An Econometric Model of *Karoshi* and Overtime Work Hours

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Outline

I. Introduction

Little literature on the topic of *karoshi*, or 'death from overwork', have extended beyond discussing the rate of overtime hours and 'workaholic culture' in their attempts to explain the basis of the high rates of *karoshi* and other negative health effects of overwork in Japan. While these factors are certainly fundamental to the problem of *karoshi*, and therefore warrant their rigorous examination, the question that this paper attempts to answer is whether other labor economic variables – for example, starting salaries, firm composition, or unionization rates – are also significant in the study of the economic basis for *karoshi*, and may offer additional insight into possible preventative measures.

The purpose of this paper, therefore, is to build a regression model of *karoshi* rates across different Japanese industries against these other labor economic variables to evaluate their significance and effect. Possible explanations of significant variables and their effect on *karoshi* rates will also be offered based on the results of the regressions.

a. The Problem of *Karoshi*

The problem of *karoshi* in Japan is one that has been gaining both national and international recognition in the past several years. Features have been published across many major international news outlets – including BBC, Reuters, and NBC – since 2015, when the number of recorded *karoshi* cases rose to a record high of 1,456 people in the calendar year. While the term *karoshi* is traceable to the 1970s, following the first reported case in 1969, substantial research by the Ministry of Health, Labor and Welfare of Japan began much later in 1987, while the first white paper report by the ministry on the topic of *karoshi* and preventative measures was published only several years ago, in 2015.

Most publications, including the most recent report by the Japanese Ministry of Labor, cite the disproportionately longer working hours in Japan (especially among male "salarymen") as the main reason for the high rates of *karoshi* incidences. As shown in Figure 1, which compiles data from the 2016 Ministry of Health, Labor and Welfare report "White Paper on Measures to Prevent Overwork Death", the gap between total work hours in Japan and other countries has fallen since the 1990s, possibly due to a transition away from the lifetime employment policy of the postwar period and major revisions in 1988 to the Labor Standards Law, which reduced the length of the statutory workweek and increased the cost to firms of overtime work. However, the percentage of employees working significant overtime hours in Japan remains much higher at 20.8%, compared to 16.4% in the United States, which indicates a subpopulation in Japan that is still afflicted with longer work hours. It should also be noted that these official statistics do not necessarily reflect the true working situation of Japanese workers, because they do not include "service overtime", or unofficial and unpaid overtime work, which is often demanded of Japanese workers at smaller firms, nor any mandated after-hours drinking or socializing, which often applies to Japanese salarymen.

Figure 1: International Comparison of Annual Working Hours and Overtime

	Annual Average Hours Worked			% of Employees Working 50+ Hours per Week (2015)		
	2015	2000	1990	Total	Men	Women
Korea	2071	-	-	32.0%	37.6%	24.5%
Japan	1734	1853	2124	20.8%	29.5%	9.5%
United States	1795	1836	1948	16.4%	21.8%	10.2%
United Kingdom	1663	1680	1953	12.3%	17.8%	6.0%
France	1399	1428	1683	10.1%	14.1%	5.8%
Germany	1304	1360	1598	9.6%	14.1%	4.4%

Finally, It is worth nothing that the problem of *karoshi* is not specific to Japan alone, as other East Asian countries such as Korea have similar or higher working hours and rates of overtime work, and have coined terms for the exact same phenomenon, occurring at high rates in their respective countries as well. Many attribute these long working hours in Japan and other East Asian countries to a "workaholic culture" inherent to Eastern Asian countries, which values face time and dedication above performance (Economist), and discourages leaving before superiors and colleagues (BBC).

To formally validate the connection between *karoshi* and longer working hours, a simple linear OLS model of the rate of *karoshi* incidences across different industries to the rate of employees who work above 60 hours in a given work week (see Figure 2). Data for this model are aggregated from the Health Statistics survey and the 2016 report on *karoshi* conducted by Ministry of Health, Labor and Welfare, and cover industries with the highest rates of *karoshi*, including transportation, construction, finance, and health care.

Figure 2: Linear Regression Model of Karoshi and Overtime Hours

Variable	Estimate	Std. Error	t-value	Pr(>|t|)
constant	0.638	(1.332)	0.479	0.6367
geq_60_hrs	65.535	(14.714)	4.545	0.0002***
Adjusted R^2	0.4502			
# Observations	24			

*** signifies significant to 0.1%
Dependent Variable: karoshi

As anticipated, there is an extremely high level of significance (to the 0.1% level) of the rate of employees with long weekly work hours to the *karoshi* rate in an industry. However, the R^2 value of 0.4502, suggests an omitted variable bias that begs further exploration into explanatory variables beyond rates of overtime work, which is the goal of this paper.

b. Existing Literature

The majority of the existing literature on *karoshi* point to cultural aspects of Japanese society as the primary basis for the longer working hours and *karoshi*. For instance, Tetsuro Kato, in his "The Political Economy of Japanese Karoshi" (1994), states that "the main reason [for *karoshi*] is clearly related to the disproportionally longer working hours in Japan", which he claims is upheld by both cultural values that Japanese workers adhere to, and the non-decision-making of the Japanese government to regulate working hours and change cultural working values. To these points, Kato cites "five flaws in Japanese society", which include "wealth without pleasure" – a lack of time or desire to consume and enjoy the high levels of Japanese production – as well as "familyism without real family bonds" – a father's tendency to abandon family connections for work – as a cultural basis for the overwork and *karoshi* deaths of Japanese workers.

Atsuko Kanai, in his "Economic and Employment Conditions, Karoshi, and the Trend of Studies on Workaholism in Japan" (2006), extends the connection between *karoshi* and Japanese work culture by attempting to build a regression model of the 'workaholism' of Japan. Kanai regresses independent variables related to overwork, such as 'time involvement', 'job stress', 'perfectionism', etc., on the dependent variable of 'drive to work', and found positive and strongly significant (to a 1% level) coefficients for all variables. Kanai's model strongly validates a connection between overwork and *karoshi* to the Japanese approach to 'workaholism': variables which one would anticipate would cause burnout and decrease a worker's 'drive to work', such as stress, time and work involvement, and even 'health

complaints', in actuality are correlated with higher drives to work, which points to a working system for which overwork is an inherent and defining attribute.

Finally, Behrooz Asgari in "Karoshi and Karou-jisatsu in Japan: Causes, Statistics and Prevention Mechanisms" (2016) further breaks down the 'workaholism' culture, which both Kato and Kanai identify as the core facet of overwork in Japan. He specifically identifies the cultural emphasis on loyalty to the workplace, the notion of work being the masculine responsibility to the family, and work evaluations based on "desk time" as the core contributing cultural factors to *karoshi*. Asgari furthermore identifies a psychology of "self-consciousness" in the Japanese population, which prevents substantial deviance from these established cultural values. Collectively, these cultural and psychological features of the Japanese working population create an environment in which overwork is the norm.

The unifying idea of Kato, Kanai and Asgari's works on *karoshi*, therefore, is the set of Japanese cultural ideas and norms which combine to create a work environment of overwork. While this is obviously significant to the study of *karoshi*, this paper will deviate from the examination of Japanese culture to examine *karoshi* from a more economic perspective, and to identify economic variables that also contribute, or are correlated with, overwork in Japan.

II. Analysis

The purpose of this paper is to attempt to answer the question of whether any economic variables beyond working hours – such as starting salaries, unionization rates, or average firm size – significantly correlate to rates of *karoshi* across different Japanese industries – and if so, to hypothesize the basis for that correlation.

a. Hypothesis

This paper hypothesizes a particular new economic interpretation of *karoshi*, which is that excessive overtime work signals an equilibrium within Japanese firms between overworking current employees and hiring new employees. That is to say, paying higher rates for overtime work, incurring the risk of compensation for negative health effects, and facing the diminishing marginal returns of workers, is less expensive for firms than hiring a new employee.

This hypothesis would suggest that such coefficients of variables such as starting salaries, level of education or training required, or contracted pay, would all be negative against rates of *karoshi* and overwork, because all of those factors signal a greater expense to hiring new employees, and firms would in effect choose to overwork existing workers. Likewise, coefficients of accession and separation rates of employees would be negative against *karoshi* and overwork, because greater turnover of employees could suggests that the firm realizes a lower cost of hiring new employees relative to overtime for existing employees, and therefore will overwork employees less.

b. Methodology

In order to test the hypothesis, a regression model will be constructed based on data from the Ministry of Health, Labor and Welfare of Japan of economic variables that are suggestive of the equilibrium between overtime and hiring new employees, against the rates of *karoshi* and overwork in Japan. Statistics will be aggregated across 16 different industry assignments, including: Mining, Construction, Manufacturing, Utilities, IT, Transportation, Wholesale/Retail, Finance, Real Estate, Scientific Research, Accommodations/Food Services, Entertainment, Education, Health Care, Compound Services, and Other.

Unfortunately – as recognized in much of the existing literature on *karoshi* – official statistics on *karoshi* are extremely limited, as the Ministry of Health, Labor and Welfare only published its first white page report on *karoshi* in 2015. For example, instances of death and health problems due to overwork was only added to the Health Statistics Survey of the Ministry of Health, Labor and Welfare in 2014, and even since then, the survey does not have full coverage of all 16 industries. Therefore, in order to expand the number of available data points and to cover all industries, the dependent variable for the regression will be a variable representing the rate of overwork, rather than *karoshi*; namely, the percentage of employees working over 60 hours per week. This variable was determined to be correlated to *karoshi* to an extremely high significance of 0.1%, and therefore, serves as an appropriate proxy for the problem of *karoshi*. In effect, the model remains relevant to the hypothesized economic equilibrium between overwork and new hires, and is still informative to the original question of whether other economic variables contribute significantly to the problem of *karoshi*.

c. Data

In order to test the hypothesis, data was compiled and aggregated from historical reports and surveys by the Ministry of Health, Labor and Welfare of Japan. A summary of the surveys reviewed and the variables extracted from each is shown in the following table.

Survey	Description	Covered Variables
Monthly Labor Survey	A monthly survey dating back to 1923, which aims to clarify changes in employment and earnings across Japanese industries	● Contractual Cash Earnings (Scheduled and Unscheduled) ● FT/PT Employee Ratio ● Accession Rate ● Separation Rate
Basic Survey on Wage Structure	A yearly survey of starting salaries across industries, broken down into four (4) levels: graduate studies, university, technical college, and high school	● Starting Salaries (Graduate, University, Technical, High School Degree Level)

Labor Management Relations Survey	A yearly survey aimed at clarifying the situation of trade union organizations across industries	• Union Member Percentage by Industry
Working Conditions Survey	A yearly survey of wage and working hour systems, with the purpose of clarifying the present working conditions in private companies	• Average Working Hours • Average Overtime Hours • Average Late Night Hours • Average Days Worked
Occupational Safety and Health Survey	A yearly survey of workplace accidents and health problems, as well as implementation of health initiatives and programs	• Rates of Karoshi (Cardio, Mental, Other)

III. Regression Results

With the data from the above mentioned surveys, a linear regression model can be constructed with a dependent variable of the percentage of employees working over 60 hours per week, with independent variables representing different attributes of the labor economics of Japan. The results of the linear regression model is shown in Figure 3, and the definitions for variables is provided in Figure 4, in the Appendix.

Figure 3: Linear Regression Model of Overwork and Labor Economic Variables

Variable	Estimate	Std. Error	t-value	Pr(>|t|)
constant	0.754	(0.323)	2.268	0.0298*
grad_deg_sal	2.800e-04	(2.823e-04)	0.992	0.3282
uni_deg_sal	-1.108e-03	(4.794e-04)	-2.311	0.0270*
hs_deg_sal	2.808e-04	(4.505e-04)	0.623	0.5373
sched_cont_cash	1.267e-06	(1.629e-07)	7.781	4.70e-09***
nsched_cont_cash	-3.995e-06	(3.627e-07)	-11.013	9.31e-13***
spec_cash	-3.487e-07	(5.386e-08)	-6.473	2.11e-07***
sched_hrs	3.325e-03	(1.679e-03)	1.980	0.0559
nched_hrs	0.014	(9.529e-04)	14.886	2.00e-16***
days_worked	-0.034	(0.014)	-2.434	0.0203*
ft_percent	-0.728	(0.335)	-2.174	0.0368*
pt_percent	-0.335	(0.345)	-0.971	0.3384
asc_rate	-0.015	(5.801e-03)	-2.581	0.0143*
sep_rate	-0.011	(5.141e-03)	-2.060	0.0471*
Adjusted R^2	0.9012			
# Observations	48			
F-statistic	33.99***			

*, **, *** signifies significant to 5%, 1% and 0.1%, respectively
Dependent Variable: geq_60_hrs

Initially, the model presents an R^2 value of 0.9012 and an F-statistic significant to the 0.1% level, which validates that the variables are jointly significant and capture the majority of the variance of the rate of overwork across the 16 Japanese industries. The coefficients of the labor economic variables provide some affirmation of the hypothesized economic equilibrium between overworking existing employees and hiring new employees, however the result is not necessarily definitive. Key variables that are used as indicators of the 'expensiveness' of hiring new employees, such as starting salaries and contractual cash earnings are split on their significance and effect. For instance, the coefficient of scheduled contractual cash earnings is positive and strongly significant, which suggests that higher paying positions have higher rates of overwork and which is consistent with the hypothesis. However, the coefficients of starting salary variables are all either insignificant or negative.

That said, the coefficients of both accession and separation rates of firms across the 16 Japanese industries are strongly significant (to the 1% level) and negative, which is consistent with the hypothesis if one interprets these variables as indicative of a firm's willingness to encounter employee turnover (i.e. fire unproductive employees and hire new employees and encounter training and other onboarding costs). Higher rates of turnover, according to the hypothesis of an economic equilibrium between hiring new employees and overworking existing employees, would be indicative of greater rates of the former, and lower rates of the latter. Therefore, the anticipated relationship in the model between accession and separation rates and the rate of overwork would be negative, as higher rates would correlated with lower rates of overwork – and given this interpretation of the variables, the result of the model is consistent with the hypothesis.

Finally, the coefficients of non-scheduled contractual cash earnings (overtime pay) and special cash earnings (e.g. bonuses) are both significant, and potentially indicate an interesting effect of both variables on the rates of overwork. Both coefficients are significant (to the 0.1% level) and negative against the rate of overwork, which suggests firstly that industries in which firms sufficiently compensating overtime work tend to have lower rates of overwork. One could interpret this result as favorable evidence for the efficacy of restrictions on "service overtime", and the work-hour regulation established in the 1988 Labor Standards Act revision, which adopted the 40 hour work week principle and enforced overtime pay. Furthermore, providing additional income to employees, such as bonuses or compensation for temporary or unexpected reasons (e.g. paid leave), is correlated with lower rates of overwork, possibly indicating a similarity between the benevolence of a firm to its employees in terms of compensation and in terms of their work demands, i.e. firms that provide employees more generous amounts of special cash earnings are likely more committed to limiting overwork as well.

IV. Conclusion

The overall results of the regression model provide some affirmation of the hypothesized economic equilibrium between overworking existing employees and hiring new employees. The accession and separation rates, which are variables that may be interpreted as indicative of the rate of hiring new employees and employee turnover in general, were significantly negative against rates of overwork, which is a consistent result with the hypothesis. Contrarily, variables which suggest the expensiveness of onboarding new employees, such as starting salary and contractual cash earnings, were inconsistent in their

reflection of the hypothesis, which anticipates that greater expense for hiring should be correlated with higher rates of overwork, i.e. positive coefficients on variables.

The primary limitation to the model is the lack of significant *karoshi* data, which forced the use of the rates of overwork (greater than 60 work hours in a week) as a proxy dependent variable. This method likely induced a level of reverse causality between the dependent and independent variables – for example, with the number of overtime hours – which would not have been the case with a *karoshi* dependent variable. Furthermore, the model could do more by way of capturing the true expensiveness of hiring new employees, such as incorporating variables of training cost, scarcity of applicants, and so forth. Therefore, while this paper attempts to extend beyond the discussion of workaholism and other cultural values as the basis for *karoshi* in Japan, and does manages to induce some meaningful economic connections between *karoshi* and variables indicative of the rates and expense of employee turnover in Japanese industries, further research is necessary to significantly suggest that any of these labor economic variables are strongly significant to the discussion of the problem of Japanese *karoshi*.

V. Works Cited

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VI. Appendix

Figure 4: Variable Definitions for Linear Regression Model

Dependent Variable	**Definition**
geq_60_hrs	Percentage of Employees Working 60+ Hours per Week (Rate of Overwork)
Independent Variables	**Definition**
grad_deg_sal	Starting Salary with a Graduate Degree
uni_deg_sal	Starting Salary with a University Degree
hs_deg_sal	Starting Salary with a High School Degree
sched_cont_cash	Scheduled Contractual Cash Earnings
nsched_cont_cash	Nonscheduled Contractual Cash Earnings (Overtime Pay)
spec_cash	Special Cash Earnings (e.g. bonuses)
sched_hrs	Average Scheduled Hours
nched_hrs	Average Nonscheduled Hours (Overtime)
days_worked	Average Days Worked (per week)
ft_percent	Percentage of Employees who are Full Time
pt_percent	Percentage of Employees who are Part Time
asc_rate	Accession Rate (new hire percentage)
sep_rate	Separation Rate