# The Impact of Sectoral Shifts on the Unemployment Rate of Different Age Groups

**Kei Sakata**[a] **and** **C.R. McKenzie**[b]

[a]*Osaka School of International Public Policy, Osaka University, Japan (ksakata@osipp.osaka-u.ac.jp)*

[b]*Osaka School of International Public Policy, Osaka University, Japan (mckenzie@osipp.osaka-u.ac.jp)*

**Abstract**: This paper examine Lilien's sectoral shifts hypothesis for Japan for different age cohorts. Previous studies of the sectoral shifts hypothesis for Japan have for the most part concentrated on the relationship between aggregate unemployment and sectoral shifts, and are typically not supportive of the hypothesis. However, recent increases in the unemployment rates of the young and the aged suggest a need to reexamine the hypothesis for different age groups. It is found that sectoral shifts have a short-term positive effect on the unemployment of aged male workers and the effects increase in times of recession.

**Keywords:** Unemployment; Sectoral Shifts Hypothesis; Age cohort effects; Time Series Analysis; Generated regressors.

## 1. INTRODUCTION

Lilien's [1982] sectoral shifts hypothesis asserts that sectoral shifts of demand affect unemployment because labour reallocation across sectors is a time consuming process. Using annual postwar data for the United States, Lilien [1982] estimated a reduced form unemployment equation that included current and lagged values of a cross-sectoral dispersion measure (Lilien's sigma) and a monetary disturbance measure. Lilien found a statistically significant positive relationship between the dispersion measure and the unemployment rate.

Abraham and Katz [1984, 1986] argue that aggregate demand disturbances can induce countercyclical movements in Lilien's dispersion measure. Abraham and Katz [1984] find that when Lilien's sigma is purged of the influence of aggregate demand shocks, this purged proxy variable can explain only a small fraction of unemployment fluctuations in the United States.

Davis [1987] suggests that Lilien fails to take into account the possibility of stage-of-business-cycle effects on the sectoral shifts hypothesis. If the value

of foregone production associated with unemployment is procyclical, then there will be incentives for unemployment spells to be shorter during expansions and longer during recessions. Therefore, a given amount of labour reallocation may lead to underestimating unemployment when aggregate macroeconomic conditions are improving and vice versa. Taking these suggestions into consideration, Mills et al. [1995] provide evidence to support the sectoral shifts hypothesis for the United States.

In contrast, Brunello's [1991] study for the aggregate unemployment rate in Japan does not support the sectoral shifts hypothesis. However, Sakata [2001] finds that sectoral shifts affect male unemployment, but not female unemployment. He speculates that gender differences in the accumulation of human capital may play a crucial part in explaining these differences. Sakata's [2001] findings suggest that it is important to examine Lilien's hypothesis for different cohorts, and that the findings for the aggregate unemployment rate can be deceptive.

If as Sakata [2001] speculates the effects of sectoral shifts on unemployment depend on the accumulation of industry-specific human capital by workers, then sectoral shocks may have a large impact on older workers who have accumulated large amounts of human capital. In contrast, sectoral shocks may have a small (or no) impact on young workers who have yet to accumulate very much human capital. Sakata [2001] indicates that there are gender differences in the effects of sectoral shocks on unemployment, and therefore, the analysis will focus on male unemployment. Currently, the unemployment rates of workers in the age groups 15-24 and 55-64 are particularly surging. In the context of the aging population and casualisation of the youth workforce, it is important to scrutinize the effects of sectoral shifts on these two groups.

In this paper, incorporating criticisms made of Lilien's work by previous studies, the sectoral shifts hypothesis is tested for males aged 15-24 and 55-64 using Lilien's dispersion index and a purged index, and tests for stage-of-business-cycle effects are conducted.

The plan of this paper is as follows. In section 2, the data used are described. In order to obtain estimates of the expected and unexpected components of money growth, a money growth equation is specified and estimated in section 3. Tests of the sectoral shifts hypothesis for the aggregate unemployment rate and the male unemployment rate of two age groups are conducted in section 4. Section 5 explores the possibility that the stage of the business cycle has an effect on labour reallocation. Section 6 provides some concluding remarks.

## 2. DATA

Employment data to compute the measures of sectoral shifts are taken from *The Monthly Report on Labour Force Survey (Roudouryoku Chousa Houkoku)* (LFS). LFS provides a thirteen-industry division of monthly nonagricultural employment. The thirteen sectors are: Fisheries; Mining; Construction; Manufacturing: Textile mill products; Manufacturing: Chemical and related products; Manufacturing: Metal and machinery;

Manufacturing: Other; Electricity, gas, heat and water supply; Transport and Communication; Wholesale Trade; Retail trade, restaurants and pubs; Finance, insurance and real estate; and Services. This categorization of industries began in January 1973. As a result, the sample is from the first quarter of 1973 to the fourth quarter of 1999. Data on the aggregate unemployment rate and the unemployment rates for males aged 15-24 and males aged 55-64 are also obtained from LFS.

The short-term and long-term interest rates, the three month Gensaki rate and the 10 year government bond yield, are taken from the *NEEDS* database. Other macrodata are taken from the *OECD Main Economic Indicators (MEI)* in the *OECD Statistical Compendium*. Money is measured as M2+CD. The real values of money and GDP are computed by deflating by the consumer price index (CPI). Energy prices are measured using the Fuel and Electricity Price Index. The inflation rate is computed using the CPI. All the macroeconomic data (except the interest rates) are seasonally adjusted.

## 3. MONEY GROWTH EQUATION

In order to test the implications of the sectoral shifts hypothesis, a well-specified unemployment equation is required. Expected and unexpected money demand shocks computed as the fitted values and residuals from a Barro [1977] type money growth equations are included in the unemployment equation as explanatory variables.

The money growth equation is estimated in a simple form. Let $m$ and $y$ be the logarithms of real M2+CD and real GDP, respectively, and $R$ and $i$ be the long-term interest rate and the inflation rate. In order to construct the expected and unexpected components of money growth, no contemporaneous variables appear in the money growth equation.

Unit root tests suggest that all variables in the money growth equation are non-stationary *I(1)*, and a Johansen test suggests that there is one cointegrating relationship between $m$, $y$, $R$, and $i$. As a result, the money growth equation is estimated as an error correction model with four lags. The residual from this money growth regression, $DMR_t$, is then used as a measure of unanticipated money growth, and anticipated money growth is defined as $\mathrm{DME}_t = \Delta m_t - \mathrm{DMR}_t$, where $\Delta$ denotes the first difference of a variable. $DME_t$ and $DMR_t$ are used as explanatory variables in an unemployment equation to test the sectoral shifts hypothesis.

## 4. TESTING THE SECTORAL SHIFTS HYPOTHESIS

In this section, the proxy variables for sectoral shocks are introduced. To check the robustness of the results obtained, two different measures, Lilien's [1982] measure and Mills et al.'s [1995] measure which takes account of Abraham and Katz's [1984] criticism, are used. Lilien's measure has the following form:

$$\sigma_t^2 = \sum_{i=1}^{N} (e_{it} / E_t) \cdot (\Delta \log(e_{it}) - \Delta \log(E_t))^2, \quad (1)$$

where $e_{it}$ is the employment level in sector $i$, $i$=1, 2,...13, at time t, $E_t = \sum_{i=1}^{N} e_{it}$ is aggregate employment at time t, and N=13.

Mills et al. [1995] purge the index of monetary shocks, regarding these as the main driving force on the demand side. Each sectoral growth rate, $\Delta\log(e_{it}) - \Delta\log(E_t)$, was regressed on the current value and four lags of expected and unexpected money growth, *DME* and *DMR*, as follows:

$$\Delta\log(e_{it}) - \Delta\log(E_t) = a + \sum_{j=0}^{4} \alpha_j DME_{t-j} + \sum_{j=0}^{4} \beta_j DMR_{t-j} + \varepsilon_{it}. \quad (2)$$

Equation (2) was estimated for each i by ordinary least squares, and the residuals, $\tilde{\varepsilon}_{it}$, were combined to obtain the purged dispersion index defined as:

$$s_t^2 = \sum_{i=1}^{N} (e_{it} / E_t) \quad \tilde{\varepsilon}_{it}^2. \quad (3)$$

Augmented Dickey-Fuller (ADF) tests applied to $\sigma_t$ and $s_t$ reject the null hypothesis of a unit root suggesting that they are both stationary. In contrast, the unemployment rates of all three groups namely, all workers, $U_t$, males aged 15-24, $U15_t$, and males aged 55-64, $U55_t$, are found to be non-stationary. As the dispersion measures are stationary, they cannot be cointegrated with the non-stationary $U_t$, $U15_t$, and $U55_t$. Thus, there can be no long-term relationship between the unemployment variables and the dispersion measures.

Following Wallis [1987], *U*, *U15*, and *U55* are the logistic transformation of the unemployment rate of each group. The unemployment equation for each group includes the short-term interest rate, *r*, the logarithm of the fuel and electricity price index, *FEPI*, and the ratio of imports to GDP, *IMP*. The inclusion of the short-term interest rate aims to capture the impacts on unemployment of changes in the working-capital costs of firms or the intertemporal substitution of leisure. Imports can be assumed to reflect the effect of shocks from the global economic environment on domestic unemployment. The fuel and electricity price index is used to control for the impact of oil shocks in the sample period.

As with the specification of the money growth equation, a vector autoregression (VAR) is first estimated to determine the order of VAR, and then, Johansen tests are conducted to determine the number of cointegrating relationships. In choosing the order of VAR and in testing cointegration, the contemporaneous values and up to four lags of *DME*, *DMR* and $\sigma_t$ are included as exogenous variables.

When the variable $s_t$ and the business cycle variables are added, it is assumed that the unemployment equations used for testing the sectoral shifts hypothesis have the same structure as the model specified when $\sigma_t$ is used. The test results for $\sigma_t$ and $s_t$ are shown in Tables 1 and 2, respectively. To save the space, the reported results are limited to estimates directly related to the dispersion measures. Furthermore, as generated regressors, *DME* and *DMR*, are included in the estimated model, t-statistics are computed using Newey-West standard errors (Parzen weights).

For aggregate unemployment, the results in Tables 1 and 2 are ambiguous in that there are both positive and negative significant coefficients. As shown in Sakata [2001], this may be due to treating the labour force as a homogeneous group.

Table 1. The impact of $\sigma_t$ on Unemployment.

| $\sigma_t$ | $U_t$ | $U15_t$ | $U55_t$ |
|---|---|---|---|
| T | -0.315** | -0.494 | |
| | (3.24) | (0.45) | |
| t-1 | | -0.675 | |
| | | (0.67) | |
| t-2 | | 1.025 | |
| | | (1.02) | |
| t-3 | 0.241* | 1.181 | 2.796** |
| | (2.43) | (1.22) | (3.46) |
| t-4 | -0.223* | -1.526 | |
| | (2.37) | (1.28) | |
| $\bar{R}^2$ | 0.36 | 0.24 | 0.32 |

T=100 (Sample Period: 1975Q1-1999Q4)

Absolute t-values are presented in parentheses.
* and ** indicate the variable is significant at the 5% and 1% significance levels, respectively.

Table 2. The impact of $s_t$ on Unemployment.

| $s_t$ | $U_t$ | $U15_t$ | $U55_t$ |
|---|---|---|---|
| T | -0.294** | -0.312 | |
| | (2.56) | (0.27) | |
| t-1 | | -0.977 | |
| | | (0.95) | |
| t-2 | | 0.371 | |
| | | (0.36) | |
| t-3 | | 1.249 | 2.456** |
| | | (1.13) | (3.33) |
| t-4 | | -1.327 | |
| | | (0.93) | |
| $\bar{R}^2$ | 0.22 | 0.17 | 0.29 |

T=95 (Sample period: 1976Q2-1999Q4)

The results for the males aged 15-24 show that none of the current or lagged values of either dispersion variable, $\sigma_t$ or $s_t$, are individually significant. Wald tests confirm their joint insignificance (p-value=0.08 for $\sigma_t$ and p-value=0.62 for $s_t$). Although the Wald test for $\sigma_t$ rejects the null hypothesis at the 10 % significance level, none of dispersion measures are significant when the current and lagged values of $\sigma_t$ are added individually.

On the other hand, for males aged 55-64 the impact of the dispersion index is positive and significant for both $\sigma_t$ and $s_t$. The results are in line with the hypothesis that the groups that have relatively more industry- and firm- specific human capital are more affected by sectoral shocks.

## 5. STAGE-OF-BUSINESS CYCLE EFFECTS

The stage-of-business-cycle effects are modeled here using the indicator of the stage of the business cycle (*Keiki Kijyun Hiduke*) announced by the Economic Planning Agency. A dummy variable, $B_t$, is constructed to take the value unity when the announced business cycle is in a downturn, and zero otherwise. Interaction variables of the form $B_t\sigma_t$ and its four lags are then also added to the baseline unemployment equation of each group with significant dispersion variables. In addition, in order to distinguish the effects of the recession from the stage-of-business-cycle effects, a recession dummy variable is also included.

Table 3 summarises the results of testing for stage-of-business-cycle effects using $\sigma_t$. Significant stage-of-business-cycle effects are present for aggregate unemployment and for the unemployment of males aged 55-64, indicating that the impacts of sectoral shocks on unemployment increases in times of recession for these two groups. In contrast, the results for males aged 15-24 show no significant interaction terms. A Wald test also accepts the null hypothesis that the current and four lags of the stage of business cycle variables are jointly insignificant for this group (p-value=0.26).

Results consistent with those in Table 3 are also obtained when the stage-of-business-cycle effects are investigated using the purged index $s_t$.

Table 3. Stage-of-Business-Cycle Effects.

| $B_t\sigma_t$ | $U_t$ | $U15_t$ | $U55_t$ |
|---|---|---|---|
| T | | 1.314 | |
| | | (0.82) | |
| t-1 | | 0.297 | |
| | | (0.2) | |
| t-2 | | 0.143 | |
| | | (0.12) | |
| t-3 | | 0.868 | 1.679** |
| | | (0.75) | (3.21) |
| t-4 | 0.163* | -0.185 | |
| | (3.47) | (0.26) | |
| $\bar{R}^2$ | 0.42 | 0.23 | 0.35 |

T=100 (Sample period: 1975Q1-1999Q4)

## 6. CONCLUSION

In contrast to the previous studies for the United States, earlier studies for Japan do not support the sectoral shifts hypothesis. However, Sakata [2001] provides evidence that in Japan, the findings for aggregate unemployment can be misleading because sectoral shocks have affects that differ according to workers' levels of industry- and firm-specific human capital accumulation.

Following Sakata [2001], this paper has examined the unemployment of males in two age groups, 15-24 and 55-64, whose accumulation of human capital should differ greatly. Although sectoral shifts do not have any long-term impacts on unemployment, sectoral shifts have positive effects on the unemployment of old males in the short-term. In addition, the aggregate unemployment rate and the unemployment rate of males aged 55-64 are strongly influenced by the stage of the business cycle. These findings suggest that policy judgments based on an analysis of aggregate unemployment may be blind to the actual impacts of sectoral shifts on different cohorts.

## 7. REFERENCES


Abraham, K.G., and Katz, L.F., Cyclical unemployment: sectoral shifts or aggregate disturbances?, *NBER Working Paper* No. 1410, 1984.

Abraham, K.G., and Katz, L.F., Cyclical unemployment: sectoral shifts or aggregate disturbances?, *Journal of Political Economy*, 94, 507-522, 1986.

Barro, R.J., Unanticipated money growth and unemployment in the United States, *American Economic Review*, 67, 101-115, 1977.

Brunello, G., Mismatch in Japan *in Mismatch and Labour Mobility* (F. Padoa-Schioppa, Ed.), pp. 140-179. Cambridge Univ Press, London/New York, 1991.

Davis, S.J., Fluctuations in the pace of labor reallocation, *Carnegie-Rochester Conference Series on Public Policy*, 27, 355-402, 1987.

Lilien, D.M., Sectoral shifts and cyclical unemployment, *Journal of Political Economy*, 90, 777-793, 1982.

Mills, T.C., Pelloni, G. and Zervoyianni, A., Unemployment fluctuations in the United States: further tests of the sectoral-shifts hypothesis, *Review of Economics and Statistics*, 77, 294-304, 1995.

Sakata, K. Sectoral shifts and cyclical unemployment in Japan, *Journal of the Japanese and International Economies*, forthcoming, 2001.

Wallis, K.F., Time series analysis of bounded economic variables, *Journal of Time Series Analysis*, 8, 115-123, 1987.