Article

Time-Series Multivariate Analysis by Orbit Analysis and Principal Component Analysis Combined (2)

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(4) Developmental principal component analysis

We have until now applied principal component analysis to the four aggregates of Japan's GDP, the basic method of which is the same as ordinary principal component analysis. There are, however, two new ingredients in it. Firstly, the ordinary one attempts to transform many variables into a small number of principal components; but our method attempts to transform a relatively small number of variables into the same number of principal components. Secondly, our method interprets orthogonal relations, namely the most outstanding feature of principal component analysis, so strictly as to extract opposing moments hidden under the surface of a research object. From now on, we thoroughly apply these two points and develop the ordinary one into what we call developmental principal component analysis.

Developmental Principal Component Analysis (Developmental PCA) is a method in which on the basis of n principal components transformed from n variables principal component analysis is repeated in the following sequence: i.e. firstly between the two variables with the two largest variances (i.e. squares of loadings), secondly among the three variables with the three largest variances, thirdly among the four variables with the four largest variances and lastly among the full n variables. Developmental PCA makes it possible to start with the most fundamental opposing relation of an object and conceptually reconstruct a multi-layered structure of opposing relations step by step. It has a close affinity with dialectics in which analysis proceeds from the simplest form to more complicated forms (i.e. the individual form → the special form → the general form) step by step.

1. Two-principal-component analysis: extraction of basic opposing relations

In Table 3-2 fixed capital formation has the largest variance (i.e. square of loading), 26,927,674,758,067 and household consumption the second largest variance, 25,815,719,992,730. That suggests those two out of the four aggregates exhibit the largest variations and have been in the center of post-World War II development of the Japanese economy. Now then, we conduct principal component analysis only on those two variables (see Table 6 "Developmental principal component analysis (Japan's GDP)"), where two principal components are extracted from those two variables.

The coefficients in the eigenvector of the first principal component are fixed capital formation 0.717 and household consumption 0.697, resulting in overwhelming proportion 86.0%. Fixed capital formation and household consumption are in highly positive correlation by 0.719 with the large coefficients in the eigenvector; that apparently suggests that the first principal component increases or decreases as those increase or decrease hand in hand. It seems to be significant that basic or "normal" relations for capitalist development in general appear as the first principal component of the most fundamental two-principal-component analysis. The centerpiece cycle of Japanese capitalism was successfully extracted here.

Combine variables of high correlation coefficients with each other, and you generally acquire the first principal component of high proportion. As an opposite extreme, if you conduct principal component analysis on variables of no correlations, for example extracted principal components themselves, you acquire the first principal component of a low proportion and the second, third, etc. principal components do not contribute very much to enhancing the total proportion. It means that combination of variables of high correlations produces as the first principal component the synthetic force that drives an object in unity. In other words, the force that unites and sustains the object or the cycle that embodies such a force is represented here in this component.

The coefficients in the eigenvector of the second principal component are fixed capital formation −0.697 and household consumption 0.717, resulting in its proportion to be

Table 6: Developmental principal component analysis (Japan's GDP)

	First PC	Second PC
Eigenvalue	4.53366E+13	7.40678E+12
Proportion	0.860	0.140
Eigenvector		
Fixed capital formation	0.717	−0.697
Household consumption	0.697	0.717
Loading		
Fixed capital formation	4,830,409	−1,896,002
Household consumption	4,690,816	1,952,424

	First PC	Second PC	Third PC
Eigenvalue	4.54063E+13	1.00374E+13	5.11753E+12
Proportion	0.750	0.166	0.085
Eigenvector			
Fixed capital formation	0.719	−0.451	−0.529
Household consumption	0.694	0.513	0.506
Trade balance	−0.043	0.731	−0.682
Loading			
Fixed capital formation	4,842,692	−1,429,487	−1,196,902
Household consumption	4,676,563	1,624,071	1,143,623
Trade balance	−290,575	2,314,391	−1,541,779

	First PC	Second PC	Third PC	Fourth PC
Eigenvalue	4.58055E+13	1.00807E+13	5.18143E+12	3.07186E+12
Proportion	0.714	0.157	0.081	0.048
Eigenvector				
Fixed capital formation	0.714	−0.459	−0.525	0.059
Household consumption	0.692	0.508	0.476	−0.193
Trade balance	−0.042	0.725	−0.685	0.067
Government consumption	0.097	0.079	0.172	0.977
Loading				
Fixed capital formation	4,833,451	−1,458,606	−1,194,678	103,131
Household consumption	4,683,135	1,611,578	1,082,588	−338,804
Trade balance	−287,146	2,300,797	−1,558,252	116,867
Government consumption	655,022	249,658	392,460	1,712,535

14.0%. Their absolute values are reversed and fixed capital formation takes a negative sign. That suggests that it is exactly the opposite moment to the first principal component, in the sense that it increases as household consumption increases and fixed capital formation decreases; more strictly speaking, it increases as the discrepancy between them spreads. The orthogonal relation between the two principal components is most vividly expressed there.

As shown in a small proportion 14.0%, such a force has not so strongly worked in the post-World War II development of Japanese capitalism. In fact, those situations are exactly opposite to the normal capitalistic cycle represented by the first principal component: fixed capital formation decreases despite an increase in household consumption; it decreases very much despite not so much decrease in household consumption; or household consumption increases more sharply than fixed capital formation does. An awkward decline in desire for capital accumulation for one reason or another or an enormous expansion of economic bubble, both leading to an increase in the second principal component, undoubtedly means “extraordinary” situations and something destructive for capitalism. In this conceptual meaning, it is the opposite moment to the first principal component.

On top of that, as we already saw in our interpretation of the third principal component in the ordinary principal component analysis, the second component here obviously embodies both positive and negative aspects of capitalistic development. Seen as development of *capitalistic* economy, a decline in desire for capital accumulation and an enormous expansion of bubble are certainly “extraordinary” and representative of serious destructive force against capitalism. However, if seen as development of capitalistic *economy*, the force that works to maintain household consumption to a certain level despite a decline in fixed capital formation displays intrinsic nature of economy. In this sense as well, it is the opposite moment to the first principal component, which demonstrates trans-historical nature of economy in contrast with historically specific nature of capitalistic economy.

Generally speaking, the first principal component, which consists of variables of high correlations, is the centerpiece of an object and by contrast, the second principal component, which consists of variables with reversed signs, can be interpreted as its fundamentally opposing moment. One is the *force of uniting the object* over time and the other is the *force of dissolving it*. Dissolution could mean either that in which the object is dissolved in its historical nature or that in its trans-historical nature, and here we mean the former. As long as the object tries to maintain itself, the second principal component remains minor.

2. Three-principal-component analysis: extraction of developed opposing relations

In Table 3-2, trade balance has the third largest variance, i.e. square of loading, 7,817,923,877,106, after fixed capital formation and household consumption. Next then, let us conduct three-principal-component analysis, including trade balance (see Table 6). External trade relations are added to the mainly domestic centerpiece of the Japanese economy.

The coefficients in the eigenvector of the first principal component are fixed capital formation 0.719, household consumption 0.694 and trade balance −0.043, with overwhelming proportion 75.0%. And its loadings are fixed capital formation 4,842,692, household consumption 4,676,563 and trade balance −290,575. These results suggest that the basic characters of the first principal component have not changed: because of negligible −0.043 and −290,575 of trade balance, it still seems to be representative of the centerpiece of Japanese capitalism and its normal business cycle. Observed in details, however, trade balance is negatively correlated with fixed capital formation (−0.198) but slightly positively correlated with household consumption (0.045) (see Table 5) and thus, their effects are somewhat offset while reflected on the first principal component. The Japanese economy is said to have been, since the end of the World War II, rather dependent on foreign trade, but in fact, its centerpiece has been formed by fixed capital formation and household consumption combined.

The coefficients in the eigenvector of the third principal component are fixed capital formation −0.529, household consumption 0.506 and trade balance −0.682, with proportion 8.5%. Although the proportion is the smallest of all the components, the third principal component inherits the features of the fundamental opposing moment that was extracted in two-principal-component analysis: i.e. the reversed relations between household consumption and fixed capital formation, which incorporate "abnormal situations" of Japanese economy, such as decline of desire for capital accumulation and extraordinary bubble economy. Furthermore, newly added trade balance brings in a new "abnormal situation" here.

The coefficient in the eigenvector of trade balance is −0.682, the largest though being negative. In terms of absolute value, those three aggregates rival each other, which can be confirmed by loadings as well, fixed capital formation −1,196,902, household consumption 1,143,623 and trade balance −1,541,779. Their reversed relations incorporate discrepancy between household consumption and trade balance in addition to discrepancy between fixed capital formation and household consumption. The third principal component increases as trade balance decreases though household consumption does not increase very much, or as trade balance sharply decreases though household consumption only slightly decreases. It might be theoretically possible that household consumption sharply increases as trade balance also increases. As examined already, however, such a situation has never taken place in the post-World War Japanese economy. Therefore, new "abnormal situations" seem to be reflected here, such as sudden trade deficit owing to oil shocks, global simultaneous recessions and the Great East Japan Earthquake, and gradual deterioration of trade balance owing to a decline of export competitiveness. In this sense, the third principal component is the fundamental opposing moment to the first principal component.

Here as well as in two-principal-component analysis, do positive and negative aspects of capitalistic development of economy appear. Third principal component does not increase merely as trade balance decreases; it does increase only when household consumption keeps at a certain level despite a decline of trade balance. An abrupt deterioration of trade balance or a gradual decline of export competitiveness is certainly a kind of negative "abnormal situation" for *capitalistic* economy and continuation of the "abnormality" may well lead to a serious dissolution of the capitalistic economy concerned. However, seen from the viewpoint of development of capitalistic *economy*, household consumption kept at a certain level despite a decline of trade balance shows the function of a natural force of an economy. The third principal component is the fundamental opposing moment to the first principal component in the sense that it embodies trans-historical features, compared with specifically historical features, of capitalistic economy in terms of trade balance.

The coefficients in the eigenvector of the second principal component are fixed capital formation −0.451, household consumption 0.513 and trade balance 0.731, with proportion 16.6%. In comparison with the third principal component, it is characterized by the reversed sign of trade balance. It has the largest loading of trade balance, 2,314,391 while being negligibly small −290,575 in the first principal component and being negative −1,541,779 in the third principal component.

The most noticeable feature of the second principal component is that the coefficient in the eigenvector of trade balance has the reversed sign to that of fixed capital formation: being in negative correlation to each other (−0.198) (see Table 5), fixed capital formation decreases as trade balance increases in ordinary situations, exactly when the second principal component increases. That occurs when domestic economy shrinks and fixed capital formation declines, leading to external emission of domestic surplus capital in the form of trade surplus. The second principal component is an indicator of internal formation of surplus capital and its external emission.

On top of that, it also demonstrates the external emission effect that contributes to maintaining or even enhancing household consumption: i.e. the coefficient in the eigenvector of household consumption 0.513. The second principal component, therefore, expresses the domestic comprehensive effects of trade balance. It allows household consumption to be kept at a certain level in a difficult situation in which fixed capital formation, the driver of capitalistic economy, unfortunately decreases but, sustain national capitalism despite exerting beggar-thy-neighbor policy.

Two-principal-component analysis extracts the first principal component, which combines highly correlated variables and embodies the force of uniting the object, and the second principal component, which combines the variables with reversed signs and embodies the force of fundamentally dissolving the object. Three-principal-component analysis, by contrast, with the previous second principal component developed, separated into two and retreating to the third principal component, extracts the new second principal component, which stands for the force of simultaneously dissolving and sustaining the object. In these senses, the second principal component is the opposite moment to both the first and third principal components. In the process of extraction the dissolving force, which was concealed in the previous first principal component, is incorporated into the new second principal component and part of the dissolving force, which was explicit in the previous second principal component, is separated and incorporated into the new second principal component; therefore, proportions of the new first and third principal components somewhat decrease.

Now again, let us compare the eigenvectors of two-principal-component analysis and three-principal-component analysis. The striking reversal of absolute values and signs in two-principal-component analysis transforms into the double opposing relations between the first and second and between the first and third principal components. As a result of the transformation/development the clear-cut symmetry in two-principal-component analysis breaks in three-principal-component analysis.

Generally speaking, interpretation of principal components is so difficult that conclusions often remain in the sphere of half-baked inference. Interpretation is by and large based on three criteria: firstly, signs of eigenvectors; secondly, absolute values or loadings of eigenvectors: and thirdly, combination of eigenvectors. However, we could not properly answer the question, for example, why the second principal component has such specific values as fixed capital formation −0.451, household consumption 0.513 and trade balance 0.731. We could say at best that it synchronized more closely with trade balance than household consumption. Developmental two-principal-component analysis, by contrast, reveals the simplest opposing relations as symmetrical eigenvectors and thus, we can trace changes in coefficients as *symmetry breaking* from three-principal-component analysis on.

Concretely speaking, the eigenvector of the second principal component in two-principal-component analysis consists of fixed capital formation −0.697 and household consumption 0.717, which are the standard value of the opposing moments or that of symmetry. Fixed capital formation −0.697 is separated in three-principal-component analysis into −0.451 of the second principal component and −0.529 of the third principal component and thus, decreases its absolute value in each component. Household consumption 0.717 is also separated in three-principal-component analysis into 0.513 of the second principal component and 0.506 of the third principal component and thus, decreases its absolute value. It suggests that those two principal components in a pair maintain symmetry against the first principal component. It would be needless to say that such reconstruction of symmetry was brought about by the introduction of a new variable, i.e. trade balance. Combination of trade balance with those two principal components, which share the symmetry, gives them a new meaning. We can expect that interpretation of principal components improves its validity by tracing changes in coefficients from the standard value of symmetry as its breaking.

3. Four-principal-component analysis: extraction of opposing relations in totality (a hierarchy of opposing relations)

"Square of loading (variance)" in Table 3-2 suggests that the last aggregate, which should be added to our analysis, is government consumption 3,578,185,270,181 in total. Now let us conduct principal component analysis with all the four variables including government consumption (see Table 6). Here we observe policies factor from the outside of purely economic sphere in addition to fixed capital formation, household consumption and trade balance, which represent internal and external economic mechanism.

The eigenvector of the first principal component consists of fixed capital formation 0.714, household consumption 0.692, trade balance −0.042 and government consumption 0.097 with overwhelming proportion 71.4%. Respective loadings are fixed capital formation 4,833,451, household consumption 4,683,135, trade balance −287,146 and government consumption 655,022, each in million yen. Compare the first principal components of two-, three- and four-principal-component analyses, and we know the standard values of symmetry, i.e. fixed capital formation 0.717 and household consumption 0.697, have hardly changed. Addition of government consumption little changes the structure of the first principal component, i.e. the axis of Japanese capitalism; in other words, variations caused by government consumption affect Japanese economy as a force completely different in dimension and tendency from that of the axis. The small coefficient of government consumption 0.097, though, can be understood to show variations of government consumption, however small they may be, which are promoted by and incorporated into the axis.

We will next examine the third principal component: its eigenvector consists of fixed capital formation −0.525, household consumption 0.476, trade balance −0.685 and government consumption 0.172 with its proportion 8.1%. As examined before, it contains discrepancy between household consumption and fixed capital formation and that between household consumption and trade balance. Namely, a decline in desire for capital accumulation, extraordinary economic bubbles, oil shocks, global simultaneous recessions, the Great East Japan Earthquake and deterioration of export competitiveness are among "abnormal situations" for Japanese capitalism. Different from previous cases, however, the third principal component increases in new relations, in which household consumption and government consumption increase but fixed capital formation and trade balance decrease or in which household consumption and government consumption slightly decrease but fixed capital formation and trade balance sharply decrease. Remember that household consumption and government consumption are positively correlated by 0.345, and we understand that government expenditures, which are mobilized owing to those “extraordinary situations”, are factored in the third principal component, although being minor in it.

Positive and negative aspects of capitalistic development are expressed here again in a new form. Those situations are serious and “abnormal” from the viewpoint of *capitalistic* economy. However, from the viewpoint of development of capitalistic *economy*, those can be understood as working of natural forces that maintain a certain level of household consumption and government consumption despite a decrease in fixed capital formation and trade balance: maintaining people's life year by year and securing a certain level of fiscal expenditures for necessary public policies are both beyond historically specific features of capitalism as an economic system, and trans-historical necessity for any mode of society.

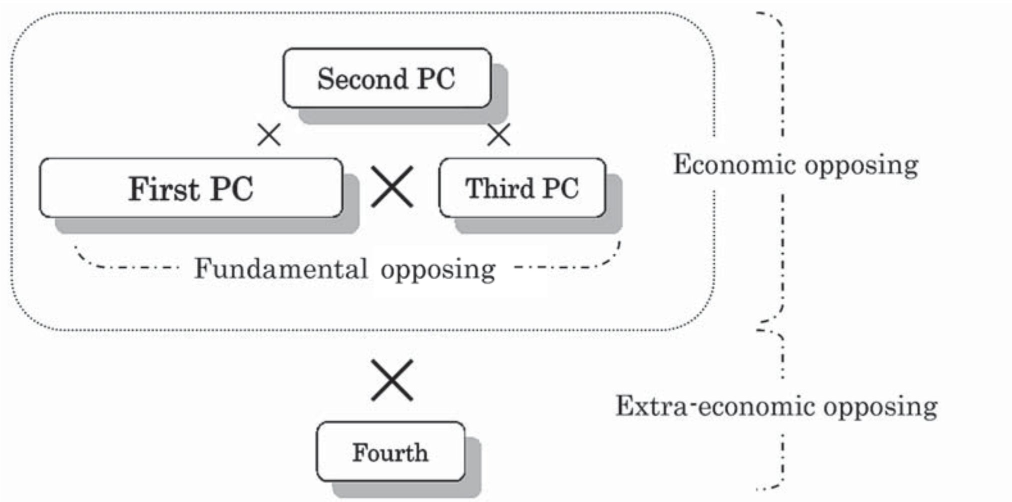
The eigenvector of the second principal component consists of fixed capital formation −0.459, household consumption 0.508, trade balance 0.725 and government consumption 0.079 with proportion 15.7%. As well as in three-principal-component analysis, trade balance plays the main role here, with government consumption slightly adding its weight to it at positive correlation coefficient 0.079. It increases when surplus capital is emitted abroad in the form of trade surplus because of shrinkage of domestic economy and fixed capital formation. Its increase reflects the effect in which household consumption is maintained or even increased due to the emission abroad and also the effect in which government expenditure, faced with economic shrinkage, is mobilized to counteract it: the second principal component is the indicator of the total effects of surplus capital, i.e. its domestic formation and external emission.

The fourth principal component is representative of effects of extra-economic policies of government in comparison with the domestic economic mechanism represented by the first, second and third principal components. Its eigenvector consists of fixed capital formation 0.059, household consumption −0.193, trade balance 0.067 and government consumption 0.977 with proportion 4.8%. As already well examined, it is understood to express autonomous variations exerted by government consumption onto the economy as a whole, which are departed from those by household consumption, trade balance and fixed capital formation. It is in the entirely different dimension from other principal components and incorporates autonomous government consumption which have little relations with Keynesian fiscal policies against recessions.

We have so far elucidated in four steps basic methods of developmental principal component analysis, which is methodologically distinguished from ordinary principal component analysis. “Development” does not suggest “developmental history” in time; it rather means *process of conceptual development*, in which concepts derived from analysis are opposing moments to each other and the process takes the form of dialectical development that is featured by unity of the opposites and negation of negation. Namely, two-, three- and four-principal-component analyses are respectively unity of the opposites, and development from two- to three-principal-component analyses and from three- to four-principal-component analyses is negation of negation [1]. We could regard developmental principal component analysis as "dialectics of statistics" or "statistics of dialectics", which expresses in a statistical method the fact that an object of research consists of a multilayered structure of opposing moments [2]. Some of its important features are briefly summarized as follows:

In ordinary principal component analysis, all principal components are at once analyzed and interpreted and thus, their complicated relations, i.e. a multilayered structure of opposing relations, are much difficult to be identified. Developmental principal component analysis, by contrast, treats only two central variables at first according to total of variances; therefore, the most fundamental opposing relations of an object of research, i.e. unity of the opposites, and as its quantitative expression, the standard values of symmetry can be correctly extracted. The first principal component represents the force of uniting and maintaining the object and the second principal component represents the force of fundamentally dissolving the object; in time-series data, those forces take the form of cycles. Addition of the third variable allows a new principal component to be extracted that is the opposing moment to both the previous principal components. And now it is clear that the new principal component has developed and separated from the original second principal component. Lastly, addition of the fourth variable allows the fourth principal component in a distinct dimension to be extracted that is categorically different from the previous opposing relations and opposing to the totality of the first, second and third principal components. As a result we can grasp the multilayered structure of opposing relations among the four principal components as illustrated below.

Note that exactly the same relations above among principal components do not necessarily emerge from developmental principal component analysis in general. It is certain that all principal components are opposing moments; however, it is not true that the first principal component and a specific principal component are



always in the fundamental opposing relations or even that specifically the first and second principal components are necessarily in the fundamental opposing relations. Having said so, the fundamental opposing relations have to be implanted somewhere in the multilayered structure between certain principal components, whether in a single or multiple manner. It would still take many empirical studies before we successfully generalize or pattern relations among principal components.

(5) Principal component analysis and orbit analysis combined

1. Multiple regression analysis of principal components

We reconstruct Japan's GDP and its four aggregates [3], i.e. fixed capital formation, household consumption, trade balance and government consumption, with the help of the four principal components. In other words, we would attempt to thoroughly explain all the variations of GDP for 57 years from 1956 to 2012 at determination coefficient 1.00 by dissolving it into the four principal components and transforming it into the four forces/cycles that drive Japanese capitalism. By doing that the "visible world" of the four aggregates would be linked with "invisible world" of principal components.

Stone (1947) was a forerunning research that successfully applied the method of ordinary principal component analysis to US GDP. It conducted principal component analysis on 17 variables that were expected to be relevant to variations of GDP and transformed them into 3 principal components. Then the author gave economic interpretations to them and succeeded to explain 97.5% of all variations of US GDP during the period 1922-38. It applied a function of principal component analysis, which was suggested by one of the originators H. Hotelling, namely extraction of principal components *fewer in number* than the original variables. Principal component analysis, however, possesses another function, namely extraction of a *more fundamental* set of independent principal components. It is the method in which we start with a small number of variables and transform them into the same number of principal components, rather than transforming a large number of variables into a fewer number of principal components. The approach we take below is based on the former.

It would be needless to say that in multiple regression analysis independent variables X_1, X_2, X_3, etc. are a different data set from dependent variables; multiple regression analysis and calculation of a determination coefficient are meaningful simply because those two sets of variables are different. And a dependent variable is never the same as one of independent variables X_1, X_2, X_3, etc. Then, what if independent variables are principal components Z_1, Z_2, Z_3, etc. which are extracted from X_1, X_2, X_3, etc.? We conduct multiple regression analysis on X_1, X_2, X_3, etc. by means of *all* of those principal components. It is quite natural that the determination coefficient is *always* 1.00: it is 1.00 for *all* the dependent variables X_1, X_2, X_3, etc. and it is also 1.00 for the dependent variable $X_1 + X_2 + X_3 + \cdots + X_n$. It is a completely different matter from that in which dependent variables are the same as independent variables because original independent variables are transformed into a set of synthetic variables, which function as a new set of independent variables, given specific economic meanings. We call such an analytical method as multiple regression analysis by means of principal components.

The results are in "Table 7: Multiple regression analysis by means of principal components of Japan's GDP (means of principal components ≠ 0)": a list of coefficients and intercepts as a result of multiple regression analysis of fixed capital formation, household consumption, trade balance, government consumption and GDP by means of their four principal components. The coefficients perfectly match their eigenvectors (see Table 3-1). The products of those coefficients and principal component scores (means ≠ 0) are shown respectively in "Fig. 12: Principal component composition of fixed capital formation", "Fig. 13: Principal component composition of household consumption", "Fig. 14: Principal component composition of trade balance", "Fig. 15: Principal component composition of government consumption" and "Fig. 16: Principal component composition of GDP".

The sum of those four principal components each year is exactly equal to the value of fixed capital formation, household consumption, trade balance, government consumption and GDP respectively [4]. Therefore, we can measure contributions to an annual change of each GDP aggregate of basic business cycle, external emission of surplus capital, various abnormalities and autonomous fiscal expenditure. Although limited space here does not allow us to conduct an in-depth analysis of the results, let us refer to some of their interesting features in order to show rich possibilities of multiple regression analysis of principal components as follows:

Firstly, GDP, which has not been examined so far as a variable of our principal component analysis, is approximately the sum of household consumption, fixed capital formation, trade balance and government consumption and thus, its determination coefficient is nearly 1.00 as well. The basic business cycle has explained almost all variations of GDP, which was especially true until the early 1970s when the period of rapid economic growth ended. Then, the cyclical process began to be disturbed and in the middle of the 1970s and early 1980s and around the early 1990s when an economic babble collapsed, economic growth was barely maintained by emitting abroad domestic surplus capital as trade surplus. That has become all the more evident since the early 1990s when normal business cycle literally collapsed. Autonomous fiscal policy did not exert much influence on GDP, while in 1980 it shot up enormously and supported a drop of the basic business cycle and since 1990, due to the collapse, has substantially enhanced its relative weight. As for the third principal component, representative of

Talbe 7: Multiple regression analysis by means of principal components of Japan's GDP (means of princicpal components ≠ 0)

	Intercept	First PC	Second PC	Third PC	Fourth PC
Fixed capital formation	0.000	0.714	−0.459	−0.525	0.059
Household consumption	0.000	0.692	0.508	0.476	−0.193
Trade balance	0.000	−0.042	0.725	−0.685	0.067
Government consumption	0.000	0.097	0.079	0.172	0.977
GDP	128,061	1.548	0.767	−0.799	0.882

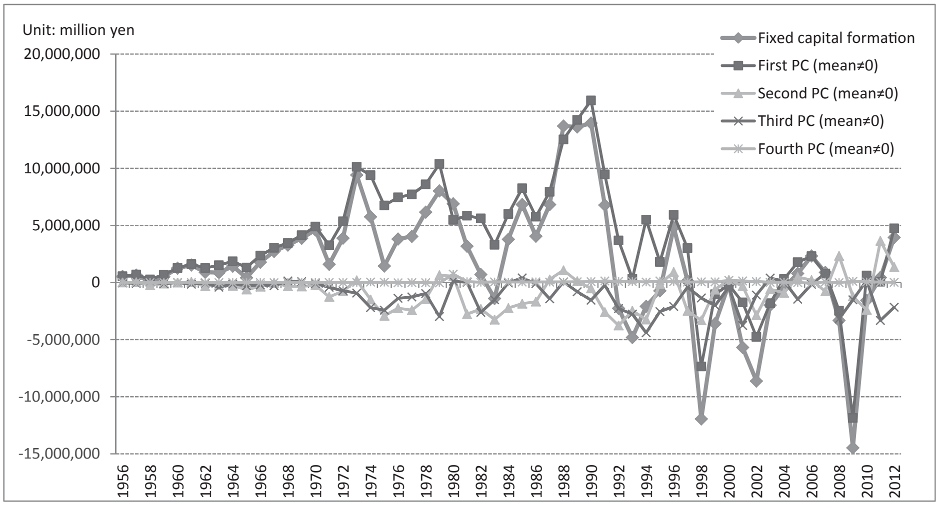


Fig. 12: Principal component composition of fixed capital formation

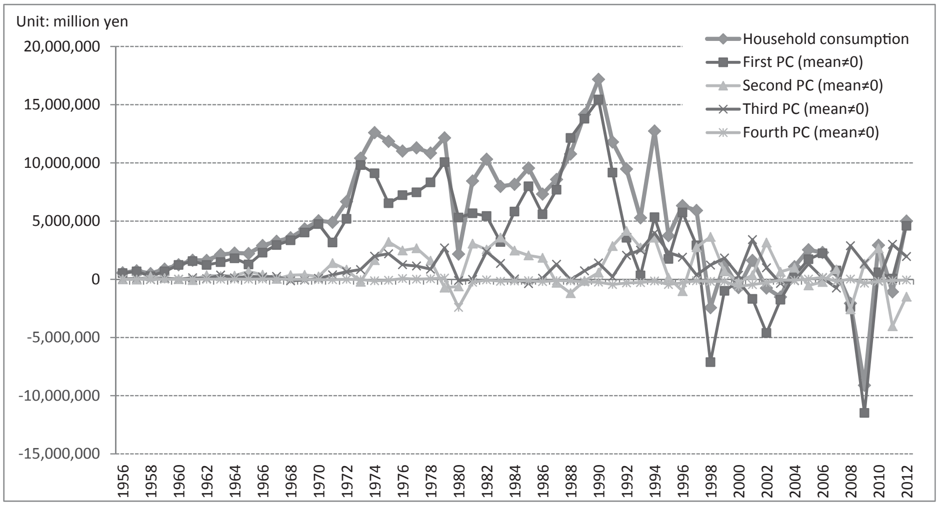


Fig. 13: Principal component composition of household consumption

various abnormalities, it should be noted that its coefficient is negative (−0.799), which suggests that the third principal component consists of negative factors to GDP such as an unexpected drop of fixed capital formation and trade deficit owing to a hike of oil price or an earthquake disaster. It has matched the second principal component in terms of absolute value and recently almost overwhelms it which undeniably demonstrates a decreasing tendency. As of 2012 the basic business cycle is in an intriguing process of recovery since the early 1990s.

“Fig. 17: Principal component composition of GDP (2000-12)” focuses especially the

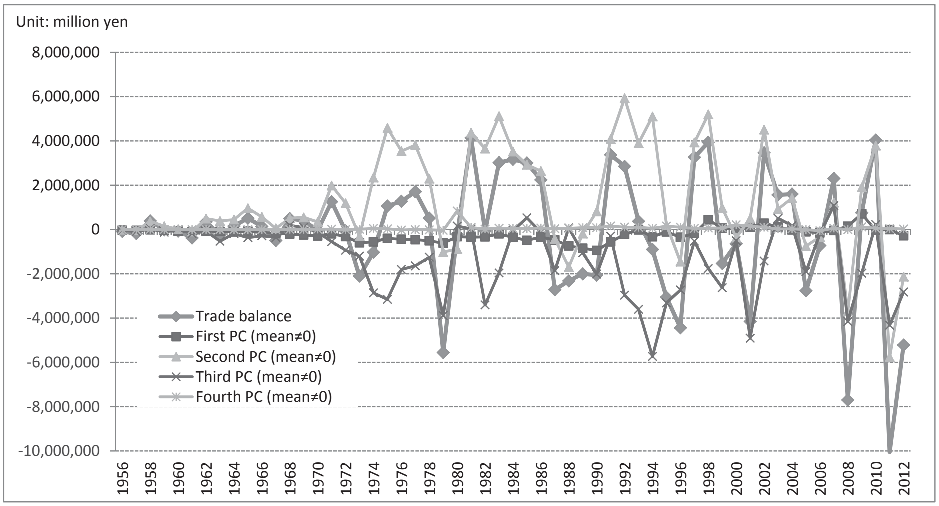


Fig. 14: Principal component composition of trade balance

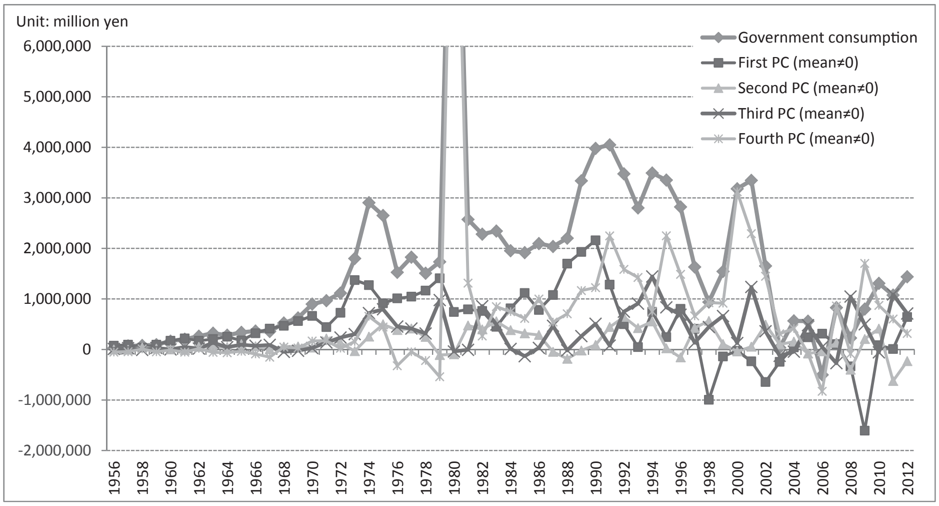


Fig. 15: Principal component composition of government consumption

period 2000-12, a focal point of recent development of Japanese economy. It reveals that the recent world economic crisis, triggered by the Lehman Brothers Shock in autumn 2008, damaged Japan's GDP by 30,070.6 billion yen year-on-year, 85.5% of which can be explained by the collapse of the basic business cycle (25,695.6 billion yen) owing to a simultaneous decrease in fixed capital formation and household consumption. So as to alleviate the negative influence, emission of surplus capital (2,018.9 billion yen) and autonomous fiscal expenditure (1,366.9 billion yen) worked, but were almost offset by a drop of the third principal

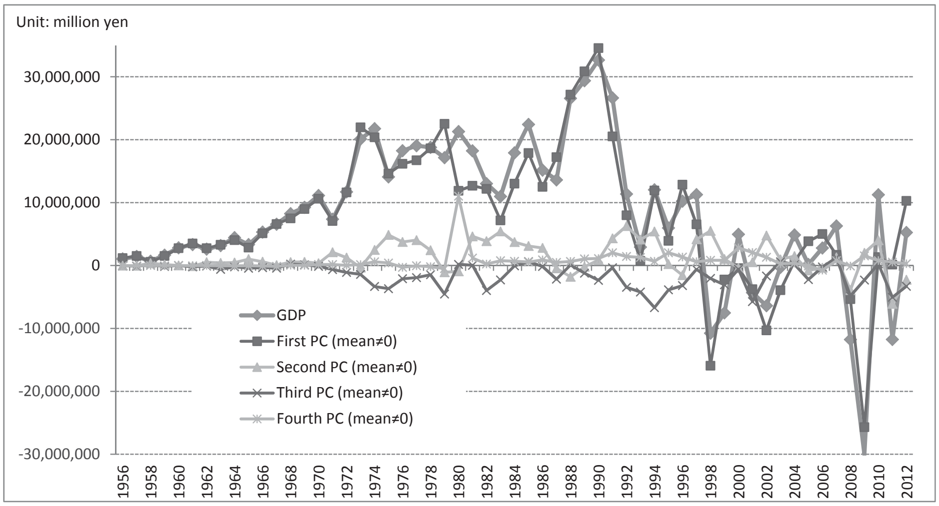


Fig. 16: Principal component composition of GDP

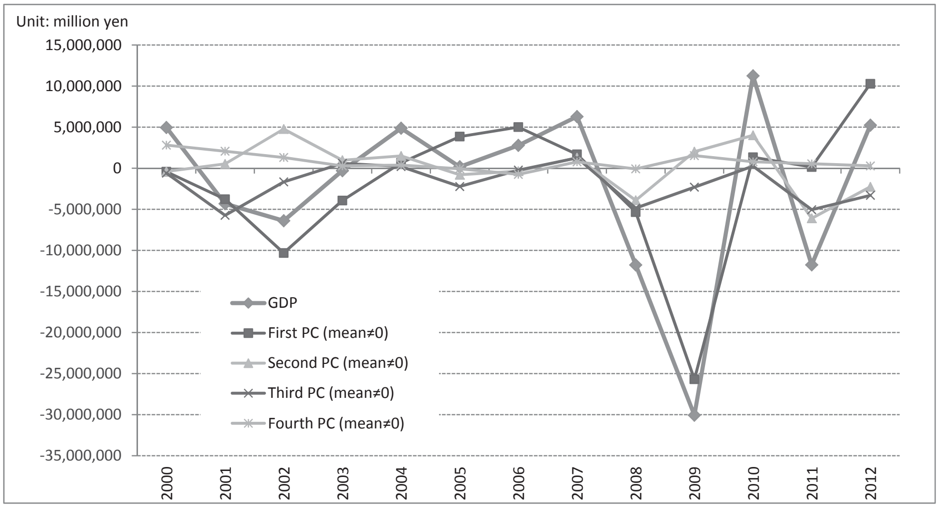


Fig. 17: Principal component composition of GDP (2000-12)

component (2,303.2 billion yen). It was caused by a sharp decrease in fixed capital formation more than that in household consumption (7,595.3 billion yen according to Fig. 10). Japanese economy, however in the next year 2010, succeeded in a V-shaped recovery (11,245.7 billion yen). A recovery of the basic business cycle (1,340.7 billion yen) was much more effective than an effect of surplus capital emission (4,011.4 billion yen) in the form of trade surplus. However, the Great East Japan Earthquake plunged Japanese economy into a recession again in 2011 (minus 11,761.2 billion yen). It was caused by shrinking surplus capital (minus

6,096.9 billion yen) and deterioration of the third principal component owing to emergency import of fossil fuel (minus 5,046.9 billion yen, of which 6,877.6 billion yen were a result of deterioration of trade surplus). We should take a special notice of the first principal component, which did not change very much from 2010 of a V-shaped recovery (148.8 billion yen). The fact suggests that the centerpiece of the Japanese economy did not break down despite a serious damage caused by the earthquake. And the year 2012 witnesses an impressive improvement of the basic business cycle (10,281.8 billion yen) despite the effect of emergency import of fossil fuel and shrinking surplus capital still being in the negative sphere, and it sustains strong recovering tendency of GDP (5,244.7 billion yen).

Next we examine the composition of fixed capital formation, i.e. the central pillar of the Japanese economy since the end of the Second World War. The first principal component mainly explains its variations; especially until 1970 they had been almost identical. Since then, however, they have departed from each other: fixed capital formation has underperformed below its normal expected level suggested by the first principal component in almost all years. The year 1990 witnessed a threshold in which the "normal" level itself began to collapse and the second and third principal components have functioned as factors that have accelerated the downward trend. Note that the second principal component has a negative coefficient, suggesting that part of fixed capital formation in the normal economic cycle is replaced by trade surplus and thus, its actual level shrinks by that amount. In other words, domestic savings are not directed to domestic investment in plants and equipments but rather, transformed into surplus capital and emitted abroad in the form of financial investment. That is exactly the process of international hollowing-out of the economy and the second principal component, as a component of fixed capital formation, plays the role of an indicator of economic hollowing-out. Note again that the third principal component also has a negative coefficient, suggesting that "extraordinary situations", such as global simultaneous depressions (1975 and 1982), the Oil Shock (1979), the collapse of the IT bubble (2001), the Lehman Brothers Shock (2008) and the Great East Japan Earthquake (2011), decreased the amount of fixed capital formation from its normal level. As for the fourth principal component, i.e. autonomous government expenditure, seems to affect little the amount of fixed capital formation.

Next we examine household consumption, another important pillar of the Japanese economy. The first principal component mainly determines its variations; especially until the early 1970s they had been almost identical. Since then there has been a big gap between them, which has been filled with an increase in household consumption thanks to external emission of surplus capital and positive effects of the third principal component. It is worth noticing that autonomous fiscal policies have had little influence on its variations. Overall variations of household consumption seem to consist of large ups and downs of the first principal component, somewhat alleviated by the second, third and fourth principal components. The reason why the third principal component has a positive effect (coefficient) on household consumption is that it stands for relative discrepancy between household consumption and fixed capital formation/ trade balance: a sharp decline of fixed capital formation or trade balance relative to household consumption works as a lifting force for household consumption; or, if not lifting it, the amount by which household consumption hangs on against a sharp decline of fixed capital formation or trade balance is taken into account as a positive effect. The reason why the fourth principal component has a negative effect is that it stands for a relative discrepancy of government consumption mainly to household consumption and thus, its positive change works as a negative factor for household consumption.

The composition of trade balance is mainly determined by the second principal component: trade balance of Japan almost correctly reflects variations of domestic surplus capital. It is not, however, a whole story; actual trade balance in many years were below the level of the second principal component. It is largely because of the third principal component with a negative coefficient: such factors alleviate the effect of the second principal component as insufficient external emission of domestic surplus capital due to stagnant export as a result of global simultaneous recession, an increase in import due to an unexpected increase in household consumption as a result of an economic bubble and trade deficit due to a hike of oil price as a result of an oil shock. Although the fourth principal component hardly has an effect on trade balance, the first principal component exerts a little negative effect on it. This is because the first principal component represents *normal* economic circulation and thus, in periods in which fixed capital formation and household consumption smoothly increase trade balance receives a negative influence from that.

> Analysis of principal component composition above suggests that it produces a meaningful insight into the structure of trade balance. Chapter 6 in Itaki (2006) used a new concept “private surplus savings = trade balance − fiscal balance” and attempted to measure potential amount of surplus capital in a domestic economy. And it also attempted to identify periods in which domestic surplus capital was generated or it did not correspond to trade surplus by means of 9-year moving correlation analysis between private surplus savings and net fixed capital formation and between trade balance and net fixed capital formation. While its purpose seems to be met there, analysis of principal component composition allows us to profoundly understand trade balance and surplus capital by dissolving trade balance as a whole into the four independent concepts, i.e. the basic business cycle, surplus capital, “extraordinary situations” and autonomous fiscal policies.

As for government consumption, Table 7 shows an overwhelming correlation coefficient of the fourth principal component. Do not forget, however, that the first, second and third principal components of large variations respectively exercise substantial influences on government consumption. According to Figure 15 government consumption is constituted by the four principal components more or less by similar amounts. Each one stands for government consumption caused by normal business cycle, surplus capital, “extraordinary situations” and autonomous fiscal policies respectively.

2. The multiplier effect measured by multiple regression analysis of principal components

We devise a new statistical method that allows us to correctly measure the multiplier effect, i.e. a change in value of GDP caused by one-unit increase in fixed capital formation, household consumption, trade balance and government consumption respectively.

Compare Table 3-1 and Table 7, and we know the coefficients of the multiple regression line are equal to the values in the eigenvector. Assign X_1, X_2, X_3 and X_4 to fixed capital formation, household consumption, trade balance and government consumption and Z_1, Z_2, Z_3 and Z_4 to the first, second, third and fourth principal components respectively, the following two sets of equations hold:

For principal components;

$Z_1 = 0.714\,X_1 + 0.692\,X_2 - 0.042\,X_3 + 0.097X_4$

$Z_2 = -0.459\,X_1 + 0.508\,X_2 + 0.725\,X_3 + 0.079\,X_4$

$Z_3 = -0.525\,X_1 + 0.476\,X_2 - 0.685\,X_3 + 0.172\,X_4$

$Z_4 = 0.059\,X_1 - 0.193\,X_2 + 0.067\,X_3 + 0.977\,X_4$

For variables;

$X_1 = 0.714\,Z_1 - 0.459\,Z_2 - 0.525\,Z_3 + 0.059\,Z_4$

$X_2 = 0.692\,Z_1 + 0.508\,Z_2 + 0.476\,Z_3 - 0.193\,Z_4$

$X_3 = -0.042\,Z_1 + 0.725\,Z_2 - 0.685\,Z_3 + 0.067\,Z_4$

$X_4 = 0.097\,Z_1 + 0.079\,Z_2 + 0.172Z_3 + 0.977\,Z_4$

Therefore, the equations for the principal components suggest that, for example, one-unit increase in fixed capital formation X_1 produces 0.714 unit of Z_1, -0.459 unit of Z_2, -0.525 unit of Z_3 and 0.059 unit of Z_4. Because the four principal components are independent from each other, those increases will not have further spill-over effects on the principal components.

The multiple regression equation for GDP in Table 7 is, if assigned to be X_5, $X_5 = 1.548\,Z_1 + 0.767\,Z_2 - 0.799Z_3 + 0.882\,Z_4$. Substitute those resultant increases in principal components as a result of one-unit increase in fixed capital formation for the four principal components in the equation, and we acquire $X_5 = 1.548 \times 0.714 + 0.767 \times (-0.459) - 0.799 \times (-0.525) + 0.882 \times 0.059$, i.e. $X_5 = 1.125$. It is the multiplier effect (spill-over effect) on GDP that is caused by one-unit increase in fixed capital formation. “Table 8: multiplier effects on Japan’s GDP” demonstrates the results of similar calculations for household consumption, trade balance and government consumption, i.e. 0.910, 1.096 and 0.934 respectively in the order household consumption < government consumption < trade balance < fixed capital formation.

Because those four principal components are independent from each other, the

Table 8: Multiplier effects on Japan's GDP

	First PC	Second PC	Third PC	Fourth PC	Total
Fixed capital formation	1.106	−0.352	0.419	0.052	1.225
Household consumption	1.071	0.389	−0.380	−0.171	0.910
Trade balance	−0.066	0.556	0.547	0.059	1.096
Government consumption	0.150	0.060	−0.138	0.862	0.934

multiplier effect contains all and only the spill-over effect of one-unit increase in fixed capital formation. It is the effect that is caused only by one-unit increase in fixed capital formation with the others intact, although it undoubtedly fluctuates with all the others. In order to confirm this point, substitute the increases it causes, i.e. Z_1 (0.714), Z_2 (−0.459), Z_3 (−0.525) and Z_4 (0.059) for those four equations for variables, and we acquire X_1=1 and X_2, X_3, and X_4=0. The results suggest that no effect is exerted on household consumption, trade balance or government consumption except for one-unit increase in fixed capital formation.

3. Orbit analysis of principal components

We will link phenomena (i.e. variables) with concepts (i.e. principal components) also in orbit analysis and reconstruct “the visible world” by means of “the invisible world”; in other words, we attempt to explain leading-following relations among variables by the forces behind that drive them. Firstly, orbit analysis of principal components is conducted in “Fig. 18: 9-year moving average of ranking points for Japan's GDP (principal component scores)”.

Note that ranks derived by orbit analysis of principal components represent temporal preceding-lagging relations rather than leading-following relations based on quantitative pulling-being pulled relations. Because principal components have zero correlation coefficients and are independent from each other, they are not in the relations in which a specific principal component quantitatively leads others or *vice versa*. Therefore, ranks derived by orbit analysis of principal components only suggest temporal order of earlier movements among them. That does not hold true, however, between variables and principal components: they are correlated with each other and thus, in leading-following relations.

The figure shows how the four forces of distinct dimensions work independently and

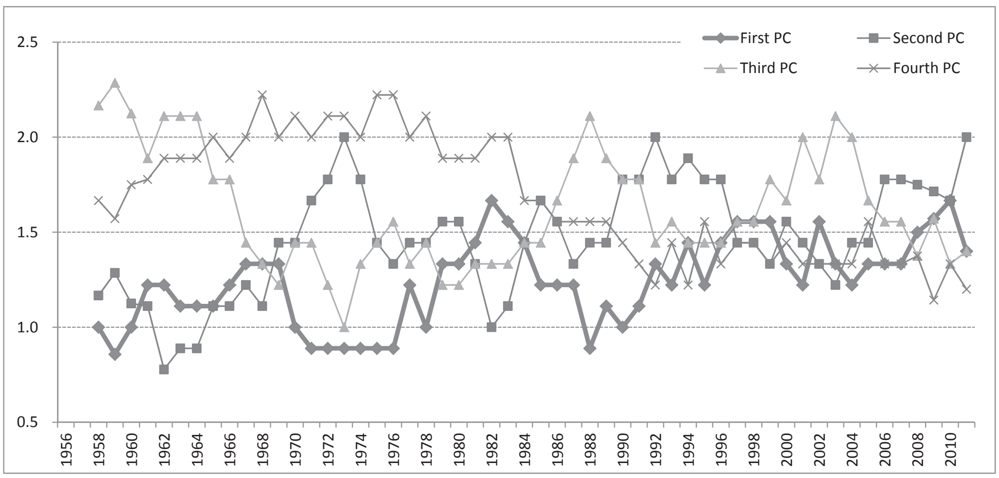


Fig. 18: 9-year moving average of ranking points for Japan's GDP (principal component scores)

sequentially, and determine Japan's GDP. The third principal component that came first in the period 1958-64 seems to imply that in the first half of the fast economic growth period household consumption expanded independently from trade balance and fixed capital formation. Autonomous expansion of household consumption took place prior to changes in all the variables regarding GDP. The fourth principal component, i.e. autonomous increase in government consumption, changed after a little lag, followed by the first principal component, i.e. the main pillar of GDP. The second principal component moved last because of virtually no existence of surplus capital in the period. Comparison between Fig. 18 with Fig. 5 that depicts leading-following relations among the original variables suggests that autonomous expansion of household consumption existed behind the leading position of fixed capital formation in the period. Japanese people's eager and autonomous consumption demand pulled investment in plants and equipments, whose standard of living enormously improved after finally recovering from the damages caused by the defeat in the Second World War and toward the Tokyo Olympic Games in 1964.

For twenty years from 1965 to 1984, the fourth principal component, i.e. autonomous fiscal policy, overwhelmed others and was in the status of the kick-starter. Another interesting feature in the period was an enhancement of ranking of the second principal component, i.e. surplus capital. The fourth principal component has been neglected as a factor of determining GDP owing to its low proportion, 4.8%. It actually overwhelmingly preceded the others through the second half of the fast economic growth period, the 1970s and the first half of the 1980s when reconstruction of public finances in deficit was attempted. The period in which eager and autonomous household consumption preceded was followed by a period of massive public expenditure in living and industrial infrastructure and on education, welfare, health care and military equipments. Comparison between Fig. 18 and Fig. 5 suggests that in 1972-80 after the first turning point, household consumption was the kick-starter and in 1983-85 government consumption was so after improving its ranking very quickly. It means that household consumption replaced fixed capital formation and established its leading position only with the help of preceding autonomous fiscal expenditures.

Again in 1986-89, the third principal component preceded. It would be almost needless to say that it was caused by an expansion of autonomous household consumption thanks to an economic babble. Comparison agin between Fig. 18 and Fig. 5 suggests that eager household consumption excited by the asset babble stimulated fixed capital formation that led other variables in the period.

Development since 1992 after the babble miserably collapsed is quite intriguing. The second principal component, i.e. surplus capital, preceded others from 1992 to 1996, which precisely corresponded to the leading status of trade balance in the period. The third principal component later replaced the second principal component, but its content was rather different from before: relative surge of sticky household consumption to a literal breakdown of fixed capital formation and a global recession. The situation continued until 2005 and then, the second principal component began to precede again, which perfectly corresponded to the leading status of trade balance. It follows that behind the leading status of trade surplus, two distinct forces functioned, i.e. an expansion of surplus capital and a collapse of investment in plants and equipments.

Another interesting point on which orbit analysis of principal components sheds light is the fact that the first principal component, i.e. the dominant cycle of the Japanese capitalism, has been almost always near the lowest rank of all: it lagged and changed after all the other cycles. It would imply that although the first principal component with the dominant proportion 71.4% was actually the main pillar of the economy, it had never been a cycle that preceded and created changes but rather, lagged and was changed by others.

4. Orbit analysis of variables and principal components: extraction of causality

As already attempted partially in orbit analysis of principal components, we here conduct orbit analysis of variables and principal components together, which allows us to analyze sequential influences of principal components on each variable. See “Fig. 19: 9-year moving average of ranking points for Japan's fixed capital formation and four principal components”, “Fig. 20: 9-year moving average of ranking points for Japan's household consumption and four principal components”, “Fig. 21: 9-year moving average of ranking points for Japan's trade balance and four principal components”, “Fig. 22: 9-year moving average of ranking points for Japan's government consumption and four principal components”, “Fig. 23: 9-year moving average of ranking points for Japan's GDP (four expenditures) and four principal components” and “Fig. 24: Standard deviation”.

Comparison between Fig. 5 and all variables in Fig. 23 reveals that there may be some slight discrepancies from year to year in ranks of leading-following relations: for example in 1988, fixed capital formation was the kick-starter in Fig. 5, but in Fig. 23 government consumption still kept the status of the kick-starter. Although orbit analysis has a property that a choice of some variables out of all does not alter the ranks among them, moving average of ranking points for many periods, in our case

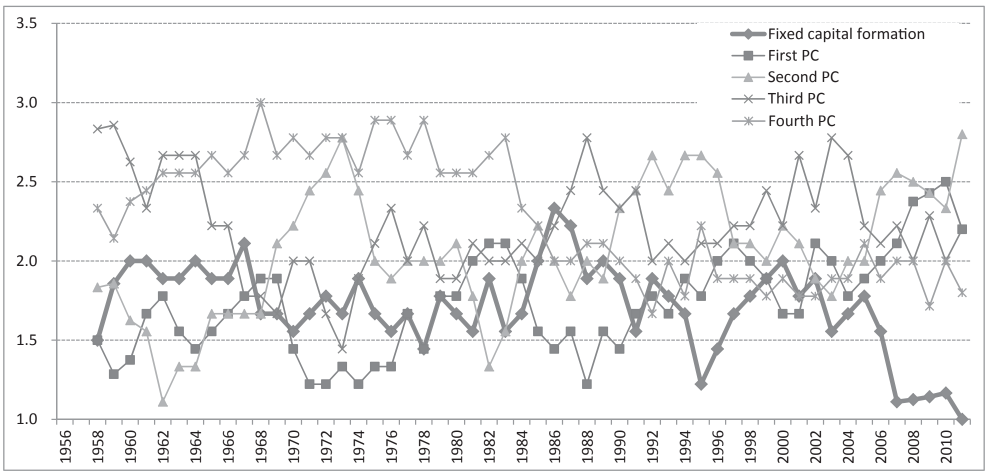


Fig. 19: 9-year moving average of ranking points for Japan's fixed capital formation and four principal components

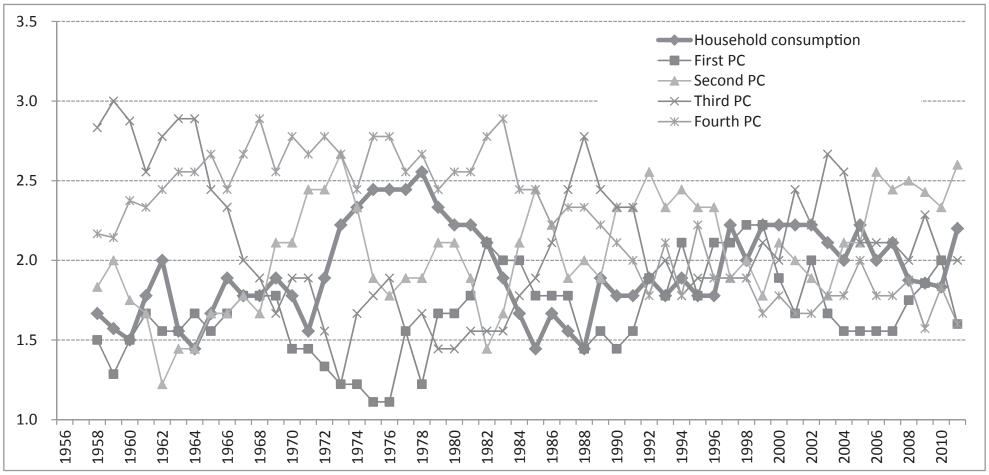


Fig. 20: 9-year moving average of ranking points for Japan's household consumption and four principal components

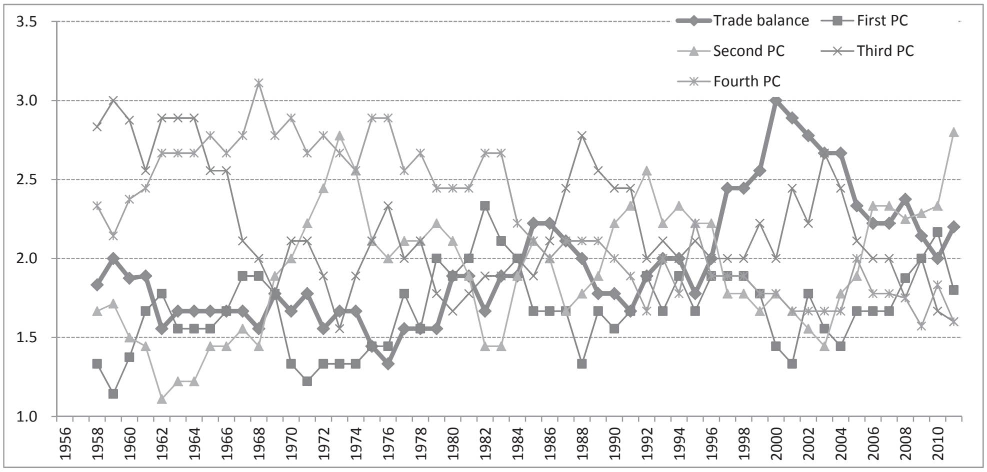


Fig. 21: 9-year moving average of ranking points for Japan's trade balance and four principal components

nine years, may sometimes lead to temporary loss of the property. We should be careful enough about that especially when conducting an analysis of a specific period.

Let us first make it clear how to read results of orbit analysis of variables and principal components together. As in the matrix of multiple regression coefficients in Table 7, the variables and principal components are in the relations of mutual determination: the columns represent the relations in which fixed capital formation and other variables determine the first and other principal components; and the rows represent the relations in which the first and other principal components determine fixed capital formation and other

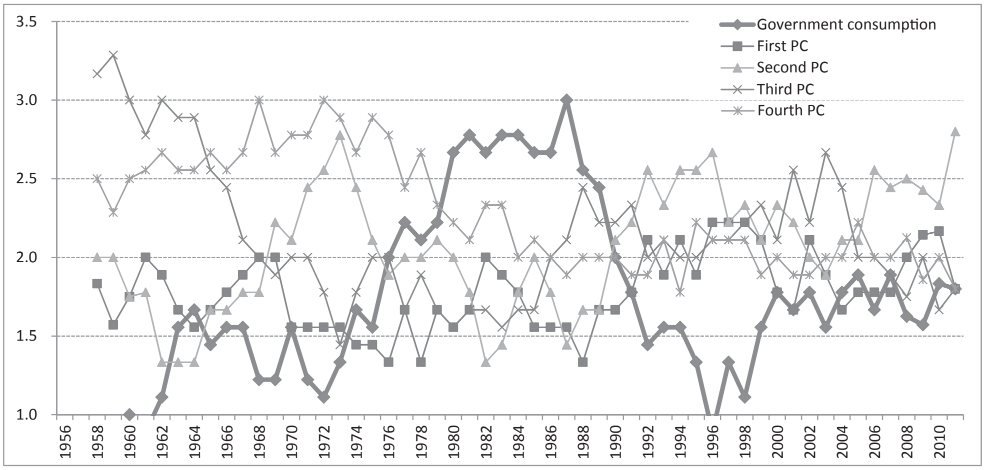


Fig. 22: 9-year moving average of ranking points for Japan's government consumption and four principal components

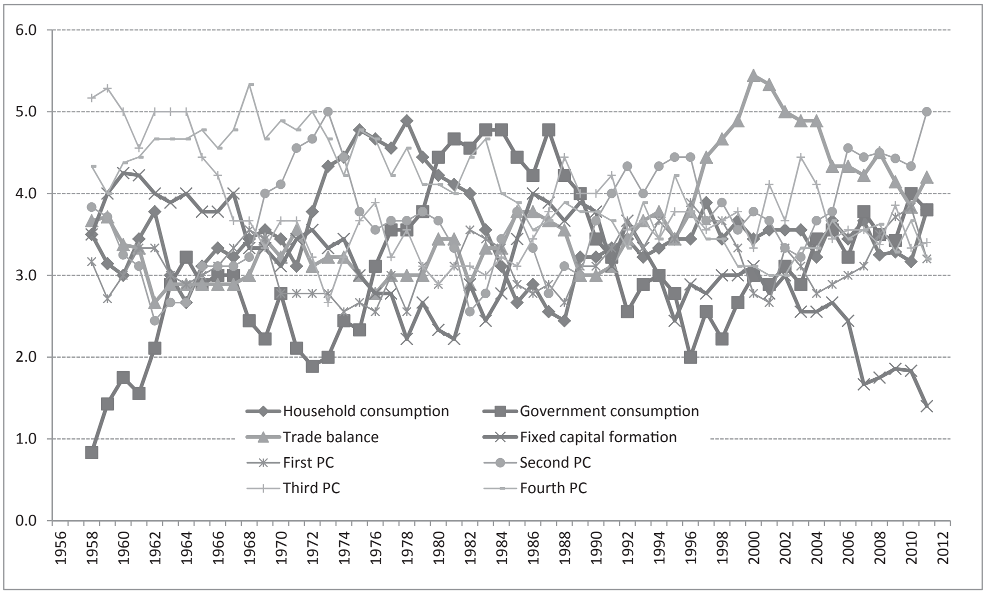


Fig. 23: 9-year moving average of ranking points for Japan's GDP (four expenditures) and four principal components

variables. Now we know in Fig. 19 that, basically speaking, those four principal components scatter above or below the bold line of fixed capital formation. Let all the variables and principal components be divided into those "above the line" and "below the line": those principal components above the line of fixed capital formation lead its variations; and other principal components below it are led by its variations.

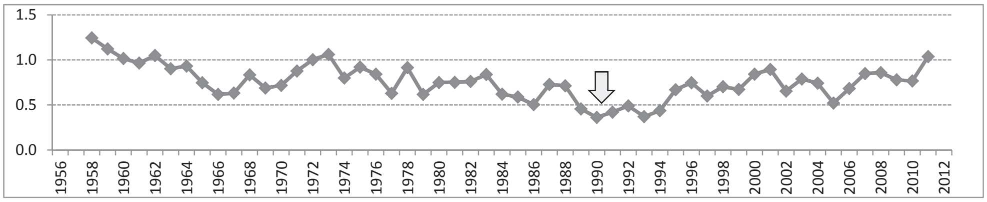


Fig. 24: Standard deviation

Here again, we should refer to "VII. Conceptual framework of orbit analysis", Itaki (2014) for conceptual distinction between leading-following relations and preceding-lagging relations. Those principal components above the line lead variations of fixed capital formation, but do not precede them; by the same token, those below the line are led by variations of fixed capital formation, but do not necessarily lag them. This is because fixed capital formation is included both as an element of the principal components above the line and below the line. From this point of view, variations of fixed capital formation should temporally precede all variations of the principal components because of the mutual determination between all variables and principal components. Therefore, we would be in a complete contradiction if we assumed that fixed capital formation and the principal components were in temporal preceding-lagging relations.

> In orbit analysis, the unit of our observation and analysis is one period: coordinates of two variables at the beginning and end of one period and those of the next period, i.e. three coordinates altogether, are observed and compared in order to determine leading-following relations between them. We could not observe preceding-lagging relations, their reversal or further reversals that actually happened or might have happened within that unit period. However short one period might be, it would be impossible in principle. What is observable is leading-following relations that express themselves *as if* being preceding-lagging relations as a result of complicated actions and reactions (i.e. positive and negative feedbacks) between two variables within one period. We understand it to be necessity that one variable is extracted as a leading variable and the other as a following variable out of complicated quantitative pulling-being pulled relations between them, rather than simple preceding-lagging relations in time.

More essential substances or forces of the original variables in Fig. 18 conceal themselves behind their superficial leading-following relations in Fig. 5. Fixed capital formation, for example, being inserted into the structure of mutually independent principal components, those above the line can be regarded as *causes* of quantitative variations of fixed capital formation according to their leading-following relations; by contrast, variations of those below the line can be regarded as being caused partly by quantitative variations of fixed capital formation according to similar leading-following relations.

More concretely speaking in Fig. 5 and Fig. 23, in the midst of the fast economic growth, 1962, the third and fourth principal components are above the line of fixed capital formation: an autonomous increase in fervent household consumption and government consumption at that time promoted fixed capital formation. It is followed by household consumption, which contains not only the autonomous household consumption but also that synchronizing with fixed capital formation, trade balance and government consumption, i.e. all the four types of household consumption. And the first principal component comes next: the main pillar of the Japanese capitalism begins to move as a result of being promoted by variations of fixed capital formation and household consumption. The third, fourth and first principal components, and fixed capital formation and household consumption altogether urge the movements of trade balance, which is sequentially followed by the second principal component and government consumption.

Orbit analysis of variables and principal components reveals transfer mechanism of variations among them. Temporal preceding-lagging relations among principal components turn into leading-following relations by inserting variables that intermediate all the principal components. The transfer mechanism can answer the question of why and how certain leading-following relations occur among variables, which we cannot answer only by looking at Fig. 5.

How, then, can we understand the situation in which a certain variable becomes the kick-starter with all principle components below the line? In 1986, for example, in Fig. 19, the dependent variable comes prior to all the principal components. The "conundrum" can be solved by properly situating variables and principal components in the continuous time line: the variations of fixed capital formation as the kick-starter in 1986 were ignited by the principal components in 1985 below the line. A similar continuous mechanism functions in the case in which a certain variable continues to be the kick-starter for many years. That is exactly what G. Hegel called reciprocal actions (Wechselwirkung) *over periods* in which causes become results and results become causes (Hegel [1817], 154, p.230.). Note that the principal components below the line in 1985 are in temporal preceding relations as well as leading relations to fixed capital formation as the kick-starter in 1986.

We regard principal components above the line of a certain variable as its "causes" that ignite its quantitative variations according to leading-following relations. In other words, we presume the establishment of "causality" between principal components and variables. The causality here is different from "the Granger causality" that was discussed in "VIII. Leading-following relations and the Granger causality", Itaki (2014). According to him, two conditions must be satisfied for causality to be established (Granger (2003)):

1. The cause occurs before the effect, and
2. The cause contains information about the effect that is unique, and is in no other variable.

No doubt that the first condition is temporal preceding-lagging relations, but it is impossible in principle to measure.

Suppose that variations of variable X_1 were observed in some year and that those of variable X_2 were observed in the next year: X_1 preceded X_2. However, it may be true that despite the fact that X_2 actually preceded X_1 in January of the first year, X_1 moved remarkably after February and thus, at the end of the year X_1 was recorded as preceding X_2. Now in order to refine our observation, we conduct monthly, rather than yearly, observations. Suppose that variations of X_1 were observed in January and that those of X_2 were observed in February: X_1 preceded X_2. However, it may be true that despite the fact that X_2 actually preceded X_1 on the first day of the month, X_1 moved remarkably on the second day onwards and thus, at the end of the month X_1 was recorded as preceding X_2. Now in order to refine our observation furthermore, we could conduct daily, rather than monthly, observations. Shorten the unit of our observation further and furthermore, we will finally reach the limit of the observation, i.e. "the minimum period of observation". Even in the minimum unit period, orbit analysis allows us to calculate seemingly consistent "preceding-lagging ranks". We could not deny a suspicion, however, that in a bit shorter period X_2 might have preceded X_1. In a word, temporal preceding-lagging relations are impossible to measure in the strict sense.

What we can observe are only leading-following relations between variables X_1 and X_2, in which complicated actions and reactions between them appear as if being temporal preceding-lagging relations and so recorded. And an actual period of observation is a multiple of the minimum unit, through which those complicated interactions develop. Therefore, *through the whole period*, causes turn into results and results turn into causes, i.e. Hegel's reciprocal actions, beyond the dogma "the cause occurs before the effect".

Hence, our causality is not "the Granger causality"; it is rather causality based on Hegel's reciprocal actions. We define it as leading-following relations between principal components and variables against the background of variables' complicated interactions, which appear as if being temporal preceding-lagging relations. The definition includes "the Granger causality" as a semblance: although it is never "the Granger causality" in the temporal terms, it has to appear as if it were. In addition, "the Granger causality" perceives it between original variables but, our causality is between principal components and variables.

We confine our analytical period to 1992-2011 in "Fig. 25: 9-year moving average of ranking points (1992-2011)" so as to concretely exemplify transfer mechanism of changes by means of orbit analysis of all variables and principal components. Fig. 24 reveals that the turning point of leading-following relations came in 1990 for Japanese economy, exactly when an economic babble collapsed. New ranking relations appear in 1992 in the aftermath of the collapse and give us some clues to predict the future of Japanese economy.

The period 1992-97 is characterized by the second principal component, i.e. the cycle of surplus capital, as the kick-starter to all variables and principal components. The impact first goes through the fourth and other principal components and is reflected on variations of trade balance (i.e. trade surplus), followed by other variables. It is the beginning of a new unprecedented era in which the whole economic forces promote the creation of surplus capital, which drives trade balance and makes the leadership of fixed capital formation in the bubble period crumble down.

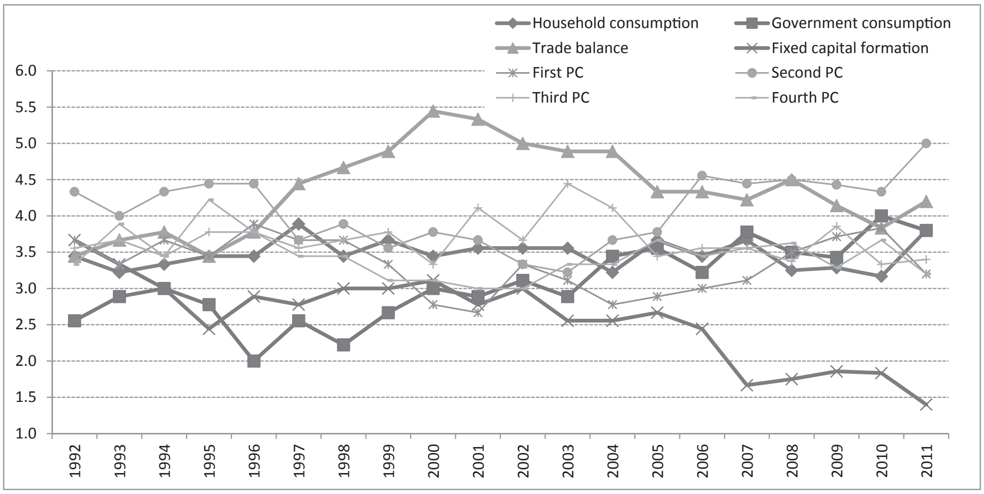


Fig. 25: 9-year moving average of ranking points (1992-2011)

The period 1997-2005, the central part of the whole period, is a rather peculiar time in the post-Second World War era, which is characterized by the overwhelming leadership of trade balance. Trade balance is followed by the second and third principal components alternately, which are further followed by other principal components and variables. At the end of the period, the lowest rank of fixed capital formation has been confirmed and then, it begins to literally crash to the ground.

The question is how to understand such leadership of trade balance. The possibility of a certain variable being the kick-starter was discussed before: it is because variations of the variable are ignited by the principal components below the line in the previous period. That holds true for trade balance for nine years from 1997 to 2005. Thus, the question should be how to distinguish between 1992-97 in which the second principal component drives trade balance (i.e. trade surplus) and 1997-2005 in which all the principal components in the previous year drive trade balance (i.e. trade surplus). It can be explained as follows:

Trade balance is determined not only by the second principal component, i.e. the cycle of surplus capital, but also by the first principal component, i.e. the pillar cycle of Japanese economy, the third principal component, i.e. the cycle of extraordinary situations and the fourth principal component, i.e. the cycle of autonomous fiscal expenditures. All of those cycles or forces move trade balance in a very complicated manner. Trade balance in 1992-97 immediately after the collapse of the economic babble remained as trade surplus that were generated simply by domestic surplus capital. By contrast, from 1997/98 of a financial crisis to 2005, trade surplus in the next year was determined by the whole economic situations in the previous year in the domestic and international economy in addition to surplus capital, such as general stagnation of fixed capital formation and household consumption, and the boom and bust of the IT babble in the world economy as a whole. Those conditions pushed up trade balance to the status of the kick-starter to all variables and principal components again and again for nine years.

Again in 2006-11 the second principal component returned back to the kick-starter. It led trade balance, followed by other variables and principal components with fixed capital formation fluctuating at the bottom. As it were, the purified pattern of 1992-97 seems to reappear, but that is just a disguise. It is declining, rather than expanding, surplus capital that has been leading the whole economic system since 2006: it has promptly promoted shrinkage of trade surplus and Japanese economy as a whole and led to further deterioration of fixed capital formation. Such a downward spiral forced surplus capital to shrink furthermore in the next year.

Against the background of enormous ups and downs of variables and principal components before and after the subprime bubble and the Lehman shock, Japanese economy as a whole has been undergoing such a declining process. That may give it a new turning point of industrial hollowing-out: it had been a decrease in the flow of fixed capital formation and loss of its initiative; but now, as a very result of that, shrinkage in quantity and quality of stock of fixed capital began to prevail. Japanese economy faces an unprecedented situation in which it can no longer throw up surplus capital into the world economy. This seems to be the essential cause of recent trade deficit. Therefore, taking into account the dry-up of surplus capital, Japan's trade deficit is expected to be a long-term irreversible phenomenon.

On the other hand after the East Japan Great Earthquake in 2011, fixed capital formation showed a slight recovery in the absolute terms in 2012. And there is a sign of improvement in the first principal component, the main pillar of Japanese economy. We should keep a very careful eye on developments in the future of the Japanese capitalism that has relied solely on surplus capital and trade surplus since 1990.

Notes

1) As for author's understanding of dialectics, see Itaki (2002a, b, c) and (2003a, b).

2) "This true and positive significance (expressed generally) is that everything actual contains opposed determinations within it, and in consequence the cognition and more exactly, the comprehension of an object amounts precisely to our becoming conscious of it as a concrete unity of opposed determinations." (Hegel [1817], 48, p.93.)

3) Strictly speaking, GDP is constituted by those four aggregates plus change in inventory. However, we here ignore it for the sake of simplicity.

4) Here we omit changes in inventory as a GDP aggregate for the sake of simplicity. This is why the intercept for GDP is not zero, i.e. 128,061, and its determination coefficient is not 1.000, i.e.0.979.

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（要旨については前号を御参照ください）