Regional Business Cycle Phases in Japan

Howard J. Wall

This paper uses a Markov-switching model with structural breaks to characterize and compare regional business cycles in Japan for the period 1976-2005. An early-1990s structural break meant a reduction in national and regional growth rates in expansion and recession, usually resulting in an increase in the spread between the two phases. Although recessions tended to be experienced across a majority of regions throughout the sample period, the occurrence and lengths of recessions at the regional level have increased over time. (JEL E32, R12)

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This paper characterizes and compares regional business cycles in Japan during the period 1976-2005. As is frequently done at the national level, following Burns and Mitchell (1946), my analysis supposes that regional business cycles can be characterized as a series of distinct recession and expansion phases. Examples of this characterization of national business cycles include the recession and expansion dates for the United States produced by the National Bureau of Economic Research's Business Cycle Dating Committee and for Japan by the Economic and Social Research Institute (ESRI).[1]

I estimate region-level business cycle turning points with a Bayesian version of the regime-switching model of Hamilton (1989). As with the Burns and Mitchell view, the Hamilton model assumes that the business cycle can be split into distinct recession and expansion phases. The Hamilton model, or the related dynamic-factor Markov-switching model of Kim and Yoo (1995) and Chauvet (1998), has been applied to aggregate Japanese data by Watanabe (2003), Uchiyama and Watanabe (2004), Yao and Kholodilin (2004), and Watanabe and Uchiyama (2005). In all of these papers, the authors are able to closely mimic the ESRI recessions, although some papers find recessions that were not documented by the ESRI.

In applying the Hamilton model to subnational data, I follow Owyang, Piger, and Wall (2005a,b), who did so for U.S. states. They found substantial state-level differences in business cycles, both in terms of the growth rates in the two phases and in the timing of recessions and expansions. They also found a tendency for national recessions to follow geographic patterns. Okumura and Tanizaki (2004) performed a similar exercise using the index of industrial production (IIP) for Japanese regions for the period 1970-2000. They found that a majority of regions rarely, if ever, experienced recession during the 1980s, despite there being two relatively long national recessions during the

[1] The ESRI dates are determined using a diffusion index—the percentage of a selection of economic indicators that are rising. The last month for which the diffusion index stays below 50 percent is the last month of recession, and the last month for which this index stays above 50 percent is the last month of expansion. For details, go to www.esri.cao.go.jp/en/stat/di/di2e.html.

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period. Further, according to Okumura and Tanizaki, three regions that did not experience recession in the 1980s—Hokkaido, Chugoku, and Shikoku—did not experience recession even during the 1990s, a period often characterized as a "lost decade" for Japan. (See the appendix for a map of Japan and the assignment of the prefectures to the nine regions.)

The present analysis differs from that of Okumura and Tanizaki in two important ways, the latter of which gives rise to very different results regarding the frequency of recession across regions. First, I include data through the third quarter of 2005 so that I can examine the ESRI recession of 2001-02; second, I take into account two structural breaks in the Japanese economy. These breaks were found by Uchiyama and Watanabe (2004) and Watanabe and Uchiyama (2005) to have occurred in the mid-1970s and the late 1980s/early 1990s.[2] When these breaks are accounted for, I find that, contrary to Okumura and Tanizaki, most regions experienced recessions during the 1980s and the 1990s that were associated with national recessions. Even so, I find interesting cross-regional differences in the pattern and timing of recessions, the growth rates in recession and expansion, and the nature of the early-1990s structural break.

The next section outlines briefly the model and data. In the third section, I apply the model to the national IIP to show the effect of the structural break and to obtain recession dates from the IIP comparable to those from the ESRI. In the fourth section, I provide and compare the results for the regions. The fifth section describes the concordances of the regional business cycles, while the sixth section discusses the sensitivity of the results to the timings of the structural breaks.

MODEL AND ESTIMATION

In Hamilton's (1989) Markov-switching model, the business cycle consists of two distinct phases—recession and expansion—that the economy switches between, each with its own growth rate. Let μ_0 be the mean growth rate in expansion and μ_1 be the difference between the mean growth rates in recession and expansion. Specify the growth rate of some measure of economic activity, y_t, as

$$y_t = \mu_0 + \mu_1 S_t + \varepsilon_t, \quad \mu_1 < 0. \tag{1}$$

The mean growth rate in (1) switches between the two phases, where the switching is governed by a state variable, $S_t = \{0,1\}$: When S_t switches from 0 to 1, the growth rate switches from μ_0 (expansion) to $\mu_0 + \mu_1$ (recession).

Assume that the process for S_t is a first-order two-state Markov chain, meaning that any persistence in the phase is completely summarized by the value of S_t in the last period. Specifically, the probability process driving S_t is captured by the transition probabilities, $\Pr[S_t = j \mid S_{t-1} = i] = p_{ij}$. I estimate the model using the multi-move Gibbs-sampling procedure for Bayesian estimation of Markov-switching models implemented by Kim and Nelson (1999).[3,4]

My data are quarterly observations of the national and regional IIPs for 1976:Q1–2005:Q3 produced by the Ministry of Economy, Trade, and Industry. I exclude Okinawa from the analysis because its data are incomplete, and I begin my dataset in 1976 to take account of the mid-1970s break found by Uchiyama and Watanabe (2004).[5] Unfortunately, because the data for the regional IIPs are available only beginning in 1968, there are insufficient data to include the pre-1976 period in the present analysis.

[2] See Yao and Kholodilin (2004) for another analysis of structural breaks in Japan using Markov-switching models.

[3] The Gibbs sampler draws iteratively from the conditional posterior distribution of each parameter, given the data and the draws of the other parameters. These draws form an ergodic Markov chain whose distribution converges to the joint posterior distribution of the parameters, given the data. To ensure convergence, I discard the first 2,000 draws when I simulate the posterior distribution. The sample posterior distributions are then based on an additional 10,000 draws.

[4] The prior for the switching mean parameters, $(\mu_0,\mu_1)'$, is Gaussian with mean vector $(1,-1)'$ and a variance-covariance matrix equal to the identity matrix. The transition-probability parameters for phases 0 and 1 have Beta prior distributions, given by $\beta(9,1)$ and $\beta(8,2)$, implying means of 0.9 and 0.8 and standard deviations of 0.09 and 0.12, respectively.

[5] Watanabe and Uchiyama (2005) account for the break by beginning their dataset in 1980. As discussed below, my results are not very sensitive to the choice of 1976 or 1980 as a starting point.

Table 1

Quarterly Growth Rates of IIP: Japan

	Actual average growth rate	Estimated average growth rate in expansion	Estimated average growth rate in recession	Expansion – recession
1976-2005	0.57	1.11 (0.84, 1.40)	–1.23 (–1.80, –0.66)	2.34
1976-1991	1.04	1.87 (1.54, 2.18)	0.01 (–0.34, 0.37)	1.87
1992-2005	0.04	0.76 (0.31, 1.18)	–1.52 (–2.19, –0.75)	2.28
Change	–1.00	–1.11	–1.53	0.41

NOTE: The 90 percent coverage intervals are in parentheses.

There are not nearly as many different measures of economic activity at the regional level as there are at the national level, so I am limited in the series that I can use. An alternative to the IIP is the regional coincident indicator (CI) produced by the Cabinet Office, which combines six series—the IIP, wholesale electricity consumption, construction starts, sales at large retailers, the ratio of job offers to applicants, and overtime working hours—into one. I use the IIP instead of the CI because the IIP has been used previously to examine the timing of regional business cycles and its success at the national level in timing recessions has already been established.[6]

My first step is to use the Hamilton model and the Japanese IIP to obtain a description of the national business cycle. The first purpose of this exercise is to demonstrate the effect that accounting for the early-1990s structural break has on the model. The second purpose is to show that the national IIP is useful for mimicking the ESRI recession dates, as shown previously by Watanabe and Uchiyama (2005). The third purpose is to provide recession dates from the national IIP for comparison with the recession dates that I obtain using regional data.

[6] Preliminary analysis indicates that, at least for the post-1990 period, the CI is not on the whole superior to the IIP in detecting regional business cycles. For some regions, the CI is much less responsive to the business cycle than is the IIP, while for other regions it is somewhat more responsive. The main difference in results between the two series is that use of the CI results in fewer region-level recessions. There are also differences in the timing of recessions, most notably for the Kanto region, although a comparison is difficult because the regions are defined differently in the two series.

THE NATIONAL BUSINESS CYCLE

Recall that, according to the Hamilton model, the average growth rate is the average of the recession and expansion growth rates, weighted by the frequencies of the two business cycle phases. The model provides estimates of the average growth rates in each of the two phases and, for each observation, the probability that the economy is in the recession phase.

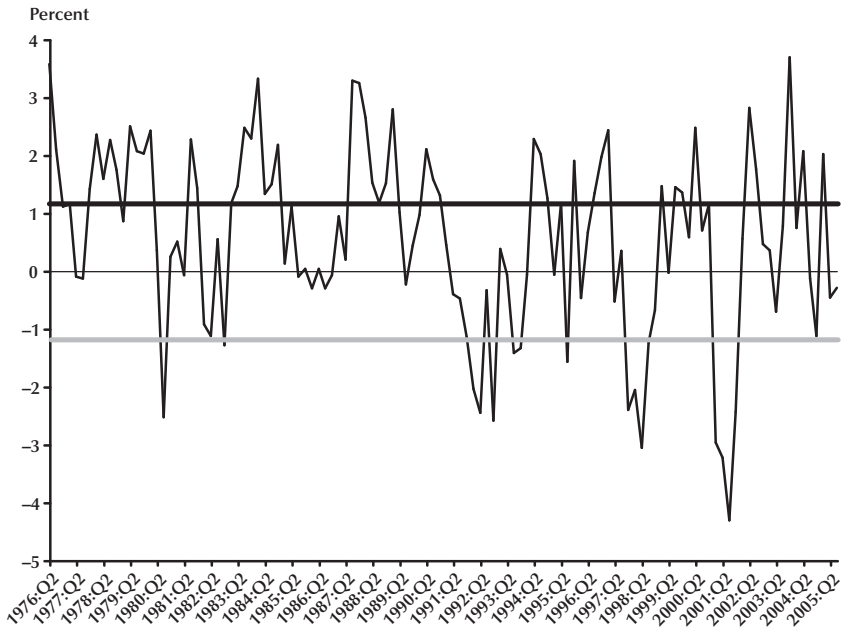
For the time being, assume, as in Okumura and Tanizaki (2004), that there were no structural breaks in the aggregate IIP growth series. When the model is applied to the data, for which the average growth rate is 0.57 percent, the estimated average growth rate in expansion is 1.11 percent, while the estimated average growth rate in recession is –1.23 percent (see Table 1).[7] Figure 1 illustrates the actual growth rate series relative to the estimated average growth rates for the two phases. In determining the probability of recession, the model considers the proximity of the actual growth rate to the two average growth rates, while also considering the persistence of the relative proximity.

The probability of recession is provided by Figure 2, for which the shaded area indicates periods of national ESRI recessions. When the probability of recession rises and falls rapidly as the economy switches in and out of recession, the model is able to cleanly separate the data into

[7] Growth rate estimates are the means of their respective posterior distributions.

Figure 1

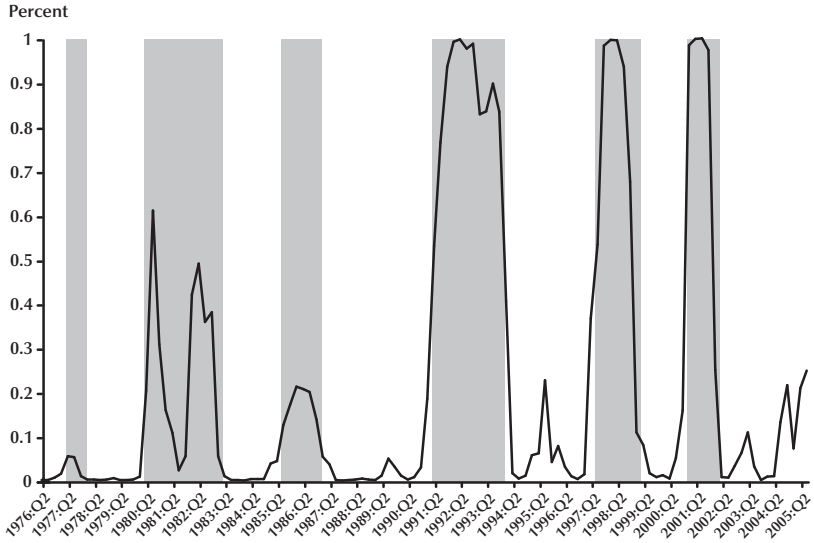
Growth of IIP: Japan, No Structural Break



NOTE: Thick black line is expansion growth rate; thick gray line is recession growth rate.

Figure 2

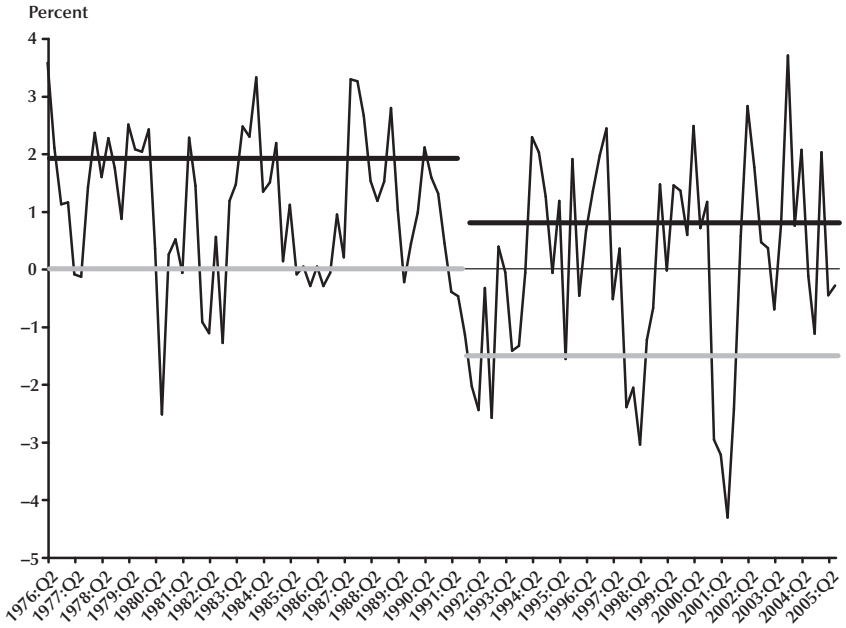
Probability of Japanese Recession, No Structural Break



NOTE: Shaded areas indicate ESRI recessions: 1977:Q2–1977:Q4, 1980:Q2–1983:Q1, 1985:Q3–1986:Q4, 1991:Q2–1993:Q4, 1997:Q3–1999:Q1, 2001:Q1–2002:Q1. IIP recessions: 1980:Q3, 1991:Q2–1993:Q4, 1997:Q3–1998:Q4, 2001:Q1–2001:Q4.

Figure 3

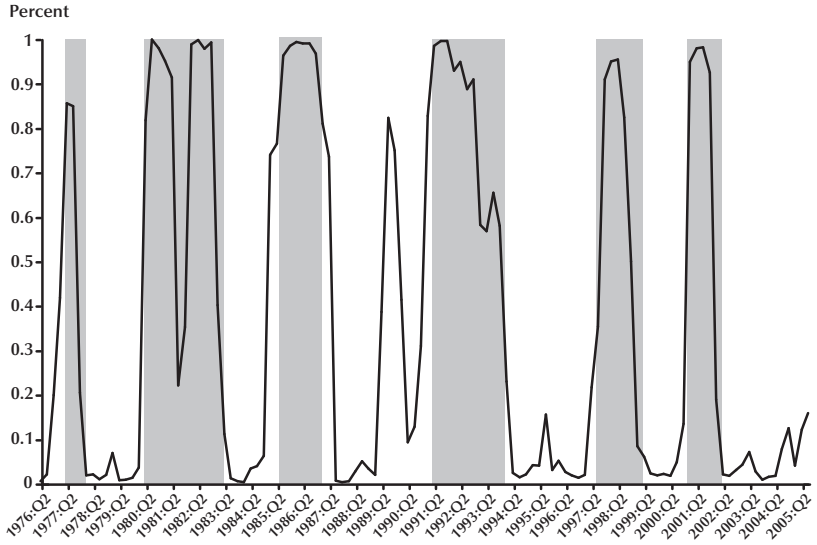
Growth of IIP: Japan, with Structural Break



NOTE: Thick black line is expansion growth rate; thick gray line is recession growth rate.

Figure 4

Probability of Japanese Recession, with Structural Break



NOTE: Shaded areas indicate ESRI recessions: 1977:Q2–1977:Q4, 1980:Q2–1983:Q1, 1985:Q3–1986:Q4, 1991:Q2–1993:Q4, 1997:Q3–1999:Q1, 2001:Q1–2002:Q1. IIP recessions: 1977:Q2–1977:Q3, 1980:Q2–1981:Q2, 1982:Q1–1982:Q4, 1985:Q1–1987:Q2, 1989:Q3–1989:Q4, 1991:Q1–1993:Q4, 1997:Q4–1998:Q3, 2001:Q1–2001:Q4.

recession and expansion phases. This occurs only for the post-1990 period, for which the recession probability approaches 1 during each of the three ESRI recessions and is close to 0 during the ESRI expansion periods. On the other hand, for the pre-1990 period, the probability of recession exceeds 0.5 (the traditional cutoff for recession) for only one quarter in 1980, even though there were three ESRI recessions during the period.

A visual examination of Figure 1 reveals the reason that the model "misses" the pre-1990 recessions. Most obviously, the growth troughs that the economy experienced before 1990 tended to occur at higher growth rates than did those after 1990. In addition, the earlier period's growth peaks were more persistently higher than were those for the later period. In other words, the economy experienced a structural break sometime around 1990 following the bursting of the so-called bubble economy. The break included a change in the average growth rates for the two phases. When no such break is allowed for, the troughs of the 1980s are given a low probability of recession because the determination of the recession growth rate is dominated by the post-1990s data.

To account for this break, I split the sample using the January 1992 break found by Watanabe and Uchiyama (2005) and apply the model independently to the two time periods.[8] The effects of the break are illustrated by Figures 3 and 4. Notice first that the actual average growth rate was much lower in the post-break period, falling by a full percentage point, from 1.04 percent to 0.04 percent (see Table 1). Also, the estimated average growth rates for both phases are lower for the post-break period. The expansion growth rate fell by 1.11 percentage points, while the recession growth rate fell by 1.53 percentage points. Thus, the gap between expansion and recession was larger after the break.

[8] Note that I do not test for statistical importance of the breaks that I have assumed for the aggregate IIP, nor do I do so for the regional IIPs that I use in the next section. Because I have imposed two breaks, one in 1976 and one in 1992, a minimally meaningful analysis would test for both of these breaks simultaneously. A serious analysis would allow for the two possible breaks to differ in timing across regions. Such an analysis, however, deserves a paper of its own and is beyond the objective of this paper.

As Figure 4 shows, the occurrence of recession and expansion is much clearer when the break is allowed for. The IIP recessions are fairly closely in line with the ESRI recessions, although there are interesting differences. According to the IIP, there was a brief expansion in 1981 between two recessions, but the ESRI determined that there was one long recession. Also, according to the IIP, there was a brief recession in 1989 that was not indicated by the ESRI. This anomalous recession was detected also by Watanabe and Uchiyama, although it was absent when they used a composite index instead of the IIP. It is possible that the recession is an artifact of the statistical uncertainty surrounding the exact break date, which Watanabe and Uchiyama place in April 1989 using their composite index.

Comparing the IIP recessions with those of the ESRI, there are relatively small differences in the timing of the switches between phases. Because the differences are typically only of one quarter, one can conclude that the model applied to the IIP provides a reasonably good approximation of ESRI recessions. On this basis, I use regional IIPs to examine regional recession and expansion phases.

REGIONAL BUSINESS CYCLES

The results from applying the model to regional IIP growth for pre- and post-break data are summarized in Table 2. As with the aggregate data, I apply the model to the data for each region for each time period: 1976:Q1–1991:Q4 and 1992:Q1–2005:Q3. The table includes the actual average growth rates, the estimated expansion and recession growth rates, the gaps between expansion and recession, and the changes wrought by the break. This information is illustrated by Figure 5, which provides for each region the plots of regional IIP growth and the two phase-specific growth rates for each period.

In terms of average growth, there were three groups of regions during the pre-break period: high growth (Tohoku, Kanto, and Chubu), medium growth (Kinki, Chugoku, and Kyushu), and low growth (Hokkaido and Shikoku). There are some

Table 2

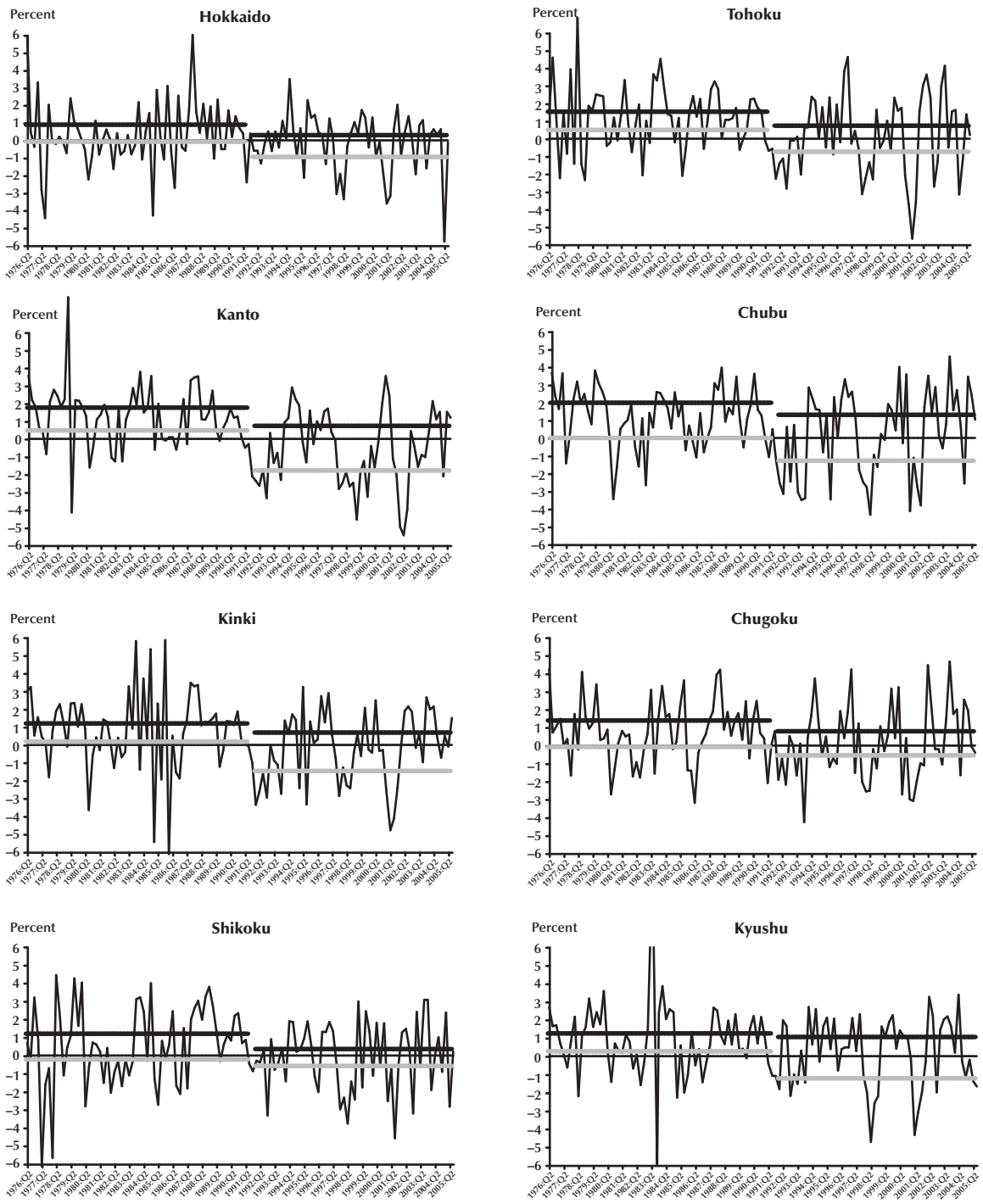
Quarterly Growth Rates of IIP: Japanese Regions

	Actual average growth rate	Estimated average growth rate in expansion	Estimated average growth rate in recession	Expansion—recession
Hokkaido				
1976-1991	0.33	0.82 (0.10, 2.23)	–0.14 (–1.00, 0.48)	0.97
1992-2005	–0.15	0.23 (–0.31, 0.80)	–1.03 (–2.35, –0.09)	1.25
Change	–0.48	–0.60	–0.88	0.28
Tohoku				
1976-1991	1.17	1.47 (0.88, 2.47)	0.43 (–0.66, 1.21)	1.04
1992-2005	0.09	0.67 (–0.09, 1.57)	–0.81 (–1.83, 0.13)	1.48
Change	–1.08	–0.80	–1.24	0.44
Kanto				
1976-1991	1.17	1.69 (0.98, 2.72)	0.41 (–0.57, 1.14)	1.28
1992-2005	–0.60	0.66 (0.01, 1.27)	–1.85 (–2.44, –1.24)	2.51
Change	–1.77	–1.03	–2.26	1.23
Chubu				
1976-1991	1.13	1.92 (1.37, 2.39)	–0.08 (–0.65, 0.57)	2.00
1992-2005	0.21	1.23 (0.25, 1.92)	–1.35 (–2.27, –0.08)	2.58
Change	–0.92	–0.68	–1.27	0.59
Kinki				
1976-1991	0.80	1.12 (0.50, 2.00)	0.10 (–0.96, 0.87)	1.02
1992-2005	–0.20	0.61 (–0.05, 1.15)	–1.55 (–2.30, –0.54)	2.16
Change	–1.00	–0.51	–1.65	1.14
Chugoku				
1976-1991	0.76	1.32 (0.68, 2.02)	–0.15 (–0.94, 0.65)	1.47
1992-2005	0.12	0.71 (–0.08, 1.75)	–0.63 (–1.46, 0.15)	1.34
Change	–0.64	–0.60	–0.48	–0.12
Shikoku				
1976-1991	0.53	1.12 (0.34, 2.08)	–0.30 (–1.24, 0.52)	1.43
1992-2005	–0.08	0.29 (–0.31, 1.05)	–0.67 (–1.64, 0.08)	0.95
Change	–0.61	–0.84	–0.36	–0.47
Kyushu				
1976-1991	0.85	1.18 (0.52, 2.26)	0.19 (–0.84, 0.95)	0.99
1992-2005	0.20	0.99 (0.35, 1.53)	–1.29 (–2.03, –0.23)	2.28
Change	–0.65	–0.19	–1.48	1.29

NOTE: The 90 percent coverage intervals are in parentheses. Numbers may not add up because of rounding.

Figure 5

Actual and Average IIP Growth Rates: Regions, with Structural Break



NOTE: Thick black lines are average expansion growth rates; thick gray lines are average recession growth rates.

deviations from this grouping when growth is separated into expansion and recession growth rates. For expansion growth rates, the grouping of regions is similar to that above, although Shikoku is in the medium-growth group, and perhaps Chubu can be placed into a very-high-growth group of its own. Recessions during the period were very mild for all regions. In fact, the recession growth rates for Tohoku, Kanto, Kinki, and Kyushu were all positive, with Tohoku and Kanto being the best recessionary performers. The gaps between expansion and recession were not very large for most regions, with Chubu as the notable exception. As a consequence, for some regions it is difficult to separate quarters into particular phases.

The effect of the break on the regions was similar to the effect it had at the national level: lower average growth, lower growth in both expansion and recession, and larger gaps between expansion and recession growth rates. The only exceptions were Chugoku and Shikoku, which saw their gaps between expansion and recession shrink. There was a good deal of variation, however, in the sizes of these changes across regions.

Four regions (Hokkaido, Kanto, Kinki, and Shikoku) had negative average growth rates during the post-break period. For Kanto, in particular, this was a dramatic change from the earlier period in that this represented a decrease in average growth of 1.77 percentage points. Large decreases in average growth (near or above a percentage point) also occurred for Tohoku, Chubu, and Kinki. Even when regions were in expansion, growth was sluggish, with Chubu and Kyushu as the high performers during expansion. Recession hit all regions hard, with five regions experiencing growth of worse than –1.0 percent per quarter. This represented large changes for Kanto and Kinki: Both had positive recession growth rates in the pre-break period that fell by 2.26 percentage points and 1.65 percentage points, respectively.

Although both expansion and recession growth rates fell across the board, it was typical for recession growth rates to fall by more, thereby increasing the gap between the two phases. This means that for most regions, the incidence of expansion and recession was much easier to determine during the post-break period. This is apparent from Figure 6, which presents the recession probabilities for the eight regions for the entire sample period.

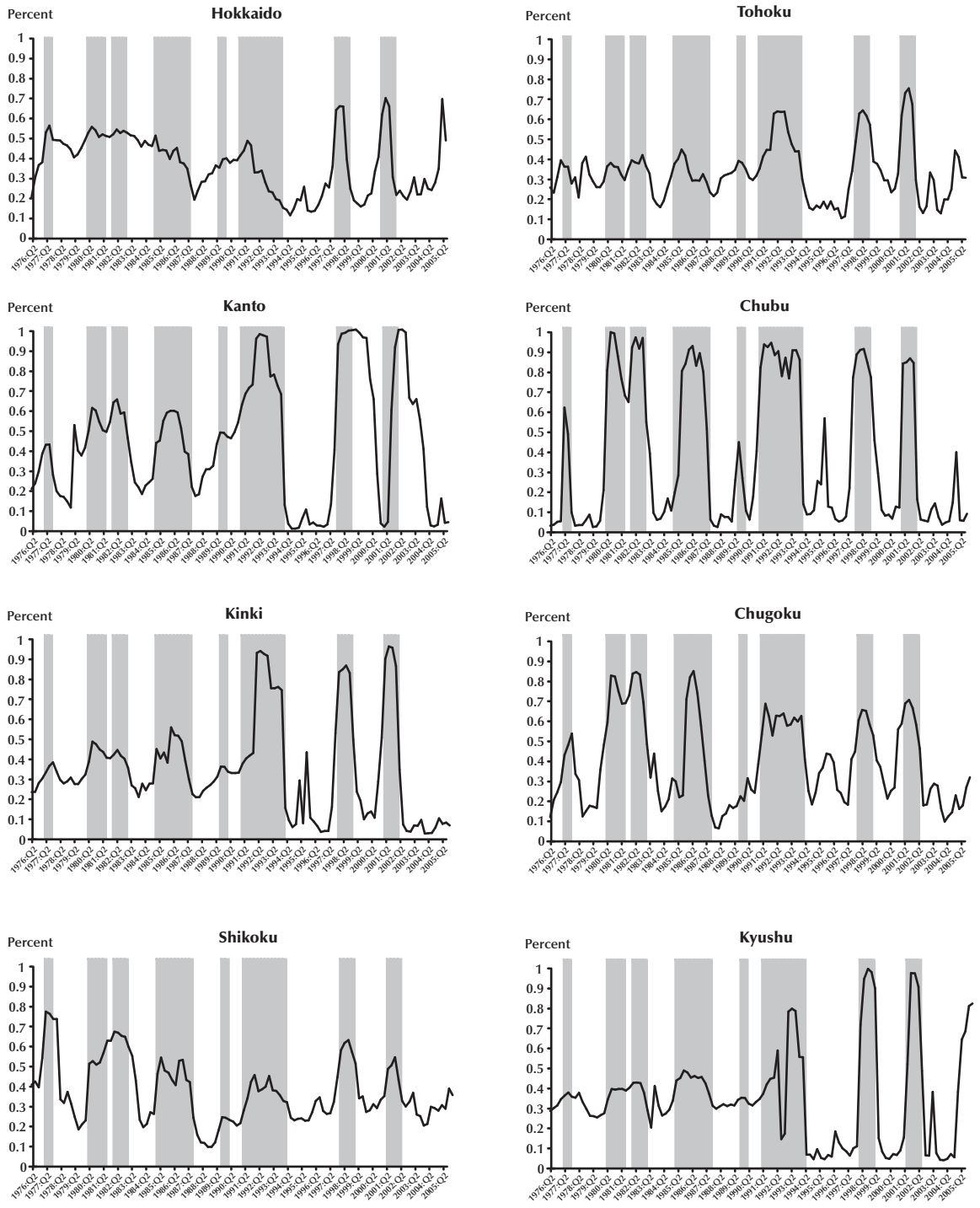
Except for Chubu, Chugoku, and Shikoku, there are marked differences in the clarity of the business cycle between the pre- and post-break periods. For Chubu, the distinction between phases is clear for both periods, while it is not terribly clear in either period for Chugoku and Shikoku. For the other five regions, the post-break period provides very clear distinctions between phases, as indicated by rapid changes in the probability of recession at turning points, and regional recessions were widespread during the period. On the other hand, the pre-break picture is more muddied.

Although changes in economic conditions are usually apparent through changes in the probability of regional recession, the probabilities of recession typically do not become close to zero in expansion nor close to one in recession. Even so, there are enough instances for which the probability of recession crosses the 0.5 threshold to indicate that regional recessions were quite common in the 1980s. Admittedly, for some regions, the simple application of the arbitrary 0.5 threshold gives the misleading impression that there is a clear delineation between recession and expansion phases. Nevertheless, even for these regions, the implication of Figure 6 is very different from the findings of Okumura and Tanizaki (2004), who found that the probability of recession usually remained very close to zero for several regions for the entire post-1976 period. Here, at least, the regional probabilities of recession usually do fluctuate in tandem with the national business cycle.

Figure 7 summarizes the occurrence of regional recessions over the entire sample period. In the figure, a "■" indicates that a region was in recession during the quarter, while the shaded areas indicate periods of national recession as determined above (using the national IIP). As shown in the figure, most regions experienced three or four recessions during the pre-break era, although Tohoku and Kyushu experienced none. This is in contrast with the findings of Okumura and Tanizaki (2004), who found regional reces-

Figure 6

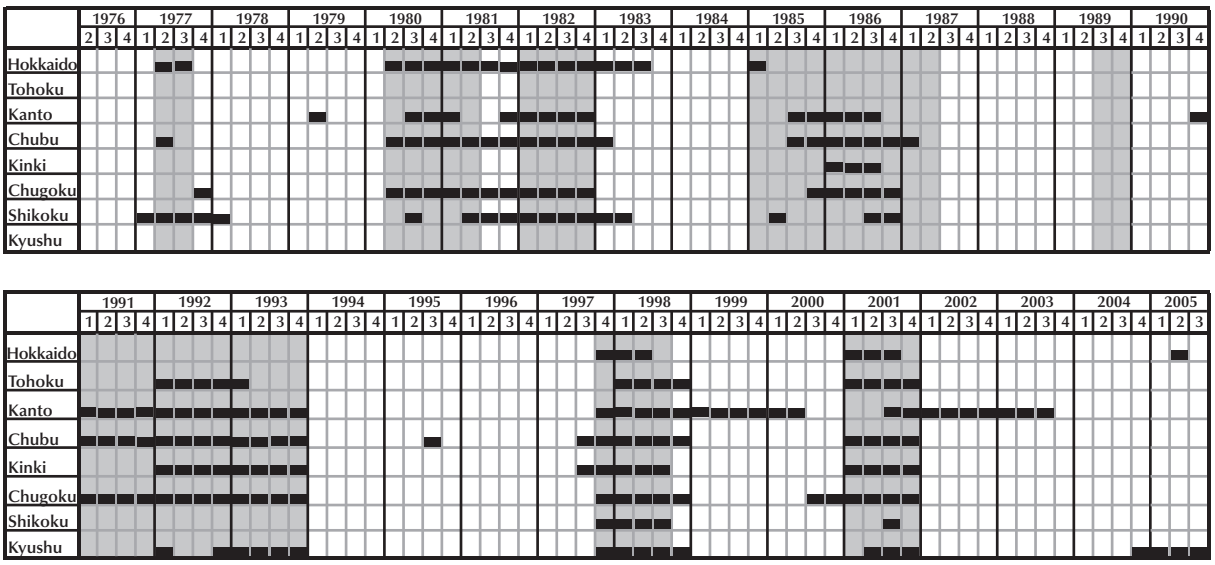
Regional Recession Probabilities



NOTE: Shaded areas indicate national IIP recessions.

Figure 7

Regional Recessions



NOTE: Shaded areas indicate national IIP recessions. A "■" indicates a quarter during which a region was in recession.

sions to be rare during the period. Also in contrast with Okumura and Tanizaki, Figure 7 shows that nearly every region experienced every recession during the post-break period, with the exceptions being Hokkaido and Shikoku, which did not experience the 1991-93 recession. I attribute the difference between my results and those of Okumura and Tanizaki to the fact that I allowed for a structural break while they assumed that a single model applied to the entire sample period.

Although there were interesting differences in the occurrence of regional recessions, for the most part, regional recessions were associated with national recessions. I find that only four regions went into recession around the period of the 1977 national recession, although the briefness of the recession and the relative noisiness of region-level data might make it too difficult for the model to pick up any regional recessions. Recall that the years of 1980-82 saw two recessions according to the IIP, although there was one long recession according the ESRI. I find that five regions went into recession during the period; two of them had two separate recessions, while the others had one long recession. The three regions for which the model does not indicate recession during 1980-82 did experience slowdowns, but the slowdowns did not reach the level of recession.

The purpose of this paper is to document, rather than to explain, differences in regional business cycle phases in Japan. Nevertheless, it is possible to suggest some reasons for the differences in regional business cycle performance. For example, industry composition probably matters a great deal. Most obviously, the recession pattern for Kanto is driven by its relatively high reliance on the financial sector; the region kept expanding through the nationwide recession of 2001 as equity markets rose, only to enter into its own nine-quarter recession following the financial market collapse in the summer of 2001. Also, Chubu's very clear recession and expansion pattern is probably due in large part to the heavy presence of auto manufacturers, whose fortunes are closely linked to the overall business cycle.

Differences in policy effectiveness across regions and over time may also explain some of the findings. As has been documented for the United States by Carlino and DeFina (1998) and Owyang and Wall (2006), among others, monetary policy can have very different effects across regions within a country, perhaps because of differences in the channels of monetary policy and/or industrial composition. Fujiki (2006) provides several examples of Japanese regional heterogeneity that matter for monetary policy. Regional differences might also be the result of the heavy use of fiscal policy in Japan to dampen the business cycle. A great deal of the fiscal policy stimulus was directed at infrastructure and construction projects, which might have had disproportionate effects in some regions.

Finally, changes in the effectiveness of monetary and fiscal policy over time probably contributed to the increasingly widespread nature of Japanese recessions. By the mid- and late 1990s, it was becoming increasingly difficult for the central government to maintain the costs of huge infrastructure projects meant to boost aggregate demand. At the same time, the Bank of Japan was finding it increasingly difficult to use its policy levers to stimulate the economy and head off deflation.

CONCORDANCE

Although regions have tended to experience recessions that were associated with national recessions, regional recessions have differed from the nation's and from each other in length and timing. Harding and Pagan (2002) measure the degree to which two business cycles are in sync by their degree of concordance—defined as the proportion of time that the two economies were in the same regime. Expressed in probabilities, the degree of concordance between two business cycles is

$$C_{ij} = \frac{1}{T}\sum_{t=1}^{T}\left[P_{it}P_{jt} + \left(1 - P_{it}\right)\left(1 - P_{jt}\right)\right], \tag{2}$$

where P_{it} is the probability of recession in i during time t and T is the total number of periods. The set of region-Japan and region-region degrees of concordance are in Table 3 and are for the entire sample, the pre-break period, and the post-break period.

For the entire sample period, the business cycles of the regions were relatively in sync with the national business cycle, although only Chubu, with a degree of concordance of 0.79, stands out as having been highly synchronous. Similarly, although the regional business cycles were related to each other, the degrees of concordance do not stand out as being particularly high.

Note, however, the differences before and after the break. All but one of the post-break degrees of concordance between the regions and Japan are higher, and some are much higher. Chubu, Kinki, and Kyushu, for example, all had degrees of concordance of 0.75 or greater for the post-break period. For Kinki and Kyushu, this represents increases of 0.22 and 0.19, respectively, relative to the pre-break period. The region-region degrees of concordance also tended to be higher for the post-break period. In particular, Kinki and Kyushu both became much more in sync with other regions.

SENSITIVITY TO BREAK DATE

As discussed above, the significant differences between my results and those of Okumura and Tanizaki (2004) are due primarily to my allowances for structural breaks. My sample begins with 1976 so as to avoid the break that Uchiyama and Watanabe (2004) found for 1975, while I simply impose the 1992 break date of Watanabe and Uchiyama (2005). Other options include: beginning my sample later, perhaps in 1980, as did Watanabe and Uchiyama; or choosing a 1989 break date to coincide with the break in the coincident indicators found by Uchiyama and Watanabe (2004) and Watanabe and Uchiyama (2005). In this section, I discuss briefly how the choices of break dates affected my results. Specifically, I discuss the effects of starting my sample in 1980 and of allowing for a break in 1989.

The results for the aggregate data depend very little on the choice of 1976 or 1980 as a starting point. The general pattern of recession changes

Table 3

Business Cycle Concordance

	Hokkaido	Tohoku	Kanto	Chubu	Kinki	Chugoku	Shikoku	Kyushu
1976-2005								
Japan	0.59	0.62	0.63	0.79	0.68	0.66	0.61	0.65
Hokkaido		0.57	0.52	0.58	0.58	0.56	0.56	0.58
Tohoku			0.57	0.61	0.61	0.57	0.57	0.61
Kanto				0.63	0.59	0.57	0.55	0.56
Chubu					0.67	0.66	0.60	0.63
Kinki						0.61	0.58	0.63
Chugoku							0.58	0.58
Shikoku								0.58
1976-1991								
Japan	0.54	0.56	0.62	0.78	0.58	0.66	0.60	0.56
Hokkaido		0.53	0.52	0.54	0.53	0.54	0.54	0.53
Tohoku			0.55	0.57	0.57	0.56	0.56	0.57
Kanto				0.62	0.55	0.58	0.54	0.54
Chubu					0.58	0.67	0.60	0.57
Kinki						0.57	0.56	0.56
Chugoku							0.58	0.56
Shikoku								0.55
1992-2005								
Japan	0.66	0.69	0.65	0.79	0.80	0.66	0.63	0.75
Hokkaido		0.60	0.52	0.61	0.63	0.58	0.60	0.64
Tohoku			0.59	0.66	0.67	0.59	0.59	0.65
Kanto				0.64	0.64	0.56	0.55	0.59
Chubu					0.77	0.64	0.60	0.71
Kinki						0.65	0.61	0.71
Chugoku							0.57	0.61
Shikoku								0.61

only marginally, and the anomalous 1989 recession arises in either case. In addition, my general conclusions about the prevalence of regional recessions during the pre-break period are the same, although the region-level results differ somewhat. For example, if I had used 1980 as my starting point, the probability of recession for Hokkaido would have been lower throughout the period. As a consequence, Hokkaido would have not been in recession at any time during the 1980s, while my results indicate long recessionary periods. On the other hand, although my results indicate that Tohoku avoided recession throughout the 1980s, if I had used 1980 as my starting point, the results would have had Tohoku in recession frequently during the period. Finally, a 1980 starting point would have put Shikoku into recession more often than what I found with my sample.

Of course, the structural break following the burst of the so-called bubble economy did not occur dramatically from one quarter to the next. If, instead of a 1992 break date, I had imposed a 1989 break date, there would only have been marginal differences in my results. The most signifi-

cant difference would have been that the model would not have indicated the anomalous national recession of 1989. Also, it would have produced closer fits for the starts of the 1991-93 recession for several regions (Kanto, Kinki, and Kyushu). Finally, it would have meant that no recessions would have been indicated for Kinki in the 1980s.

Taken together, the most important consequences of my handling of the structural breaks were at the regional level. The fact that regions are affected differently by the timings of structural breaks suggests that future research might take into account the possibility of region-specific breaks occurring at different times around the occurrence of an aggregate break.[9]

CONCLUDING REMARKS

In this paper, I applied a Markov-switching model with a structural break to Japanese IIP data for 1976-2005. The purpose of the exercise was to determine and compare the national and regional patterns of recession and expansion phases. The methodological contributions of the paper relative to previous analyses of the Japanese business cycle are (i) the addition of five recent years of data and (ii) the allowance for structural breaks in the mid-1970s and the early 1990s.

The early-1990s structural break meant a reduction in national and regional growth rates in both expansion and recession, usually resulting in an increase in the gap between the growth rates of the two phases. Also, there were interesting differences in the occurrence of recession across regions. For example, although recessions tended to be experienced across a majority of regions in both the pre- and post-break periods, the occurrence and lengths of recessions were much greater after the break. In addition, the region-level recession experiences became much more similar over time, especially during the post-break period.

[9] In fact, there might even be regional structural breaks that are unassociated with an aggregate break, a possibility that was suggested to me by Mahito Uchida for Tohoku in the mid-1990s.

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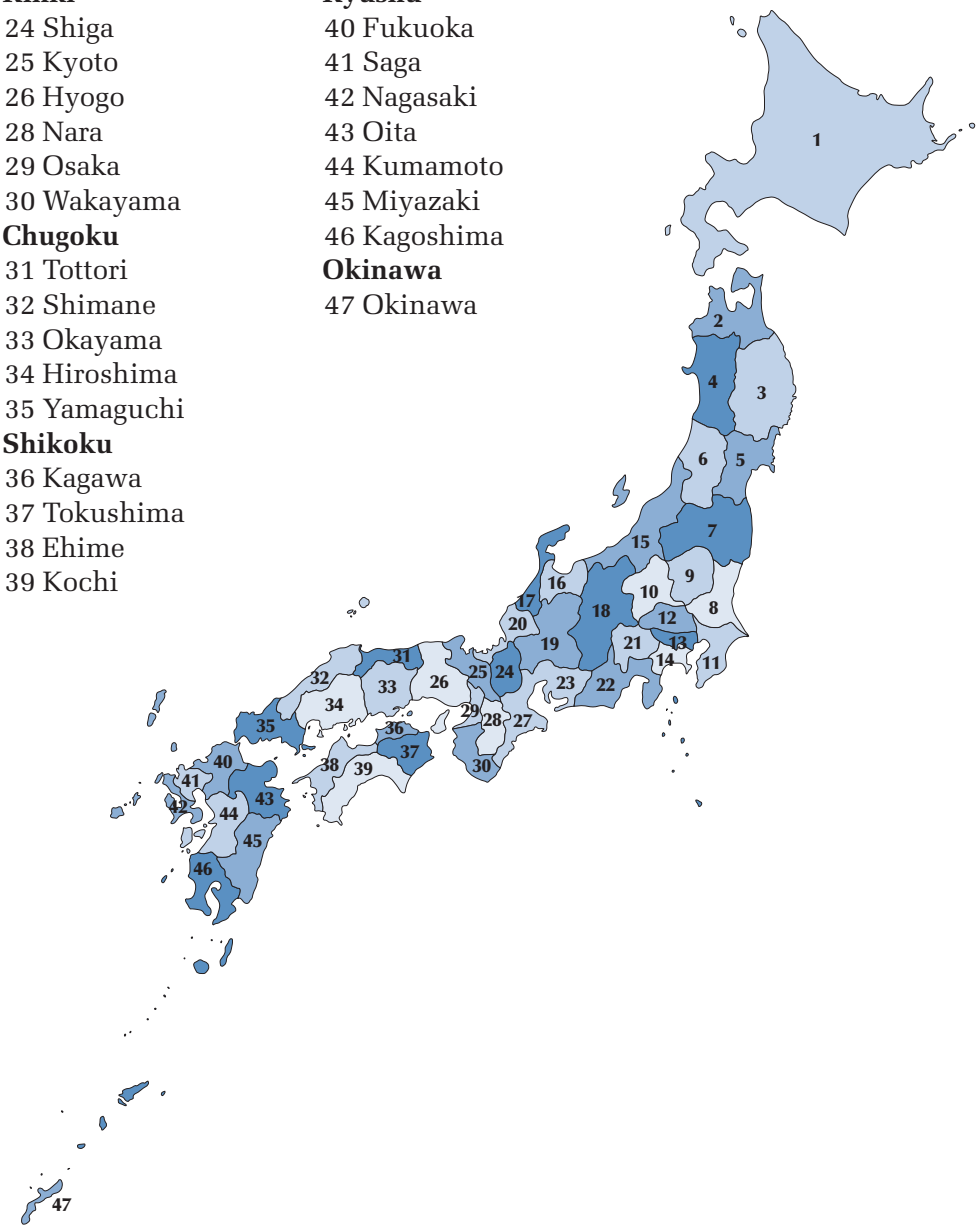
APPENDIX

Japanese IIP Regions and Their Prefectures

Hokkaido
1 Hokkaido
Tohoku
2 Aomori
3 Iwate
4 Akita
5 Miyagi
6 Yamagata
7 Fukushima
Kanto
8 Ibaraki
9 Tochigi
10 Gumma
11 Chiba
12 Saitama
13 Tokyo
14 Kanagawa
15 Niigata
18 Nagano
21 Yamanashi
22 Shizuoka
Chubu
16 Toyama
17 Ishikawa
19 Gifu
20 Fukui
23 Aichi
27 Mie

Kinki
24 Shiga
25 Kyoto
26 Hyogo
28 Nara
29 Osaka
30 Wakayama
Chugoku
31 Tottori
32 Shimane
33 Okayama
34 Hiroshima
35 Yamaguchi
Shikoku
36 Kagawa
37 Tokushima
38 Ehime
39 Kochi

Kyushu
40 Fukuoka
41 Saga
42 Nagasaki
43 Oita
44 Kumamoto
45 Miyazaki
46 Kagoshima
Okinawa
47 Okinawa