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THE STYLIZED FACTS OF BUSINESS CYCLE IN JAPAN

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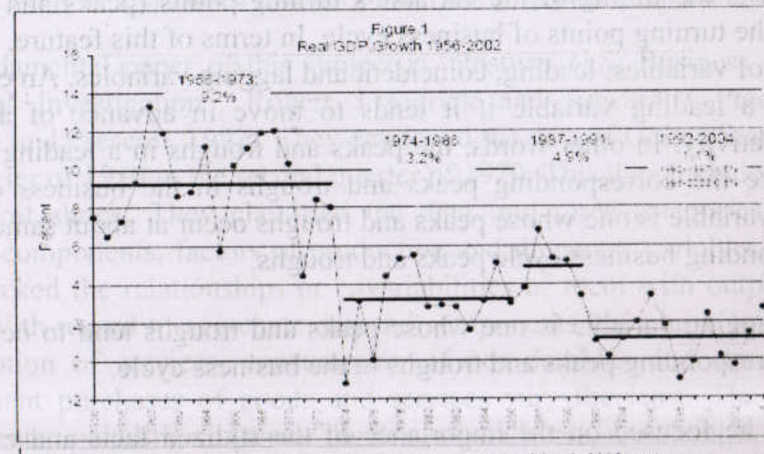
Introduction and justification

Since the end of 1960s, the economists have tried to forecast and predict the business cycles through determining the basic facts of it. The reason why they are interested in this topic is that unpredictable cycle is very costly and has harmful impact on the economies and societies. For example, The Great Depression, Oil shocks and Asian financial crisis etc, all these shocks had caused the high level of unemployment, poverty, a decline in a real wage or income, a fall in living standard and so on. These big depressions have had serious and chronic effects not only on their own economies but also on the rest of the world. In addition, other small economic cycles often occur in each country with different reasons and durations. In order to lessen these negative effects of the business cycle, the economists, policymakers and politicians have to know the reasons of the cycles and prepare the shocks by forecasting it. Business cycles are not always negative, but positive shocks or cycles take place sometimes.

Figure 1. The growth rate



Source: [illegible] (May 5, 2005) and [illegible] (September 10, 2004).

What is a business cycle? Lucas defined business cycles as the deviations of aggregate real output from its trend. According to broadly accepted definition of business cycle from the National Bureau of Economic Research (NBER), business cycle is the fluctuations of aggregate economic activity. This includes not only GDP but also employment and financial variables.

There are a number of different approaches to estimate the cyclical behavior which real business cyclical economists apply. In this paper, I am going to apply the stylized facts approach known as a popular method among economists.

Several decades ago, the economists had observed that some variables change because of a change in other variables, or move together during cycles. For instance, after an increase in input prices, then an economy goes down in other words, economic recessions occur frequently. An example of this is the Oil shocks. They call these behaviors as stylized facts. In addition, Lucas viewed the stylized facts of business cycles as the statistical properties of the comovements of deviations from trend of various economic aggregates with those of real output. Two characteristics of the cyclical behavior of macroeconomic variables are important for the discussion of the stylized facts of business cycles. The first characteristic is the direction in which a macroeconomic variable moves, relative to the direction of aggregate economic activity. According to this, we classify the economic aggregate variables as a procyclical (co-movement), counter-cyclical and acyclical variable. An economic variable that moves in the same direction as aggregate economic activity (up in expansions, down in contractions) is procyclical. A variable that moves in the opposite direction to aggregate economic activity is countercyclical. Variables that do not display a clear pattern over the business cycle are acyclical.

The second is the timing of the variable's turning points (peaks and troughs) relative to the turning points of business cycle. In terms of this feature, there are three types of variables; leading, coincident and lagging variables. An economic variable is a leading variable if it tends to move in advance of aggregate economic activity. In other words, the peaks and troughs in a leading variable occur before the corresponding peaks and troughs in the business cycle. A coincident variable is one whose peaks and troughs occur at about same time as the corresponding business cycle peaks and troughs.

Finally, a lagging variable is one whose peaks and troughs tend to occur later than the corresponding peaks and troughs in the business cycle.

First of all, he focused on the importance of the stylized facts and explained why the stylized facts are more useful than the other econometric models which are used for testing a theory. As he wrote, it is more important for a model to explain a broad range of stylized facts than to pass some statistical tests.

Michael Reiter pointed out that the stylized facts are important because of the limitations of statistical testing and evaluating economic models. According to limitations of statistical testing, sample size should be long or large enough. Besides that, it is difficult to model the decision problem of an economic agent, to solve the aggregation problem, to approximate to more complicated nonlinear specification and to describe the data generating process because errors are not white noise. Due to these conditions, the errors cannot be assumed to have the desirable properties generally supposed in econometric applications. According to his and Leamer's view points, whether rejection of the model or not is mainly matter of sample size. On the other hand, evaluating economic models depends on the power of tests, not the correctness of the model. In his opinion, a model is developed in order to explain the stylized facts.

Detrended data are needed for two purposes: first, the most important tool for establishing stylized facts is spectral analysis, which can be applied only to stationery time series. Secondly, models of fluctuations alone, without growth, must be applied to detrended data.

Literature Review

The stylized fact of business cycle is one of most demanding and challenging topics for macro-economists, because its methodology is still on the debate among economists and econometricians. In this section of the paper, I am going to write about the different facts of business cycle that economists have studied

last two decades. Although I have chosen the most popular papers for my literature review, there are a number of the working papers on this topic.

The fundamental paper of this subject is "Postwar U.S. Business Cycles: An Empirical Investigation", Robert J.Hodrick and Edward C.Prescott, 1997 (Hodrick and Prescott, 1997). They employed the data of United States from the first quarter of 1950 to the second quarter of 1979. This data includes the period of first oil shock. They classified the data into three categories: aggregate demand components, factors of production and monetary variables. After that, they checked the relationships or covariabilities of them with output (GDP or GNP). With regard to aggregate demand components, they have found out that consumption of services, consumption of non-durables and state and local government purchases of goods and services vary the least. The investment components, including consumer durable expenditures, are about three times as variable as output. Covariabilities of consumption and investment with output are much stronger than the covariabilities of government expenditures with output (H-P, 1997, pp7). According to their results, a strong and stable positive relationship between hours and output appeared. As well, the variability in hours is similar with the variability of output. The very unusual result was the weak and unstable strength of relationship between productivity and output. However, they noted that when lead and lag GNPs are included, the relation between GNP and productivity increases dramatically with the R-squared increasing from 0.01 to 0.453.

Capital stocks, both in durable goods and nondurable goods industries, are less variable than the real output and negatively correlated with output. Inventory stocks, on the other hand, have variability comparable to output, and their correlations with output are positive. Further, the strength of association of inventories with GNP increases when lag and lead GNPs are included in the regression. This is indicated by the increase in the R-squared from 0.257 to 0.622. (H-P, 1997, pp9)

Correlations between nominal money, velocity and real money with GNP are all positive. The differences in the correlations in the first and second halves of the sample, with the exception of nominal M1, suggest considerable instability over time in these relationships. A similar conclusion holds for the short-term interest rate. The correlations of GNP with price variables are positive in the first half of the sample and negative in the second half with the correlation for the entire period being small and negative. (H-P, 1997, pp10) The Conference Board has noted some business cycle facts shown in Table 1.

Table 1. The cyclical behavior of key macroeconomic variables

Variable	Direction	Timing
Production		
Industrial production	Procyclical	Coincident
Durable goods in industrial are more volatile than nondurable goods and services		
Expenditure		
Consumption	Procyclical	Coincident
Business fixed investment	Procyclical	Coincident
Residential investment	Procyclical	Leading
Inventory investment	Procyclical	Leading
Government	Procyclical	-
Investment is more volatile than consumption		
Labor Market Variables		
Employment	Procyclical	Coincident
Unemployment	Countercyclical	Unclassified
Average labor productivity	Procyclical	Leading
Real wage	Procyclical	-
Money supply and inflation		
Money supply	Procyclical	Leading
Inflation	Procyclical	Lagging
Financial Variables		
Stock prices	Procyclical	Leading
Nominal interest rates	Procyclical	Lagging
Real interest rates	Acyclical	

Source: Andrew B.Abel and Ben S.Bernanke "Macroeconomics", Pearson-Addison Wesley, 2005, pp290

Hideaki Hirata, Sunghyun Henry Kim and Ayhan Kose wrote a paer "Source of Fluctuations: The case of Middle East and North Africa (MENA)". Concerning their results, the MENA economies are more volatile than other groups of countries. For instance, total output in the MENA economies is approximately 28% and 45% more volatile than that in the Asian and G7 countries, respectively. Consumption including the durable goods is on average slightly more volatile than output in these countries. According to their explanation, limited access to international financial market leads to this kind of volatility of consumption. Like other studies, investment is more volatile than output and consumption. One interesting result is that exports and imports are mush higher

volatile in these countries than in the Asian countries. The reason is less diversification of export and import goods in the MENA countries. As a result, it makes them more vulnerable to external shocks. Both exports and imports are procyclical. The correlation between exports and output is on average higher than that between imports and output in the MENA countries.

With regard to their results, a substantial fraction of cyclical fluctuations in the MENA countries is explained by the shocks to the terms of trade, which account for 60% of the variation in aggregate output in the short run (one-year forecast horizon). Domestic productivity shocks account for roughly 38 percent of output variation.

Methodology

A univariate structural time series model is important with two purposes. Initially it was established to forecast and predict future observations and still this role is vital and popular. Another important function is to estimate the salient features of a time series. Therefore, this will give me opportunity to determine the trend of a time series or its growth component. The component rather than these features can represent cyclical behavior of a time series, which can be explained by other variables and their changes. To estimate the structural time series model, I am going to use the Kalman filter, a powerful tool for the time series analysis.

What is the trend? The trend represents the long-term movements in a series, which can be extrapolated into the future. The simplest structural time series models consist of a trend components plus a random disturbance term. The random disturbance term may be interpreted as an irregular component in the time series or as a measurement error. Either way the model may be written as

$$y_t = \mu_t + \varepsilon_t, \qquad t = 1,...,T \qquad (1)$$

where μ_t is the trend and ε_t is a white-noise disturbance term which is assumed to be uncorrelated with any stochastic elements in μ_t

The trend may take variety of forms. In this paper, I will concentrate on the case when it is linear. The deterministic linear trend is

$$\mu_t = \alpha + \beta t, \qquad t = 1,...,T \qquad (2)$$

and on substituting in the previous equation, the following model is obtained:

$$y_t = \alpha + \beta t + \varepsilon_t$$

The deterministic trend in the equation (2) could be made stochastic by letting α and β follow random walks. A more satisfactory model is obtained by working directly with the current level, μ_t, rather than with intercept, α. Since μ_t may be obtained recursively from

$$\mu_t = \mu_{t-1} + \beta, \qquad t = 1,...,T \qquad (3)$$

With $\mu_0 = \alpha$, stochastic terms may be introduced as follows:

$$\mu_t = \mu_{t-1} + \beta_{t-1} + \eta_t \qquad (4a)$$

$$\beta_t = \beta_{t-1} + \zeta_t, \qquad t = ...,-1,0,1... \qquad (4b)$$

where η_t and ζ_t are mutually uncorrelated white-noise disturbances with zero means and variances σ_η^2 and σ_ζ^2 respectively. The effect of η_t is to allow the level of the trend to shift up and down, ζ_t allows the slope to change. The larger the variances, the greater the stochastic movements in the trend. If $\sigma_\eta^2 = \sigma_\zeta^2 = 0$, the equations (4) collapses to the equation (3) showing that the deterministic trend is a limiting case.

The local level model consists of a random disturbance term around an underlying level which moves up and down, but without any particular direction.

Table 2. The specified models of univariate time series

Level and slope are all stochastic	$\sigma_\eta^2 \neq 0,\ \sigma_\zeta^2 \neq 0$
Fixed level and stochastic slope	$\sigma_\eta^2 = 0,\ \sigma_\zeta^2 \neq 0$
Stochastic level and fixed slope	$\sigma_\eta^2 \neq 0,\ \sigma_\zeta^2 = 0$
Fixed level and slope	$\sigma_\eta^2 = 0,\ \sigma_\zeta^2 = 0$
Stochastic level and no slope	$\sigma_\eta^2 \neq 0$
Fixed level and no slope	$\sigma_\eta^2 = 0$

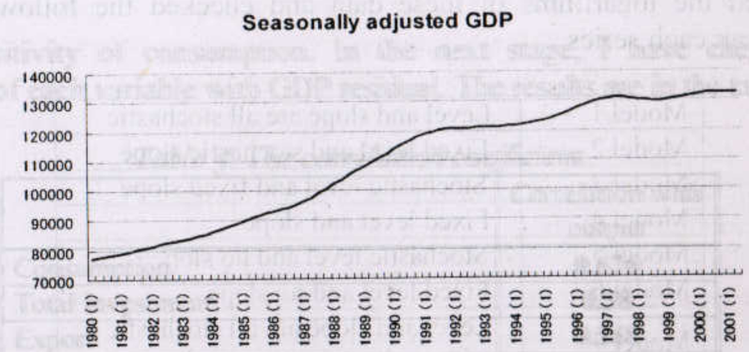
The estimation

Preliminary analysis of data and model specification

In this paper, I have used the Japanese data from first quarter of 1980 to fourth quarter of 2004. During this period, Japan experienced the second oil shock and the bubble economy. According to data, I classified the data into two categories: the components of GDP and input (labor and capital) data. The components of GDP and labor data are available between first quarter of 1980 and second quarter of 2001. Private and public inventories (might include here the interest rates and price indexes) are logged data while other variables are level.

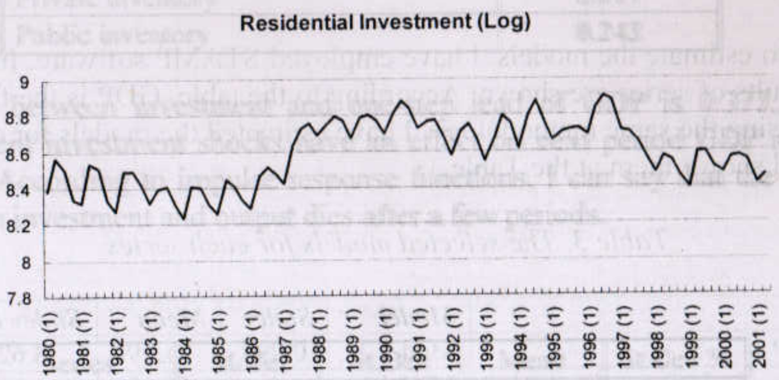
According to this graph, seasonal volatility was increasing between mid 1980s and the end of 1990s. This might indicate the effect of the bubbles on the economy. Now let's look at the seasonally adjusted GDP. In this figure, we can see that before 1990 the Japanese economy had grown more rapidly and during 1990s, economic growth rate became slower. The economists call this slow growth period as a decade of economic stagnation of Japan.

Figure 1.



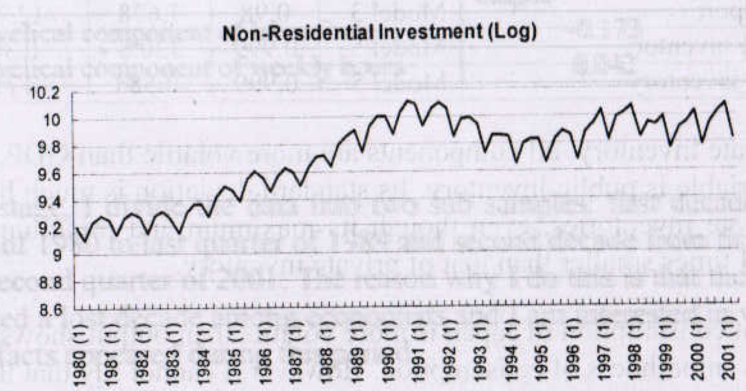
The most interesting series to me is the residential investment because it used to be higher during the bubble time than it was in other periods.

Figure 2



On the other hand, non-residential investment was declining stably at that (bubble) time. Before, it was growing rapidly.

Figure 3



I have used the logarithms of these data and checked the following seven models for an each series.

Model 1	Level and slope are all stochastic
Model 2	Fixed level and stochastic slope
Model 3	Stochastic level and fixed slope
Model 4	Fixed level and slope
Model 5	Stochastic level and no slope
Model 6	Fixed level and no slope
Model 7	Level and slope are all stochastic with cyclical component

The model 1 is called local linear model, while the model 5 is called the local level model or random walk plus noise. Model 3 is local level with drift. Model 2 is smooth trend.

Estimation results

In order to estimate the models, I have employed STAMP software. In the table 1, the results of series are shown. According to the table, GDP is the fixed level model. Using the same methodology, I have estimated the models for other time series and shown them at the Table 3.

Table 3. The selected models for each series

	Model	*St.dev*	*Mean*	*St.dev (%)*
GDP	Model 2	0.999	11.59	8.623
Consumption	Model 1	1	10.98	9.105
Residential investment	Model 5	1	8.584	11.649
Non-residential investment	Model 1	1	9.707	10.301
Government Expenditure	Model 3	0.973	9.678	10.054
Public investment	Model 3	0.999	8.974	11.138
Export	Model 1	0.999	9.161	10.901
Import	Model 2	1	8.877	11.265
Net export	Model 3	0.98	7.678	12.761
Private inventory	Model 5	0.999	320.8	0.312
Public inventory	Model 5	0.999	-0.584	-171.1

Except private inventory, all components are more volatile than GDP. The most unstable variable is public inventory. Its standard deviation is much higher than that of private inventories, even though its maximum and minimum volumes are almost 4 times smaller than that of private inventory.

The fact that consumption of Japan is more volatile than output shows that there is no excess smoothness of consumption. However, I cannot say that there is

excess sensitivity of consumption. In the next stage, I have checked the correlation of each variable with GDP residual. The results are in the table 4.

Table 4. The correlation coefficient

	Correlation with output
Consumption	**0.676**
Total Investment	**0.58**
Export	**0.268**
Residential Investment	**0.424**
Non Residential Investment	**0.385**
Government Expenditure	0.093
Public investment	**0.226**
Import	0.161
Net export	-0.067
Private inventory	0.077
Public inventory	**0.243**

Correlation between investment and one-step lead of GDP is 0.377, which means current investment shocks have an effect on next period GDP residual positively. According to impulse response functions, I can say that the impact of shocks in investment and output dies after a few periods.

Series	Model	St.Dev	Mean	St.Dev %
Labor force	Model 1	0.994	8.752	11.356
Week hour	Model 5	0.988	25.535	3.867

Correlation of labor variables with output

	Correlation with output
Cyclical component of labor force	-0.173
Cyclical component of weekly hours	0.042

In the next stage, I divide the data into two sub samples: first decade is from first quarter of 1980 to last quarter of 1989 and second decade from first quarter of 1990 to second quarter of 2001. The reason why I do this is that the 1990s in Japan is called a lost decade among economists and I am interested in what kind of different facts appeared during this period.

Table 5. Serial Correlation with cyclical component of GDP

	1980-1989	1990-2001
Consumption	0.597	0.708
Residential investment	0.365	0.34
Non-residential investment	0.524	0.314
Government expenditure	-0.135	0.271
Public investment	0.396	0.101
Export	0.318	0.311
Import	0.246	0.203
Net export	0.077	0.034
Private inventory	0.321	0.06
Public inventory	0.187	0.317
Total investment	0.691	0.513

Conclusion

In this paper, I study the stylized facts of business cycle in Japan based upon the data between first quarter of 1980 and fourth quarter of 2001. First, I determine trend models of the series applying Kalman filter. Therefore I am able to get cyclical component of the series using the fact that any series consists of the trend and cyclical components. In accordance with my estimation, consumption, non-residential investment and export are the model with stochastic level and slope in other words, local linear model while the residential investment and private and public inventories are the model with stochastic level and no slope (random walk plus noise). Government expenditure, public investment and net export are local level model with drift.

Except private inventory, all components are more volatile than GDP. The most unstable variable is public inventory. Its standard deviation is much higher than that of private inventories, even though its maximum and minimum volumes are almost 4 times smaller than that of private inventory. The fact that consumption of Japan is more volatile than output shows that there is no excess smoothness of consumption.

At next stage, I have checked the correlation of each variable with GDP residual. According to the results, all variables are procyclical except net export. With respect to timing, import and net export are the leading variables, but only private inventory is lagging variable. On the other hand, other variables are coincident, which means, these variables vary simultaneously with a cyclical component of GDP.

Correlation between investment and one-step lead of GDP is 0.377, in other words, current investment shock has an effect on next period GDP residual positively. Also we can see it from impulse response function of both investment and output shocks. According to impulse response functions, the impact of shocks in investment and output dies after a few periods.

Finally, I divide the data into two sub samples: first decade is from first quarter of 1980 to last quarter of 1989 and second decade from first quarter of 1990 to second quarter of 2001. The reason why I do this is that the 1990s in Japan is called a lost decade among economists and I am interested in a question "what kind of different facts appeared during this period". However, the result of last decade was similar to that of whole period. During first decade, there are some different features among facts. For instance, the government expenditure was leading, net export was lagging and procyclical, private and public inventories were leading, but public inventory was countercyclical.

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Appendix

Table A.1

	Model	St.Dev	Mean	St.Dev %
	1980-1989			
GDP	Model 1	0.977	11.411	8.563
Consumption	Model 1	0.953	10.813	8.813
	Model 7 AIC	0.942	10.813	8.708
Residential investment	Model 7	0.999	8.492	11.763
Non-residential investment	Model 1	0.995	9.467	10.513
Government expenditure	Model 1	0.992	9.504	10.438
	Model 7 AIC	0.995	9.504	10.469
Public investment	model 5	0.999	8.785	11.374
Export	Model 7	0.996	8.917	11.173
Import	Model 7	0.978	8.555	11.428
Net export	Model 2	0.983	7.655	12.843
	Model 7 AIC	0.949	7.655	12.402
Private inventory	Model 7	0.987	379.880	0.260
Public inventory	Model 7	1.000	-27.080	-3.692
Total investment	Model 7	0.985	10.123	9.731
	1990-2001			
GDP	Model 7 AIC	0.949	11.737	8.086
Consumption	Model 2	0.973	11.130	8.746
Residential investment	Model 1	0.997	8.665	11.508
Non-residential investment	Model 7	1.000	9.915	10.085
Government expenditure	Model 3	0.999	9.829	10.162
Public investment	Model 5	0.991	9.138	10.847
	Model 7	0.993	9.138	10.868
Export	Model 3	0.998	9.374	10.649
Import	Model 2	1.000	9.156	10.920
Net export	Model 1	0.989	7.698	12.848
Private inventory	Model 5	0.997	269.420	0.370
Public inventory	Model 7	0.999	22.457	4.448
Total investment	Model 7	0.977	11.411	8.563