series. (Because the cyclical portion has been removed, this series should not suffer from the same endpoint problem that afflicts the actual series.)

The resulting series for potential output based on the cyclical indicator equation (CIE) is shown in the chart below along with the adjusted HP filter series (HPFA) and the actual series. Corresponding to the larger output gap, the CIE series is considerably higher at the end of the sample. It also does not track the actual series as closely as the HPFA series over the historical period, although these differences are less pronounced.



The implied rates of potential growth from the different methods are shown in chart 11. Both the CIE and HP filter estimates show a sharp decline in potential output growth over the time period, although the patterns are somewhat different. In the most recent period, the unadjusted HP filter estimate is a little under 1 percent. When adjusted (using the first method) the growth rate jumps considerably, to about 1.6 percent. The second method (CIE) shows a smaller acceleration during the bubble period than the HP filter, followed by somewhat higher growth during the past decade, as the sharp deterioration in the labor vacancy rate and resulting sizable widening in the output gap over that period implies that potential was growing faster than actual GDP. However, the estimated growth rate has slowed more recently as the capacity utilization and vacancy rates have stabilized even though output growth is still low, implying that potential growth is lower as well. The most recent estimate is a little over 1 percent.



Applying the Methodology to the Individual Components of Potential Output

One shortcoming of the potential output series derived in the previous sections is that, although they may be able to describe the recent behavior of potential output growth, they give little guidance to its future performance. Although forecasting potential output growth is always tricky, some additional insight perhaps may be gained from examining the behavior of some of the component parts. A traditional production-function approach usually identifies three main elements of potential: labor input, capital input, and the level of technology. In this section we use a modified version of this methodology. Potential output is broken down into two major components, output per hour and total hours worked. Hours worked are then further subdivided into: hours per employee, the employment rate, the participation rate, and working age population.

This approach effectively combines the contributions to labor productivity of improvement in technology on the one hand and capital deepening on the other. The main reason for doing this is that it is difficult to obtain a good measure of capital services for Japan. It is widely thought that there was considerable overinvestment in unproductive capital during the bubble period, for instance, and this stock is only gradually being dissipated. It is thus problematic to simply assume that capital services are proportional to the measured capital stock. However, capital stock that is productive should, by definition, show up in improved labor productivity, which can be measured more accurately.

The cyclical component of each item (labor productivity, hours per employee, the employment rate and the participation rate) was estimated using the same methodology as in the indicator method described in the preceding section. This essentially assumes that actual and potential output in equation (6) can be broken into their component parts and the relationship of each to the cyclical indicators estimated separately. Because the errors are likely to be correlated across equations, the equations were estimated as a system using full information maximum likelihood.

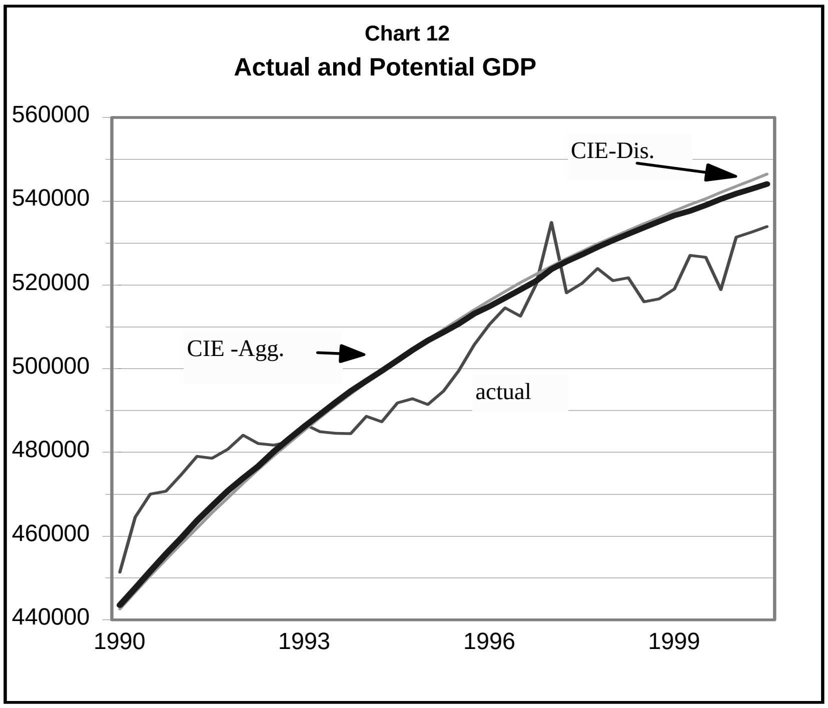
The results are shown in the table below. Although the initial estimation used the same form (equation (6)) for each of the four components of output (including four lags of the dependent variable, the three time trends described earlier, and a constant term), not all variables were significant in all of the equations. The insignificant variables were eliminated in the final estimation. For productivity, the vacancy rate was significant but the capacity utilization rate was not, while the opposite was true for hours per employee. Both cyclical indicators were significant in the equation for the employment rate, and neither was significant in the participation rate equation. The sum of the long-run cyclical effects across equations is .048 for the labor vacancy rate and .071 for the capacity utilization rate. This compares with .054 and .043, respectively, for the aggregate equation.

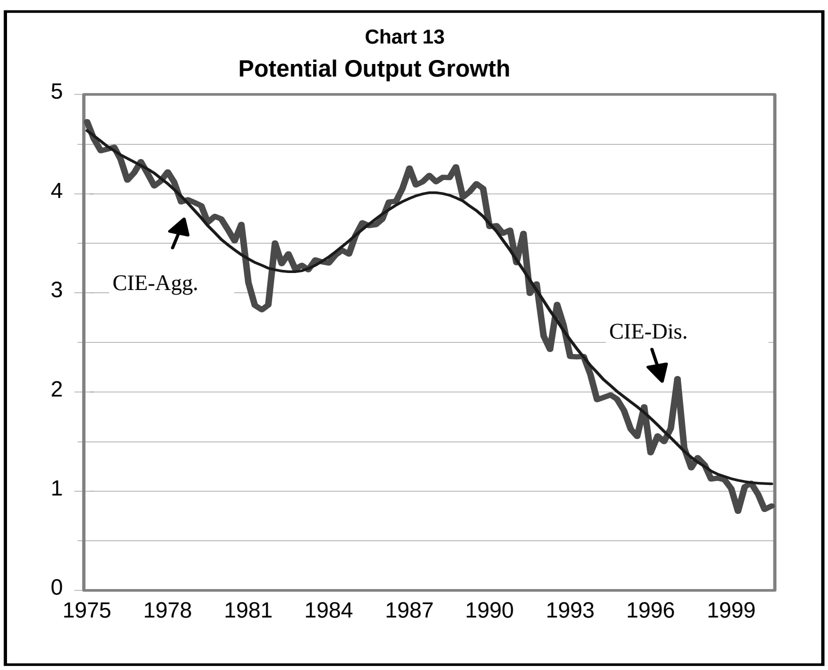
Results from Estimation of Cyclical Indicator Equations for Components of Potential Output[1]

	productivity	hours per worker	employment rate	participation rate
vacancy rate Long-run coeff.	.0684 (3.538)* .0397 (3.665)*	n.a.	.0057 (2.233)+ .0085 (2.346)+	n.a.
capacity util. rate long-run coeff.	n.a.	.0638 (2.671)* .0471 (2.635)*	.0156 (2.600)* .0235 (2.183)+	n.a.
Trend	-.0116 (-3.761)*	.0050 (2.804)*	-.000003 (-2.084)+	n.a.
$(\text{Trend})^{1/2}$	.6948 (3.658)*	-.2986 (-2.698)*	n.a.	n.a.
$(\text{Trend})^{1/3}$	-1.5212 (-3.626)*	.6480 (2.654)*	n.a.	n.a.
Constant	1.2795 (3.597)*	-.5274 (-2.556)*	n.a.	n.a.
Lagged variables				
1st lag prod.	-.4519 (-5.896)*	n.a.	n.a.	n.a.
2nd lag prod.	-.2703 (-3.654)*	n.a.	n.a.	n.a.
1st lag hours	n.a.	-.3527 (-4.558)*	n.a.	n.a.
3rd lag emp. rate	n.a.	n.a.	.3350 (3.688)*	n.a.
1st lag part. rate	n.a.	n.a.	n.a.	-.1804 (-1.887)+

1. t-statistics are shown in parentheses. + significant at 5 percent level. * significant at 1 percent level.
n.a. not applicable

Each component was then adjusted to its "equilibrium" level using the estimated labor vacancy rate and capacity utilization rate gaps, as described in section III above for the aggregate output gap. The components were then aggregated, along with actual population, to obtain an alternative estimate of potential output. As shown in the chart below, the resulting series is quite similar to that derived from the aggregate cyclical indicator equation, although it is a little higher at the end. The growth rates of the two series, shown in chart 13, are also similar (the greater volatility of the disaggregated series is due to variation in the growth in working-age population).





The table below shows the contributions to potential output growth of each of the components over five-year intervals starting in 1975. The dramatic decline in potential output growth, from 4.2 percent in the latter half of the 1970s to 1.4 percent in the latter half of the 1990s, has been about equally divided between a decline in the growth of labor input from .9 percent to -.4 percent and a drop in labor productivity growth from 3.3 percent to 1.8 percent.

Contributions to Potential Output Growth						
	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000
1. Hours/emp.	-.1	.0	-.4	-1.1	-.4	-.1
2. Emp. rate	.0	-.1	.0	.0	-.3	-.4
3. Part. rate	-.1	.0	.0	.2	-.3	-.5
4. Working-age pop.	1.1	1.2	1.3	.9	.6	.4
labor input (sum of 1-4)	.9	1.0	.8	-.1	-.4	-.6
labor prod.	3.3	2.3	3.1	2.9	1.8	1.5
total output	4.2	3.3	3.9	2.8	1.4	.9

Growth in the working-age population, which fell from 1.1 percent in the 1970s to about .4 percent in the latter half of the 1990s, is projected to decline even further, to about .2 percent over the next few years. Because working-age population is defined as persons 15 years of age and over, this drop in fact understates the actual impact on the labor force because many of those workers are moving into older age groups and retiring. The aging of the work force is in fact largely responsible for the recent declines in both hours per employee and the participation rate.

If we assume that the equilibrium employment rate will stabilize near its current level, but that the participation rate and hours per employee will continue to fall enough to offset the small projected growth in the labor force, it is apparent that growth in labor input will at most be near zero over the next few years and could in fact be closer to -½ percent. This implies that potential output growth will be largely defined by growth in output per worker, which was about 1½ percent in 2000. This would suggest that absent a significant acceleration in productivity growth, Japanese potential output growth is currently in the range of 1-1½ percent.

V. Conclusions

The above analysis suggests that there is a role for other cyclical indicators to play in assessing the size of the gap between actual and potential output near the end of a data sample, when estimates based on simple filters may not be reliable. The other indicators have the advantage of being available in "real time" since they do not change as additional data is added to the sample. Their primary disadvantage may be that they are not as comprehensive as total GDP. The capacity utilization rate refers only to the manufacturing sector, while the job-offers-to-applicants ratio may not reflect the entire labor market, most notably the self-employed.

Each of the two methods of utilizing the information in the cyclical indicators also has both advantages and disadvantages. The first method implicitly assumes that the HP filter estimates can provide an approximately true measure of potential after enough time has passed. Given the nature of the filter (a type of moving average of the actual data), this will produce a measure of the output gap that will roughly average to zero over the sample period. If this premise is incorrect the estimated relationship between the output gap derived from the HP filter and the other cyclical indicators could be biased. This relationship also may not remain stable.

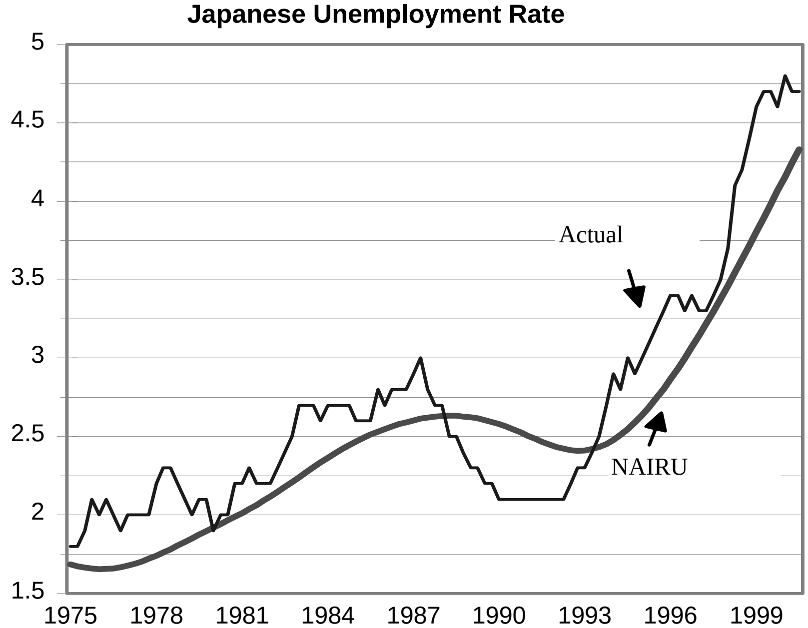
The second method assumes that the output gap equals zero when the other cyclical indicators are at their equilibrium levels as measured by Phillips curve-type equations. It is thus vulnerable to any misspecification in these equations.

Despite these drawbacks, the other cyclical indicators do appear to provide additional information on the current state of the economy. Most notably, they currently imply that the Japanese output gap is about 1½ -2 percent, not near zero as a straight HP filter approach would suggest, but also not as large as a simple extrapolation of earlier growth rates might imply. The analysis also implies that potential output growth is currently in the range of 1-1½ percent.

The main purpose of the analysis done here is use information embodied in the cyclical indicators in a systematic way. As shown in the previous section, the analysis can also be used to estimate cyclically-adjusted series for the components of GDP. Most notably, the inverse of the equilibrium employment derived in the section above can be interpreted as an estimate of the NAIRU. This estimate, shown in the chart below, suggests that the unemployment rate gap in Japan is currently about ½ percent. Future research will attempt to apply this methodology to estimates of NAIRUs and potential output for other industrial countries.

Chart 14

Japanese Unemployment Rate



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