

Career Checkup Analysis Using Selective Multigroup Principal

Component and Ridge Regressions

Sho Kawasaki, Genso Watanabe, Takenori Takahashi (Mejiro University, Japan)

Abstract: The career checkup developed by the Ministry of Health, Labor and Welfare promises to be useful as a diagnostic tool to objectively understand, to the extent possible, the current situation and challenges in human resources development from the standpoint of how best to aid career development within companies. The study has a two-fold purpose. The first is to analyze data from the career checkup using the quantitative and mathematical methodologies of selective multigroup principal component and ridge regressions to determine the optimal form of career development assistance to influence employees' awareness of their occupations. The second is to compare analytic results with ridge estimates in order to verify the applicability of selective multigroup principal component regression, and based on an understanding of the characteristics of these methodologies, to propose career development assistance policies from the analytical results.

Key words: selective multigroup principal component; ridge regressions; career development; career checkup

JEL code: L2

1. Introduction

1.1 Background

In the 1990s, autonomous careers of employees began to be noted even in Japanese companies. However, in recent years after the long economic downturn of the 1990s, employee employability began being sought even in Japan. Beginning in the 2000s, a noticeable movement has been observed among major corporations, researchers, the national government, and the overall society to promote career formation as a part of one's work life. The Ministry of Health, Labour and Welfare began developing the "career checkup" project in 2011.

The diagnosis of career checkups generally focuses on deviations from the average research results to understand perception gaps between employees and companies in regard to careers. The purpose is to analyze and examine the differences in perception between employees and companies regarding current and future situations as well as the deviation in average scores inside and outside a company, thereby leading to further steps. The results of the diagnosis can be used to identify approaches to supporting employees' career development based on the current organizational circumstances of the company being diagnosed.

Sho Kawasaki, Ph.D. Candidate, Mejiro University; research areas/interests: human resource management. E-mail: sho-kawasaki@od.matrix.jp.

Genso Watanabe, Professor, Mejiro University; research areas/interests: mathematical statistics. E-mail: cho@mejiro.ac.jp. Takenori Takahashi, Professor, Mejiro University; research areas/interests: quality management. E-mail: takenori@mejiro.ac.jp.

However, devising specific measures to improve employees' perceptions of their jobs such as proactive efforts or job motivation requires more detailed analysis than merely comparing mean values obtained from a general diagnosis. This study analyzes "career checkup sheets", a diagnostic tool for career checkups, using the quantitative methodologies of selective multigroup principal component and ridge regressions to consider career support approaches that influence employees' perceptions of their jobs.

1.2 Prior Research

1.2.1 Relationship between the Organization and Individual in Career Theory

Theories regarding "careers" were first seen in the U.S. in the early 1950s. In his book *Career Dynamics*, Schein (1978) described the relationship between the organization and individual as one in which the organization depends on the individual to carry out his role, and the individual depends on the organization to provide work and career opportunities. In this book, Schein studies the harmonization process between the organization and individual from the perspective of career development, arguing that both organization and individual benefit when the harmonization process functions optimally.

Later, after the U.S. recession of the late 1980s, a series of concepts was proposed, beginning around 1990, that included boundaryless and protean careers and career self-reliance. Waterman (1994) posits a state of affairs in which the organization supports employees' exercise of career autonomy within the organization. This idea spread to become especially popular among smaller startups in the U.S., primarily those located in Silicon Valley with its rapidly changing labor environment.

In Japan as well, the concepts of "career autonomy" and "autonomous careers" within the firm took root against a background of changes in the management and labor climates. With the prolonged recession that began in the 1990s, the business climate changed in a variety of ways, including globalization of the economy, intensified competition resulting from technological advances, and maturation of markets. It thus became more difficult for Japanese firms facing these conditions to guarantee long-term employment to their workers. Beginning at approximately the same time, more companies began incorporating into their human resources policies results-oriented ideas of assessing and rewarding individual workers' short-term performance. Such traditional Japanese employment practices as lifetime employment and the seniority system became a thing of the past, and the focus shifted to the nature of the new relationship between the corporate organization and individual employee.

Much of the research being conducted in modern career theory concerns career autonomy and boundaryless careers that transcend organizational confines. This symbolizes the fact that we have entered an era in which society and the individual can be directly connected, rather than having an organization serving as an intermediary between society and the individual (Suzuki, 2002). In other words, this is an era in which the individual transcends the organization, with the relationship between organization and individual shifting from a "relationship of dependence", as Schein expressed, to a "relationship of autonomy". The early 2000s, with times thus changing, saw the beginning of empirical research on career formation support at large enterprises and government assistance in this regard. Subsequently, the Ministry of Health, Labor and Welfare took the lead in developing the "career checkup", aiming for a symbiotic relationship between corporate organization and individual employee as a way to promote initiatives supporting autonomous career development, particularly at small- and medium-sized enterprises.

1.2.2 Career Checkup Objectives and Diagnosis

The career checkup developed by the Ministry of Health, Labor and Welfare promises to be useful as a

diagnostic tool to objectively understand, to the extent possible, the current situation and challenges in human resources development from the standpoint of how best to aid career development within companies. The Ministry of Health, Labor and Welfare began developing a specific methodology for this career checkup in fiscal 2008. Subsequent enhancements to the methodology following phased-in implementation at model companies brought us to where we are now. In fiscal 2010, a "career checkup manual" was written that summarizes the points to be considered in implementation, including how to interpret the Diagnostic Results Report.

According to this career checkup manual, the general procedure is to conduct a survey of the company and the employees using the career checkup sheet, interview executives and human resource managers, and offer counseling to employees individually or in groups. Based on the outcome of these steps, career consultants provide proposals and advice to the company (human resource managers and others) regarding how they can support employees' career development. This career checkup process leads to an understanding of gaps in the perceptions of employees and company and helps to resolve any challenges or problems that may exist, the objective being to build a symbiotic growth relationship whereby the company and its employees can grow together.

The career checkup diagnostic results report covers four areas: (1) the distribution of employees by level of career awareness, (2) perception gaps between the company and employees concerning functions of career development support that the company should conduct, (3) differences in satisfaction with the status quo between groups with high and low levels of career awareness, and (4) employees' current degree of satisfaction with the company's assistance in career formation and areas in which they would like to see improvement. The results are summarized in graphs and tables so that they can be easily understood. Since the information is compiled and analyzed from actual employee responses, it can be considered an objective representation of the actual situation regarding careers at the company being diagnosed. Because employee awareness, an internal feeling, is numerically expressed, the diagnostic results are highly persuasive to the company, providing the company with an objective basis for its initiatives in supporting career development.

However, these metrics are shown as descriptive statistics and stop at being perceptions of current circumstances. This study analyzes data obtained from career checkups using selective multigroup principal component and ridge regressions and offers specific proposals based on the results of the analysis.

1.2.3 Selective Multigroup Principal Component Regression

Principal component regression (Figure 1) enables us to examine surveys with many questions, such as those with multiple groups having high correlation among independent variables. In analyzing surveys with many questions, the existence of multiple cases with high correlation among questions is not uncommon. Hence, the essential principal component data are extracted from groups with high correlation, and multiple regression analysis is conducted with its summarized principal components and target variable Y. However, principal component regression analysis involves the following problems.

(1) The principal components of candidates for explanatory variables do not always describe the target variable because the summary is conducted only on candidates for explanatory variables that are independent of the target variable, while those that describe the target variable well are mixed with the ones that do not describe the target variable well.

(2) In some cases, the lower level of the principal component is selected instead of the upper level. Aspects that do not describe the target variable well are included as candidate explanatory variables, and if they make up the majority, then the principal component of the upper level cannot explain the target variable. When a survey



contains many questions, there is also the risk of potential problems.

Figure 1 Models and Procedures of Selective Multigroup Principal Component Regression Analysis

Therefore, candidate explanatory variables with a high correlation to the target variable should be selected in advance, the principal components should be determined from candidate explanatory variables after selection, and multiple regression analysis should be performed. This is referred to as selective principal component regression analysis, and the conventional method is referred to as nonselective multiple regression analysis. When conducting a principal component regression analysis, the variance inflation factor (VIF) is checked. If it is below 2.0, we can infer that the independence of the principal component is comparatively maintained, and therefore it is applied. Using selective regression from the results can also be connected to the proposals. If the VIF is greater than 2.0, other approaches are considered. When the VIF is above 2.0, and we want to confirm the effect including the relationship between the selected primary components, principal component path analysis is performed. When interpretation is still difficult, a stronger correlation exists among principal components, and latent variables are considered to exist behind the primary component, then the model is built by taking account of the effect of latent variables, and principal component structural equation modeling (SEM) is considered.

1.2.4 Ridge Regression

Ridge regression, a methodology proposed by Hoerl and Kennard (1970), is considered to have better predictive accuracy than principal component regression or partial least square regression. Ridge regression attempts to avoid multicollinearity by adding a constant to the covariance matrix of the explanatory variables (Sawa, 1979), but it is used mostly for numerical analysis, and there is almost no practical research on the topic.

Ridge regression offers an alternative estimation methodology for cases in which the explanatory variables are on the same straight line. Prediction models require clarity of interpretation, ease of design, and small the mean squared error (MSE) values. To verify the effectiveness of selective multigroup principal component regression, we compare it to ridge regression, giving particular attention to the contribution ratio and MSE.

Recent questionnaire surveys such as the career checkup sheet pose an increasing number of questions that are highly correlated. This study explains how selective multigroup principal component regression is effective in analyzing and formulating proposals in such cases. We compare and review the effectiveness of selective multigroup principal component regression using ridge trace, Euclidean norms, total variance, and residual sum of squares in addition to MSE.

1.3 Objectives and Significance of the Study

The purpose of this study is twofold. The first is to analyze the data from the career checkup using the quantitative and mathematical methodologies of selective multigroup principal component and ridge regressions to determine the optimal means for career development assistance in order to influence employees' awareness of their occupations. The second is to compare analytic results with ridge estimates to verify the applicability of selective multigroup principal component regression, and based on an understanding of the characteristics of these methodologies, propose career development assistance policies from the analytic results.

While previous career research focused on qualitative and case studies involving employees' psychological processes, our discussion is based on quantitative and mathematical methodologies. Consequently, our research is significant in that the quantitative data enable us to formulate concrete proposals that will be useful in actual business practice.

2. Survey

2.1 Questionnaire

The career checkup is a multigroup questionnaire-style survey that comprises strongly correlated multiple questions for each group. The survey contains 38 analytic items, summarized in Tables 1 and 2.

Area	Group	Concept of the question items	Number of questions
1	А	Setting career goals	5 questions
2	В	Career assistance	5 questions
3	С	Support workspace awareness	4 questions
4	D	Career autonomy	3 questions
5	Е	Discretion working	3 questions

 Table 1
 Questions about Career Development Assistance of the Company

Table 2	Questions abou	t the Awareness	and Action	n on the (Carrier of	f the I	Emplo	yee
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Area	Group	Concept of the question items	Number of questions
1	Y	Duty consciousness	2 questions
2	F	Degree of self-awareness	8 questions
3	G	Future career image	8 questions
4	Н	Efforts towards the current and future	9 questions
5	Ι	Health of body and mind	9 questions
6	J	Work-life-balance	7 questions

The questions concerning career development assistance on the part of the company (Table 1) cover five areas (A–E), with a total of 20 questions. These questions ask respondents to choose which of the following five levels best describe their opinions regarding the current situation in the organization: (1) dissatisfied, (2) somewhat dissatisfied, (3) not sure, (4) somewhat satisfied, and (5) satisfied. In addition, to learn about corporate

initiatives as well as employees' perceptions and behavior concerning company career development support, the survey has six groups of questions regarding employees' perceptions, attitudes, and behaviors vis-a-vis their jobs and lives (Table 2). We set "job perception" as the response variable, calling that Group Y, and from the explanatory variable areas we analyzed Groups H and J. These questions, a total of 18, asked respondents to choose among five levels: (1) applicable, (2) somewhat applicable, (3) not sure, (4) not very applicable, and (5) not applicable.

2.2 Overview of Cases

The survey was conducted in November 2011 with the cooperation of Company A, a small business, using the company diagnostic sheet (for employees), one of the career checkup sheets. The breakdown of the 72 respondents was as follows. By gender, 30 were male (41.7%) and 42 were female (58.3%). By age, 35 were in their 20s (48.6%) and 37 were in their 30s or older (51.4%). By job classification or employment type, nine were managers (12.5%), 32 were regular employees (44.4%), and 31 were part-time employees (43.1%).

Since the proportion of part-time (nonregular) employees at Company A was more than 40% at that time, we excluded from our analysis the question in the job perception section asking whether respondents believed their current job to be extremely important. We also excluded from the 72 respondents any who omitted even one question, with the result that the number of responses analyzed was 70.

Since Company A, the target of this study, had a mix of part-timers who had been with the company for a few months, and regular employees who had been with the company for three or more years, it is conceivable that there were differences in their knowledge of themselves and their future career paths. We therefore classified career path awareness into several tiers by calculating the average of all items regarding career path in Groups F and G in the career checkup and placing those with values under 3.50 in the low tier, those between 3.50 and 4.0 in the middle tier, and those with values 4.0 and above in the high tier. This study focused on the high tier of career path awareness.

Table 3 shows the breakdown of respondents by tier. Company A had 26 people in the high tier of career path awareness. This tier primarily consisted of employees who knew the areas of work in which they excelled, had clear objectives for the future, and were therefore most likely to perform their job duties proactively with a sense of purpose. We chose this tier as the first target of our analysis, since these employees are the ones who can be expected to work hardest and contribute the most.

Face sheet	Total		Sex	ex Age			Employment classification		
items Hierarchy	N (%)	Male	Female	20's	30's over	Managers	Regular employee	Part-time employee	
Total	70	29	41	35	35	8	32	30	
	(100.0)	(41.4)	(58.6)	(50.0)	(50.0)	(11.4)	(45.7)	(42.9)	
Law	15	7	8	10	5	1	5	9	
LOW	(100.0)	(46.7)	(53.3)	(66.7)	(33.3)	(6.7)	(33.3)	(60.0)	
Middle	29	13	16	13	16	6	13	13	
	(100.0)	(44.8)	(55.2)	(44.8)	(55.2)	(20.7)	(44.8)	(34.5)	
High	26	9	17	12	14	1	14	11	
	(100.0)	(34.6)	(65.4)	(46.2)	(53.8)	(3.8)	(53.8)	(42.3)	

Table 3 Respondents Breakdown by the Hierarchy of the Career Self-concept

3. Analysis

3.1 Selective Multigroup Principal Component Regression

3.1.1 Analysis Model and Procedure

First, to set the target variable Y, principal component analysis was conducted on the two items of "duty consciousness". As a result, we found that the principal component accounts for 61.6%. In addition, the eigenvalues that exceed 1.0 involve only the first principal component, and even from the viewpoint of items that we want to set to Y in this study, we can infer that it is appropriate to select the first principal component ZY1 (duty consciousness). Therefore, this study advances the discussion by focusing on the first principal component.

Next, ZY1, which was set as the target variable, is checked for correlation with each question item, and those with a correlation coefficient with X and Y of 0.3 (contribution ratio of 0.09) or higher are selected and subjected to principal component analysis. There is nothing absolute in the selection criteria at this point, and as a first attempt, a contribution ratio of 0.09 (impact of 10% or higher) was consciously selected.

Then, principal component analysis of the selected items for each concept was conducted, and each first principal component (horizontal axis) and second principal component (vertical axis) was selected. Owing to space limitations, shows the interpretation of the principal component analysis results on the axis of the E group (Figure 2). Principal component analysis in other groups was performed using selective multigroup principal component regression analysis using the results.



Figure 2 Principal Component Analysis Results on the Axis of the E Group

3.1.2 Results of Selective Multigroup Principal Component Regression Analysis

We conducted a principal component regression analysis using ZY1 as the response variable and the principal components extracted from the selected questions as explanatory variables. We found that R-squared was 0.65 and adjusted R-squared was 0.59, indicating that the model fit relatively well. Table 4 shows the results of selecting variables using stepwise regression (with the criteria for both selection and elimination set at 0.25) and eliminating those with absolute t-value of less than 1.50.

Summary of fit						
RSquare	0.653635					
Rsquare adj	0.58766					
Root mean square error	0.712658					
Mean of response	-6.90E-16					
Observations (or Sum Wgts)	2.60E+01					
Analysis of variance						
Source	DF	Sum of squares	Mean square	F ratio		
Model	4	20.127139	5.03178	9.9074		
Error	21	10.665505	0.50788	Prob > F		
C. total	25	30.792645		0.0001		
Parameter estimates						
Term	Estimate	Std error	t Ratio	Prob > t	Std Beta	VIF
Intercept	2.39E-16	0.139764	0.00	1.0000	0	
ZE1	0.2616222	0.125162	2.09	0.0489	0.290526	1.17126
ZE2	0.3609186	0.216566	1.67	0.1105	0.225566	1.1106997
ZH1	0.331117	0.161796	2.05	0.0534	0.298351	1.2885808
ZJ1	0.545011	0.176755	3.08	0.0056	0.491079	1.5378748

Table 4 Results of Selective Multigroup Principal Component Regression Analysis

Each VIF is under 2.0, confirming that independence among the selected principal components has been maintained. We therefore examine the estimates and consider quantitative proposals based on the analysis results.

3.1.3 Examining Key Questions on the Vector

If the following suggestions are implemented, the results of principal component regression analysis will focus on standard partial regression coefficients with large absolute values. If a vector is created using the values of the standard partial regression coefficient, the "upper margin" and "lower margin" will examine "positive" and "negative", respectively. In addition, we can then check the sign of the vector and perhaps perform pattern classification and consider initiatives.

However, even when the absolute value of the standard partial regression coefficient is small and the absolute value of the standard partial regression coefficient is large, after recognizing the meaning of these questions, in some cases, you might intentionally choose to do nothing. Even in the case in which nothing is done, the situation can be divided into the following three patterns and examined. The first pattern, when it can be determined that it is better to maintain the status quo, is a case in which you would "watch", but do nothing. The second pattern is a case in which you would remain neutral and do nothing in the sense of "watchful waiting". With the third pattern, improvement is desired, but it can be assumed that attempting to do so is likely to have the opposite effect; hence, it is a case in which you would choose "acceptance" and do nothing.

3.2 Comparison of Analytic Results from Selective Multigroup Principal Component and Ridge Regressions

We also conducted a ridge regression analysis and compared the results with those of the selective multigroup principal component regression. Table 5 summarizes the results of three other analyses applied to the same case. From these results, we can confirm that selective multigroup principal component regression is an effective method for analyzing this case.

- (1) Results of multiple regression analysis with all items without using variable selection.
- (2) Results of multiple regression analysis with variable selection.
- (3) Results of principal component regression. Here, we did not classify these 10 items into groups.
- (4) Results of multigroup principal component regression. This has the characteristic of enabling us to avoid

the VIF problem for multigroup question sheets containing many highly correlated questions and offer proposals based on the analysis results.

Table 5 Comparison of Anarytical Methods								
Methods	R*^2	VIF in many cases	[A] MSE [unbiased variance]	[B] Upper: MSE by Ridge Lower: (k-value)	[A]/[B] Ratio of MSE			
(1) Multiple regression analysis with all items without using variable selection	0.45	Not good	1.307 [1.53]	0.429 (8.771)	3.05			
(2) Multiple regression analysis with variable selection	0.60	Not so good	0.118 [1.164]	0.087 (5.272)	1.36			
(3) Conventional principal component regression	0.56	Very good	0.855 [0.63]	0.362 (2.867)	2.36			
(4) Selective multigroup principal component regression	0.59	Good	0.115 [0.485]	0.098 (1.405)	1.17			

Table 5 Comparison of Analytical Methods

4. Discussion and Proposals

4.1 Effectiveness of Selective Multigroup Principal Component Regression Analysis

As shown in Table 5 in Section 3.2, for multiple regression analysis using all items, the value of [A] MSE is 1.307, and the value of [B] MSE using ridge is 0.429 (upper). These values are worse than those for any other analytic methodology. In contrast, in the results for (4) selective multigroup principal component regression, the value of [A] MSE is 0.115, the best of all. Comparing the [MSE] in (1) and (4), the method yields more than 10 items. Even comparing [B] MSE in (1), which contains the ridge times of [A], with the [A] MSE in (4) yields a difference of more than three times.

Next, looking at the difference between the value of (4) [A] MSE and [B] MSE (upper) using ridge, we get [A] at 0.115 and [B] at 0.098, with almost no difference. Therefore, in the case of (4), we conclude that the analytic results are more reliable. Table 6 shows the results under other criteria. In the case of also (4) in this table, reliable results were obtained. These results confirm that selective multigroup principal component regression is an effective method of analysis for this case.

Methods		Total	Residual sum of	Coefficient of
Methods	norm	variances	squares error	determination
Multiple regression analysis with all items without using variable	0.696	1.307	24.472	0.205
selection				
(1) Ridge regression ($k = 8.771$)	0.372	0.300	24.600	0.174
Ratio	1.871	4.356	0.995	1.178
Multiple regression analysis with variable selection	0.482	0.118	26.790	0.130
(2) Ridge regression ($k = 5.272$)	0.349	0.069	26.808	0.122
Ratio	1.381	1.710	0.999	1.066
Conventional principal component regression	0.786	0.855	10.080	0.673
(3) Ridge regression ($k = 2.867$)	0.653	0.324	10.118	0.666
Ratio	1.204	2.639	0.996	1.011
Selective multigroup principal component regression	0.778	0.115	10.666	0.654
(4) Ridge regression ($k = 1.405$)	0.726	0.094	10.670	0.652
Ratio	1.072	1.223	1.000	1.003

Table 6 Results under Other Criteria

4.2 Proposal based on Analysis Results

We used a resultant vector, as explained earlier, to derive proposals based on our data. If we examine the results of selective multigroup principal component regression analysis, the focus is on obtaining a large absolute value of the absolute value of the standard partial regression coefficient among the selected principal components. When a vertical line is drawn on that vector, the positions with larger values are variables (question items) that have a significant impact on Y.

Interpreted when two principal components are selected, for creating a composite vector of two vectors, as shown in Figure 3, it is important to ask proper questions regarding the absolute value when it is projected onto the composite shaft. Question E18 asks respondents if they "can select their style of work, including workplaces and work times." This item is likely important as a means of increasing the job awareness of employees. When confirming the univariate distribution for E18, there is really very little margin. We next considered measures for maintaining the current status as well as for raising it based on the results of group E.



Groups J and H were selected for only one item. In the results of the selective multigroup principal component regression, they were selected as items that influenced Y. Question H27 was, "I interact with my colleagues outside of work," and J40 was, "I have friends I can confide in about my troubles." Based on this, we can say that the results revealed that employees with rich human relationships both publicly and privately have high job awareness. Among measures companies can take to support careers, those that improve employee discretion (selection of one's workstyle including workplace and work times) are effective.

We propose three measures for increasing the discretion of employees. First is implementation of a discretionary labor system. This system has no fixed hours of work and enables workers to freely set their own work start and finish times. Company A implemented such a system for higher level professional grade employees in August 2015. The second is flextime implementation. In this system, workers themselves determine the hours when they begin and finish work within a given timeframe. The third is implementation of a work-at-home system. This is a means of allowing workers to work from home as the name implies.

5. Conclusion

The study has a two-fold purpose. The first is to analyze data from the career checkup using the quantitative and mathematical methodologies of selective multigroup principal component and ridge regressions to determine the optimal form of career development assistance to influence employees' awareness of their occupations. The second is to compare analytic results with ridge estimates in order to verify the applicability of selective multigroup principal component regression, and based on an understanding of the characteristics of these methodologies, to propose career development assistance policies from the analytical results.

Future research includes (1) developing a methodology of effect verification after implementation of a discretionary labor system in Company A and (2) comparing with examples from other companies. We intend to increase the number of samples as well as refine and generalize the methodology.

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