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THE NAIRU IN JAPAN : MEASUREMENT AND ITS IMPLICATIONS

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ABSTRACT/RÉSUMÉ

The NAIRU is estimated by using the Japanese data. There are three major findings. The NAIRU has been increasing modestly since 1970. Unlike the standard specification adopted in many OECD countries it can be estimated more precisely when the unemployment rate with a several-quarter lead is used. Hysteresis or "speed limit" effects are also detected. These findings lead to the following implications. Structural reform in the labor market should be pursued. Seeking for alternative labor market indicators which move ahead of inflation will be useful. Macroeconomic policy aimed at rapidly reducing unemployment could be costly in terms of inflation.

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Cet article fournit une estimation du NAIRU à partir des données japonaises. Trois conclusions principales peuvent être tirées. Le NAIRU a légèrement augmenté depuis 1970. Contrairement aux spécifications généralement retenues pour de nombreux pays de l'OCDE, la mesure obtenue du NAIRU est plus précise si le taux de chômage pris en compte dans l'estimation est celui observé avec plusieurs trimestres d'avance. Enfin, l'existence d'effets d'hystérèse ou de "speed limit" a aussi été détectée. Ces résultats suggèrent les enseignements suivants. Il semble nécessaire de poursuivre la réforme structurelle du marché du travail. Il serait utile de chercher des indicateurs du marché du travail permettant d'anticiper les variations d'inflation. Utiliser une politique macro-économique pour réduire le chômage rapidement pourrait être coûteux en termes d'inflation.

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THE NAIRU IN JAPAN: MEASUREMENT AND ITS IMPLICATIONS[1]

Fumihira Nishizaki[2,3]

1. Introduction

1. In theory, the non-accelerating inflation rate of unemployment (NAIRU) has been considered as one of the most useful indicators for policymakers in a variety of ways. It can be an important tool for structural reform in the labor market because it demonstrates that a major part of actual unemployment stems from institutional rigidities. It can potentially serve as an indicator assessing the cyclical position of the economy in macroeconomic policy formulation. The gap between actual unemployment and the NAIRU indicates slackness in the labor market, and can be used as a leading index of inflation, in conjunction with other relevant indices. Furthermore, it can be used for estimating the output gap, which itself has some predictive power for future inflation and helps separate cyclical portion of public deficit.

2. Among many relevant indicators used in macroeconomic policy formulation, the NAIRU has several strengths. First, it directly focuses on the trade-off between unemployment and inflation, both of which are the ultimate targets of macroeconomic policy. Second, the data on unemployment and inflation are usually available monthly and, therefore, the NAIRU from reduced-form regressions can be quickly updated.

3. However, the usefulness of the NAIRU as a policy guideline has recently come under rigorous challenge. Apart from the theoretical issues surrounding it - including the existence of hysteresis - estimating the NAIRU with precision has proved to be very difficult (see, for example, Staiger, Stock and Watson (1994) for the U.S., and Setterfield, Gordon and Osberg (1992) for Canada). In this paper, we run, as did the above studies, reduced-form regressions using the Japanese data to obtain the NAIRU, and examine its implications on policymaking.

4. The NAIRU is defined here by the expectations-augmented Phillips curve.

$$D\ln P = \alpha + \beta\, U + \gamma\, Z + \delta\, D\ln P^{e} \qquad [1]$$

where $D\ln P$ denotes inflation rate, U unemployment rate, Z supply shocks including structural changes in the labor market, and $D\ln P^{e}$ expected rate of inflation, ignoring lagged effects. Normally, δ must be unity

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1. This is a revised version of the paper submitted to the meeting of Working Party No.1 of the Economic Policy Committee, OECD, 10-11 October 1996.

2. Coordination Division, Economic Planning Agency, Tokyo.

3. With statistical assistance from First Domestic Research Division, Economic Planning Agency, Tokyo.

to ensure the fully compatible behavior of the economic agents with the current inflation rate. Then, the NAIRU can be obtained by assuming $D\ln P = D\ln P^e$.

$$\text{NAIRU} = -(\alpha + \gamma Z)/\beta \qquad [2]$$

2. Recent empirical studies

5. In Japan, estimating the NAIRU was relatively fashionable during the 70s and 80s after experiencing stagflation triggered by excessive liquidity and oil price hikes. However, the long-lasting price stability during the bubble economy and the subsequent disinflation period diverted economists' interests from that subject. At this stage, therefore, very few empirical studies on the NAIRU are available. Ironically, the recent surge in unemployment, at a historical high of 3.5% despite reasonably good growth, has ignited discussion on whether the structural portion of unemployment is increasing. In such a debate, however, structural unemployment is usually measured by the Beveridge curve.

6. The Economic Planning Agency (1994) estimated wage and price equations and derived estimates for the NAIRU from the following equations.

$$D\ln W = \alpha_0 + \alpha_1 (1/U) + \alpha_2 D\ln P^e + \alpha_3(L)R \qquad [3]$$

$$D\ln P = \beta_0 + \beta_1(L)D\ln ULC + \beta_2(L)D\ln P_m + \beta_3(L)D\ln P_r + \beta_4(L)CU \qquad [4]$$

where $D\ln ULC$ = growth rate of unit labor cost, P_m = import price, P_r = current profit to sales ratio, CU = capacity utilization rate and R = growth rate of labor productivity. The estimation period is from 1972 Q1 to 94 Q2. Note that $D\ln ULC = D\ln W - R$. Assuming $D\ln P^e = D\ln P$ and eliminating $D\ln W$ from both equations, the NAIRU is obtained as:

$$\begin{aligned}\text{NAIRU} \\ &= \alpha_1 \beta_1(1)/((1-\alpha_2 \beta_1(1))D\ln P - (\beta_1 + \alpha_0 \beta_1(1)) \\ &\quad - (\beta_2(1)D\ln P_m + \beta_3(1)D\ln P_r + \beta_4(1)CU) + (1-\alpha_3(1))\beta_1(1)R) \qquad [5]\end{aligned}$$

In this regression, no restriction is imposed on the coefficient of $D\ln P^e$, implying violation of the axiom of the vertical Phillips curve. As a result, unlike usual analyses, the estimated NAIRU should depend on the level of price inflation. By assigning 'trend' or 'equilibrium' values to $D\ln P$, $D\ln P_m$, $D\ln P_r$, CU and R, the NAIRU is estimated to be somewhere in the range of 2.2 to 2.6%.

7. Nishimura (1994) estimated four equations simultaneously: wage, price, unemployment and production functions.

$$D\ln W = \alpha_1(U - \text{NAIRU}) + \alpha_2 D\ln P^e + \alpha_3 R^T \qquad [6]$$

$$D\ln P = \beta\,(D\ln W - R^T) \qquad [7]$$

$$U = \gamma_0 + \gamma_1(\ln Y - \ln Y^T) + \gamma_2 Z + \gamma_3 U_{-1} \qquad [8]$$

$$Y = F(K, H) \qquad [9]$$

where Z refers to tertiary industry employment ratio, K capital stock, H labor input, R^T trend productivity growth and Y^T trend output. Using data for 1970 Q1 - 90 Q4, the estimated NAIRU shows an upward trend reflecting the expansion of the service sector. In the late 1980s it increased to around 2%, up from the level slightly above 1% in the early 70s.

3. Specification of the models: standard regressions

8. Our basic formulation is the generalized expectations-augmented Phillips curve.

$$D\ln P - D\ln P^e = \alpha + \beta(L)f(U_{-1}) + \gamma Z_{-1} + \delta(L)(D\ln P_{-1} - D\ln P^e_{-1}) \qquad [10]$$

where $D\ln P$ and $D\ln P^e$ are the actual and expected rate of inflation, respectively, U is the unemployment rate and Z represents other pertinent variables. As shown in Staiger, Stock and Watson (1996), the NAIRU can be obtained by setting $D\ln P = D\ln P^e$ and solving for U.

$$\text{NAIRU} = f^{-1}((-1/\beta(L))(\alpha + \gamma Z)) \qquad [11]$$

The function $f(.)$ usually takes the simplest form $f(U) = U$ in the U.S. studies, but it has proved to work poorly in estimating the Japanese Phillips curve. We thus also tried another function, $f(U) = 1/U$, which would yield better estimates for $\beta(L)$[4].

9. We use seasonally adjusted quarterly data for 1970 Q1 to 1996 Q1, although in certain cases some data for the first several years are missing. Therefore, the polynomials $\beta(L)$ and $\delta(L)$ should have at least four-period lags. Nevertheless, the high serial correlation of U suggested the reduction of the length of the lags of $\beta(L)$ to one or two periods. The data are consumer price index for P and total unemployment rate or that of the prime-aged males. The latter is in principle free from demographic factors.

10. As for the formation of inflationary expectations, we considered two possibilities. The first is the random walk hypothesis in which $D\ln P^e$ is set to $D\ln P_{-1}$. This assumption is widely used in the existing NAIRU literature. In this case, the estimated equation takes the form:

$$D^2\ln P = \alpha + \beta(L)f(U_{-1}) + \gamma Z_{-1} + \delta(L)D^2\ln P_{-1} \qquad [12]$$

where $D^2\ln P$ denotes the increase in inflation. However, the Dickey-Fuller test rejects a unit root in the CPI inflation rate for Japan. Furthermore, Baba (1995) conducted the Phillips-Perron test and the augmented Dickey-Fuller test on the rate of inflation and rejected a unit root hypothesis at the 5% level. We therefore explore another formulation by estimating an AR(1) process for inflation.

4. This can have an important policy implication. If inflation responds more to excess demand than to excess supply as this nonlinear function shows, governments should lean toward disinflation since inflation is more costly (see, for example, Turner (1995)). However, the evidence in this paper is inconclusive in this regard because linear specifications can also work if the lag of unemployment rate is replaced by leads as shown later.

11. For structural variables Z, we use the share of female labor force, the share of employment in the non-manufacturing sector, the share of elderly labor force, the search effectiveness, and the dummy variables for changes in unemployment benefits.

- *Share of female labor force* Female workers often quit in the early stage of their careers and seek reemployment after a certain period of childraising, thus the high turnover in the labor market. This index started to increase in the late 1970s but has been shown a declining trend since 1991.

- *Share of employment in the non-manufacturing sector* This index also represents an increase in employees with relatively high turnover. It has been showing a secular upward trend and accelerated the increase since 1992, where the construction, service and wholesale, retail and restaurant sectors registering strong increases in their share.

- *Share of elderly male labor force* In the large Japanese companies, the retirement age is usually set at 55 to 60, although it has been gradually extended in accordance with the intention of the government. Therefore, elderly workers should expose themselves to the external labor market, resulting in contributing to the frictional unemployment.

- *Search effectiveness* This concept includes a variety of factors affecting the speed with which the unemployed find jobs. Here we assumed that those factors can be represented by the time-varying intercept of the Beveridge curve, which is fitted to a cubic function.

- *Unemployment benefits* In Japan, the "gross" replacement ratio has been quite stable (60-80% depending on the qualifications of the insured) since the foundation of the program while the benefit-duration schedule has been subject to occasional revision. After a slight improvement in the benefits for workers with longer job tenure in 1970, important changes have been observed twice. The first change, aimed at extending benefit duration for those aged 45 or more, was enacted in 1975. The second change, implemented in 1984, however, cut the benefit duration for those aged 45 or more with a contribution period of less than ten years. We assign dummy variables to these changes.

4. The results

12. The results are listed in Table 1. The results of the following types of regressions are not listed because of their wrong signs: the regressions with an AR(1) inflation expectation; with the dummy variables for unemployment benefit; and those with two or more structural variables.

13. Reviewing the table, we first notice that the NAIRU has increased modestly in the last decade, except for the result with the term $1/U$ and the non-manufacturing sector ratio. It also confirms that the recent historically high unemployment rate is partly a cyclical phenomenon. Incidentally, the latter result

emerged because the non-manufacturing sector ratio has surged in the past several years to which the trend of the NAIRU was fitted in the Procrustean manner, and therefore should not be taken seriously. The increasing trend, albeit modest, suggests a need for structural reform in the labor market.[5]

14. Secondly, the estimated sacrifice ratio is higher than that perceived in the past. Conventional wisdom says that the Japanese labor market is so flexible that the unemployment cost in reducing inflation is low. The sacrifice ratio, or the nominal wage rigidity, is calculated by $(1+\delta(1))/\beta(1)$ when $f(U) = U$, and $-U^2(1+\delta(1))/\beta(1)$ when $f(U) = 1/U$. From Table 1, our estimate for the sacrifice ratio is at least around 0.5 (calculated by $-0.25U^2(1+\delta(1))/\beta(1)$ in order to evaluate inflation at annual rates), while Layard, Nickell and Jackman (1991), for example, reported 0.05. This difference probably stems from the fact that our estimation period spans mostly low inflation years except for the early 1970s.

15. Thirdly, the statistical significance of $\beta(L)$ is very poor for the case of $f(U) = U$ and barely acceptable for the case of $f(U) = 1/U$. And even for the central projections for the NAIRU, we have a broad range of values. The instability of the estimated NAIRU can also be confirmed by subsample regressions. We run the regressions with $f(U) = 1/U$ for the four overlapping decades. The only subsample that yields reasonable values of the NAIRU was the first decade (1970 Q2 - 1980 Q1). Furthermore, the estimated sacrifice ratio is negative or infinite for the other decades.

16. The second and third findings naturally lead us to the inference that the long-lasting, low-inflation period has made the inflation-unemployment trade-off invisible and that meaningful estimates for the NAIRU can only be obtained with relatively long time series data that includes high inflation periods.

5. Alternative specifications

17. The characteristics of the Japanese labor market could have affected the poor statistical results in the standard regressions. In the Japanese labor market, employment adjustment has been initially carried out through a reduction of working hours, and subsequently through changes of job positions within a firm or a transfer to other related firms. This labor-hoarding practice makes the rise in the unemployment rate lag considerably behind the coincidental cyclical indicators.

18. In fact, we can obtain higher statistical significance in the expectations-augmented Phillips curve when the unemployment rate with a several-quarter lead is used than when the lagged unemployment rate is used (Table 2).

$$D^2\ln P = \alpha + \beta U_{+k} + \gamma Z_{-1} + \delta(L)D^2\ln P_{-1} \qquad [13]$$

The *t*-value is maximized when the unemployment rate is two-quarter ahead of the increase in inflation. The estimated NAIRU, however, is almost invariant to the length of lead, probably due to the strong persistence of the unemployment rate.

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5. The demographic factors such as the increasing share of female and elderly workers or the changing industrial structures measured by the share of the non-manufacturing sector are eventually associated with lower search effectiveness. Therefore, one possible policy direction is to increase search effectiveness by helping the market cope with the rising rate of job turnover and by encouraging information flow. More specifically, for example, the restrictions on temporary employment agencies and private job placement firms - which limit their activities to certain job categories - should be relaxed.

19. Given the unsatisfactory statistical results for the NAIRU, the existence of hysteresis or "speed limit"[6] arises as another possibility for explaining unemployment. To examine such a possibility, we add a term DU_{-1} to the generalized expectations-augmented Phillips curve.

$$D^2 \ln P = \alpha + \beta / U_{-1} + \theta\, DU_{-1} + \gamma\, Z_{-1} + \delta\,(L) D^2 \ln P_{-1} \qquad [14]$$

In this case, we restrict ourselves to the simplest form for the term $1/U_{-1}$. If hysteresis exists, the coefficient θ should be negative.

20. The results are listed in Table 3. The coefficient θ is reasonably estimated. Hence, hysteresis exists and the NAIRU is affected by the past record of unemployment. Again, this does not conform to the conventional wisdom that says the Japanese unemployment is free from hysteresis. The cause of hysteresis/speed limit effects, if they exist, is at this stage not well understood. One possible explanation is that Japanese firms are slowly and cautiously beginning to hire new workers, who implicitly will have long-term job tenure, after the conjunctural situation improves and price inflation emerges.[7]

21. When there is hysteresis or "speed limit," the short-run NAIRU deviates from the long-run NAIRU, or the structural rate of unemployment. As Table 3 shows, the short-run NAIRU is quite different from the long-run NAIRU, but is close to the actual rate of unemployment. This implies hysteresis/speed limit effects are relatively strong in Japan.

6. Concluding remarks

22. As mentioned at the outset, the NAIRU is rarely estimated or referred to in policy debates in Japan despite policymakers' interests on the structural portions of unemployment. Our empirical results show that the NAIRU seems to be increasing modestly but that their statistical precision and stability are unsatisfactory, explaining why the NAIRU is not the focus of the policy debates. Furthermore, the lagged property of the unemployment rate in Japan significantly limits its usefulness as a leading indicator of inflation.

23. It is obvious that the poorly estimated target is not very useful for policy guidelines, but many of the similar concepts like output gap or capital utilization rate also suffer from such a deficiency. Therefore, looking at these various indicators - including the NAIRU or its improved alternatives if they exist - would be the second-best solution. In so doing, the distinction between the short- and long-run NAIRU should be noted, where the former is more relevant for macroeconomic policy formulation, given

6. When hysteresis or "speed limit" exists, the short-run NAIRU returns only slowly to the long-run NAIRU after labor markets are hit by shocks. The short-run NAIRU can be expressed as a weighted average of the long-run NAIRU and the actual rate of unemployment in the previous period (see, for example, Elmeskov and Macfarlan (1993)).

7. Hysteresis or "speed limit" is often attributed to "insider-outsider" mechanisms or the deterioration of human capital. However, these explanations are difficult to apply to the case of Japan, since union militancy is weak and the incidence of long-term unemployment is relatively low.

the existence of hysteresis or "speed limit." Macroeconomic policy aimed at rapidly reducing unemployment could be costly in terms of inflation. In addition, from the lagged property of the unemployment rate, one possible direction for future work is to find appropriate labor market indicators which move ahead of inflation and can substitute for the unemployment rate in the expectations-augmented Phillips curve.

Table 1. **The standard regressions**

Equation: $D^2 \ln P = \alpha + \beta(L) f(U_{-1}) + \gamma Z_{-1} + \delta(L) D^2 \ln P_{-1}$, P = CPI

period: 1970 Q1 -96 Q1

Eq. #	Type of Def.[1]	$\beta(L)f(U_{-1})$ $f(.)$	lags	Type of Z[2]	$\beta(1)$ (t-value)	Estimated NAIRU 76Q1	86Q1	96Q1
1	T	U	2	-	-0.11 (-0.55)	2.4	2.4	2.4
2	T	U	2	F	-0.22 (-0.90)	1.6	2.5	2.8
3	T	U	2	N	-0.16 (-0.41)	2.2	2.4	2.7
4	T	U	2	E	-0.18 (-0.69)	2.0	2.3	2.8
5	T	U	2	S	-0.27 (-0.90)	2.1	2.4	2.8
6	T	$1/U$	2	-	1.06 (1.61)	2.2	2.2	2.2
7	T	$1/U$	2	F	1.47 (1.78)	1.8	2.3	2.6
8	T	$1/U$	2	N	2.33 (1.60)	1.8	2.2	3.1
9	T	$1/U$	2	E	1.37 (1.67)	1.9	2.2	2.6
10	T	$1/U$	2	S	2.25 (2.18)	2.0	2.3	2.7
11	T	$1/U$	1	-	1.09 (1.45)	1.9	1.9	1.9
12	T	$1/U$	1	F	1.94 (2.09)	1.5	2.2	2.7
13	T	$1/U$	1	N	3.96 (2.46)	1.7	2.1	3.4
14	T	$1/U$	1	E	1.59 (1.71)	1.7	2.0	2.6
15	T	$1/U$	1	S	2.92 (2.44)	1.8	2.2	2.7
cf. Actual unemployment rate (Total)						2.0	2.7	3.3

1. T = Total, P = Prime-aged male.
2. F = Female labor force ratio, N = Non-manufacturing sector ratio, E = Elderly male labor force ratio,S = Search effectiveness (an intercept of the Beveridge curve fitted to a cubic function).

Table 1. (continued)

Equation: $D^2 \ln P = \alpha + \beta(L) f(U_{-1}) + \gamma Z_{-1} + \delta(L) D^2 \ln P_{-1}$, P = CPI
period: 1970 Q1 -96 Q1

Eq. #	Type of Def.[1]	$\beta(L)f(U_{-1})$ $f(.)$	lags	Type of Z[2]	$\beta(1)$ (t-value)	Estimated NAIRU 76Q1	86Q1	96Q1
16	P	U	2	-	-0.21 (-0.71)	1.5	1.5	1.5
17	P	U	2	N	-0.28 (-0.65)	1.4	1.6	1.6
18	P	U	2	S	-0.38 (-1.01)	1.5	1.6	1.6
19	P	$1/U$	2	-	0.70 (1.17)	1.5	1.5	1.5
20	P	$1/U$	2	N	1.09 (1.16)	1.3	1.5	1.9
21	P	$1/U$	2	S	1.40 (1.71)	1.5	1.6	1.7
22	P	$1/U$	1	-	0.76 (1.29)	1.4	1.4	1.4
23	P	$1/U$	1	N	1.44 (1.56)	1.3	1.5	2.0
24	P	$1/U$	1	S	1.66 (2.01)	1.4	1.6	1.7
cf. actual unemployment rate (prime-aged male)						1.7	1.9	2.3

1. T = Total, P = Prime-aged male.
2. F = Female labor force ratio, N = Non-manufacturing sector ratio, E = Elderly male labor force ratio,S = Search effectiveness (an intercept of the Beveridge curve fitted to a cubic function).

Table 2. **Alternative leads/lags in unemployment**

Equation: $D^2 \ln P = \alpha + \beta\, U_{+k} + \gamma\, Z_{-1} + \delta\, (L) D^2 \ln P_{-1}$
P = CPI, U = Total unemployment rate, Z = Non-manufacturing sector ratio, $\delta(L)$: 3 lags, period: 1970Q1 - 96Q1

Eq. #	*k*	β (*t*-value)	γ (*t*-value)	Estimated NAIRU 76Q1	86Q1	96Q1
1	-1	-0.36 (-0.93)	0.05 (0.60)	1.8	2.2	2.7
2	0	-0.52 (-1.33)	0.07 (0.92)	1.8	2.2	2.7
3	+1	-0.82 (-2.10)	0.12 (1.56)	1.9	2.3	2.8
4	+2	-0.94 (-2.50)	0.14 (1.84)	1.9	2.2	2.8
5	+3	-0.88 (-2.46)	0.12 (1.70)	1.8	2.2	2.8
6	+4	-0.61 (-1.70)	0.08 (1.12)	1.7	2.2	2.7
7	+5	-0.57 (-1.60)	0.07 (0.96)	1.7	2.3	2.6
8	+6	-0.43 (-1.19)	0.05 (0.68)	1.8	2.3	2.6

Table 3. **Hysteresis/"Speed Limit" Effects**

Equation: $D^2 \ln P = \alpha + \beta / U_{-1} + \theta\, DU_{-1} + \gamma\, Z_{-1} + \delta\, (L) D^2 \ln P_{-1}$
P = CPI, U = Total unemployment rate, $\delta\,(L)$: 3 lags,
period: 1970Q1 - 96Q1

Eq.#	Type of Z[1]	β	θ	γ	Long-/Short-run NAIRU 76Q1	86Q1	96Q1
1	-	0.96 (1.32)	-2.99 (-2.75)	-	2.2/2.1	2.2/2.8	2.2/3.3
2	F	1.63 (1.79)	-2.81 (-2.57)	0.13 (1.23)	1.6/2.0	2.3/2.7	2.8/3.3
3	N	3.37 (2.13)	-2.75 (-2.53)	0.15 (1.71)	1.7/2.0	2.2/2.7	3.5/3.3

1. F = Female labor force ratio, N = Non-manufacturing sector ratio.

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