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Evaluation of Police Efficiency in Japan: Validation Using Data of the Detection of Crimes and Corruption Occurring in the Police Organization *

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As described herein, using panel data of prefectural police departments during 2005–2019, which are available as data, we conducted a police efficiency assessment using DEA. DEA is useful for conducting efficiency evaluations using multiple inputs and multiple output variables simultaneously. Then the factors affecting efficiency can be analyzed.

Empirical analyses revealed the police officers' salary compensation as a factor affecting police organizations' efficiency. Police organizations that experience corruption, especially bribery and embezzlement to obtain money, might be less efficient. Moreover, salary compensation effects on efficiency can be expected to be strong. In light of the points above, we regard the pay level as an important factor when considering police organizations' efficiency.

Keywords: Corruption, DEA, Pay Level, Police Organization Efficiency, Salary Compensation

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I. Introduction

This study was conducted for evaluation of the efficiency of prefectural police in Japan by simultaneously analyzing crime detection and corruption data generated in the police organization, and for empirical identification of factors affecting their efficiency.

Although various discussions and accumulated research have evaluated police efficiency both domestically and internationally, no report has described a study using corruption data generated within police organizations. In police organizations that are fundamentally responsible for detecting crimes, corruption can have a tremendous effect on police officers working in the organization. Moreover, existing studies indicate the possibility that corruption occurrence might be attributable to relative or absolute police officer pay levels. In light of these earlier works, it seems possible that several factors influence police efficiency. Nevertheless, existing studies have not examined these factors adequately.

To fill gaps in the discussion of earlier studies, this study uses panel data from prefectural police organizations in Japan to evaluate efficiency using data envelopment analysis (DEA), then this study identifies factors affecting efficiency.[1)]

The following is a summary of the findings obtained from empirical analyses. (i) Salary is one factor affecting the efficiency of police organizations. (ii) Police organizations that experience corruption, especially those involving bribery, embezzlement, and other money-oriented cases might be less efficient. The effects of salary compensation on efficiency might be more pronounced. Considering the points raised above, we conclude that pay levels are an important factor when considering the efficiency of police organizations. The conclusions obtained have succeeded in filling some gaps in earlier studies, therefore making a certain academic contribution.

The structure of this paper is the following. Section 2 provides the background for the study. Section 3 describes the empirical analyses. Finally, Section 4 presents the conclusions.

II. Background of the Study

1. Public Sector Efficiency Assessment Using DEA

Public sector productivity has long been an unexplored academic field. Flat productivity assumptions have been made because of the difficulty of measuring government and local government output volumes. In recent years, however, understanding public sector production efficiency has become a matter of global interest. Various studies have been conducted in other countries, with theoretical and empirical attempts taken to elucidate the issue (Inatsugu, 2018).

In Japan, various empirical studies have been conducted as efficiency evaluations with local governments as the main subject of analysis, taking advantage of well-developed databases compared to those of other countries (Adachi, 2013; Kikuchi and Suzuki, 2021; Miyara and Fukushige, 2002, 2003; Ogawa and Tanahashi, 2007; Saito, 2011; Umemura and Ogawa, 2006). In fact, the DEA analytical method has been used for numerous studies.

Table 1 presents the major domestic and international trends of earlier studies, particularly addressing evaluations of police efficiency using DEA. A number of empirical evaluations of police efficiency in various areas of the world have been accumulated. For such studies, the numbers of police officers and personnel costs are often used as inputs, but it is often the case that expenses other than personnel costs, such as the numbers of crimes committed, are also used. Outputs often include various crime arrest rates or numbers of crime arrests.

Miyara and Fukushige (2002) present the only report of an empirical study of the efficiency evaluation of prefectural police organizations in Japan using DEA.[2)] The following discussion specifically pertains to this study.

Miyara and Fukushige (2002) conducted an efficiency evaluation using prefectural police data compiled during 1975–1999, combining DEA and

Table 1 Earlier Studies Evaluating Police Efficiency Using DEA

Research	Input	Output
Thanassoulis (1995)	Number of police officers Number of violent crimes Number of larceny crimes Number of other crimes	Arrest rate for violent crimes Arrest rate for theft Arrest rate for other crimes
Carrington et al. (1997)	Number of police officers Number of civilian police officers Number of police cars	Number of arrests Number of summonses Number of crimes Number of traffic accidents Number of kilometers driven by police cars
Drake and Simper (2000)	Personnel expenses Vehicle expenses Building expenses Other expenses	Arrest rate Traffic crimes Assessment score by the Comptroller General's Office
Drake and Simper (2001)	Personnel expenses Vehicle expenses Building expenses Other expenses	Violent crime arrest rate Violent crime arrest rate Success rate of calls for service Vehicles arriving within 10 minutes of a call Number of sobriety tests administered Score of assessments by the Comptroller General's Office
Diez-Ticio and Mancebon (2002)	Number of police officers per 100,000 people Inverse of population	Violent crime arrest rate Theft arrest rate
Sun (2002)	Number of police officers Number of larceny cognizances Number of misdemeanor cognizances Number of other crimes cognizances	Number of theft arrests Number of misdemeanor arrests Number of other crime arrests
Miyara and Fukushige (2002)	Number of police officers	Number of arrests for criminal offenses Number of arrests for special offenses Number of arrests for traffic accidents (negligence)
Gorman and Ruggiero (2008)	Number of police officers Number of other officials Number of vehicles	Homicides Other violent crimes
García-Sánchez and Rodríguez-Domínguez (2009)	Number of police officers Number of vehicles	Number of miles traveled by police vehicles Number of persons arrested who were taken to court Number of items recovered Number of charges filed Number of vehicles removed from public roads Number of sobriety tests conducted Number of accident reports filed
Wu et al. (2010)	Personnel expenses General operating expenses Equipment purchases	Number of robberies handled Number of arrests for violent crimes Number of arrests for other crimes Number of traffic accidents Number of general and special services Number of residents' satisfaction with public safety

Research	Input	Output
Kumar and Kumar (2012)	Number of non-agents Number of investigators Number of police vehicles Number of property crimes Number of recognized injury crimes Value of lost property	Number of property crime arrests Number of injury crime arrests Value of property recovered
Aristovnik et al. (2014)	Occupied Posts IT equipment Police vehicle radio stations Number of criminal offenses Public order offenses Traffic accidents	Number of arrests for criminal offenses Traffic accidents with serious injuries Number of traffic accidents with minor injuries Average response time of police patrols Number of restraints and warning shots used
Rahimi et al. (2017)	Number of patrol teams Number of police officers Number of patrol vehicles Number of motorcycle vehicles Number of arrests Cultural and educational scores Number of speed cameras	Number of conflict accidents Number of personal accidents Number of fatal accidents
Antić et al. (2020)	Number of traffic violations due to driving under the influence of drugs or alcohol Number of traffic violations due to exceeding maximum speed Number of traffic violations due to not wearing seat belts Number of registered vehicles Road density	Number of deaths per 100,000 inhabitants (inverse) Injuries per 100,000 inhabitants (inverse)

Note: Table prepared by the author.

non-probabilistic frontier analysis, and using the number of police officers as input and the number of arrests for criminal offenses, special law offenses, and traffic accidents (negligence) as outputs.[3)] Furthermore, regression analysis using the CCR and BCC efficiency values (logarithmic values) obtained by DEA as explanatory variables and the number of criminal code citations (average values of 1995–1999) as the explained variable shows that each efficiency value has a positive effect on the number of criminal code citations.[4)] However, this study does not apply panel data analysis. Also, the sample size is 47, which leaves some analytical challenges in terms of the use of averages for each year.

Table 2 shows results of an efficiency evaluation of prefectural police organizations analyzed using DEA by Miyara and Fukushige (2002). The table shows the mean, standard deviation, and minimum values for CCR and BCC for each year. From the table, it is apparent that the BCC efficiency values tend to be higher, on average, than the CCR values.

Tables 3 and 4 present results of our evaluation of the efficiency of prefectural police organizations after 2000, using the same analytical framework as that used by Miyara and Fukushige (2002). Table 3 shows the efficiency values for CCR. Table 4 shows the efficiency values for BCC. These are expressed as results by prefecture by year. Regarding the average values of CCR and BCC during the period under analysis (right side of each table), the highest value for both is found to be 1.000 in Gunma prefectural police. When examined in conjunction with the data in Table 2 presented earlier, it is also apparent that the highest average value for CCR was achieved in 2003. The highest average value for BCC was in 1987. Since the 2000s,

Table 2 Efficiency Assessment of Prefectural Police (1975--1999)

Year	CCR			BCC		
	Mean	Std.	Min	Mean	Std.	Min
1975	0.749	0.134	0.437	0.825	0.128	0.544
1976	0.770	0.136	0.457	0.857	0.124	0.515
1977	0.751	0.141	0.449	0.840	0.124	0.525
1978	0.728	0.152	0.393	0.829	0.129	0.484
1979	0.747	0.152	0.388	0.848	0.130	0.502
1980	0.741	0.162	0.383	0.838	0.136	0.482
1981	0.727	0.163	0.365	0.830	0.138	0.463
1982	0.759	0.159	0.397	0.851	0.132	0.484
1983	0.780	0.151	0.429	0.871	0.121	0.498
1984	0.778	0.152	0.454	0.884	0.118	0.529
1985	0.755	0.148	0.433	0.876	0.119	0.510
1986	0.777	0.143	0.358	0.888	0.109	0.537
1987	0.759	0.151	0.345	0.893	0.114	0.534
1988	0.741	0.147	0.374	0.879	0.122	0.528
1989	0.787	0.148	0.388	0.885	0.115	0.542
1990	0.773	0.149	0.381	0.870	0.126	0.566
1991	0.776	0.138	0.468	0.872	0.128	0.553
1992	0.781	0.130	0.483	0.874	0.117	0.559
1993	0.758	0.138	0.537	0.872	0.121	0.578
1994	0.782	0.144	0.496	0.877	0.117	0.567
1995	0.789	0.150	0.465	0.883	0.116	0.544
1996	0.726	0.145	0.413	0.863	0.131	0.479
1997	0.758	0.152	0.452	0.858	0.134	0.493
1998	0.758	0.152	0.452	0.861	0.135	0.520
1999	0.761	0.154	0.462	0.859	0.135	0.538

Note: Data in the table were referred from Miyara and Fukushige (2002).

each efficiency value has been declining. What could have caused this trend?

In reviewing Table 1, we have already noted that earlier studies often use the number of police officers and personnel costs as DEA inputs. However, only the number of police officers is regarded as an input in calculating each of the efficiency values in Tables 2–4. In other words, it is noteworthy that the pay level and related issues (occurrence of corruption cases) are not considered in producing each efficiency value.

2. Relation between pay level suppression and corruption occurrence

In the 2000s, pay levels for public officials in Japan were regarded as higher than those in the private sector, which constituted a major social problem at the time. Debate about correcting public and private sector disparities in pay levels is gaining momentum as public opinion has become increasingly involved.

During the Koizumi administration, which was established in 2001 under the slogan of "structural reform without sanctuary," various public officials' reforms were implemented. In 2005, the Cabinet approved the "Handling of Salary Revisions for Public Officials" in response to recommendations of the National Personnel Authority. In line with this, several decisions were made for local public officials to reduce staff quotas, to appropriate pay levels when they exceed those of national public officials and the private sector, and to reflect the status of private sector pay in the region appropriately.

Table 3 Efficiency Assessment of Prefectural Police (CCR)

Prefecture name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Mean
Hokkaido	0.595	0.595	0.595	0.586	0.574	0.607	0.656	0.644	0.520	0.520	0.520	0.565	0.586	0.649	0.633	0.582	0.661	0.679	0.660	0.685	0.606
Aomori	0.690	0.690	0.690	0.707	0.536	0.624	0.557	0.536	0.540	0.540	0.537	0.611	0.572	0.514	0.467	0.495	0.503	0.558	0.568	0.559	0.575
Iwate	0.518	0.518	0.518	0.561	0.481	0.546	0.532	0.493	0.504	0.504	0.575	0.480	0.451	0.465	0.408	0.456	0.455	0.452	0.450	0.503	0.493
Miyagi	0.796	0.796	0.796	0.868	0.716	0.752	0.738	0.705	0.650	0.650	0.674	0.618	0.637	0.664	0.669	0.686	0.726	0.784	0.953	0.869	0.737
Akita	0.641	0.641	0.641	0.654	0.594	0.629	0.644	0.564	0.463	0.463	0.472	0.482	0.481	0.507	0.504	0.474	0.518	0.484	0.506	0.562	0.546
Yamagata	0.736	0.736	0.736	0.747	0.657	0.732	0.673	0.706	0.658	0.658	0.632	0.686	0.688	0.728	0.658	0.677	0.837	0.771	0.745	0.665	0.706
Fukushima	0.953	0.953	0.953	0.943	0.699	0.744	0.759	0.686	0.603	0.603	0.602	0.628	0.566	0.582	0.552	0.537	0.566	0.532	0.703	0.728	0.695
Ibaraki	0.938	0.938	0.938	0.902	0.952	0.951	1.000	1.000	0.942	0.942	0.844	0.981	0.880	0.885	0.892	0.850	0.934	0.983	0.959	0.920	0.932
Tochigi	0.934	0.934	0.934	0.889	0.790	0.895	0.876	0.881	0.853	0.853	0.802	0.887	0.858	0.918	0.859	0.861	0.860	0.863	0.917	0.873	0.877
Gunma	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Saitama	0.806	0.806	0.806	0.773	0.828	0.827	0.870	0.908	0.898	0.898	0.965	1.000	1.000	0.959	0.894	0.857	0.892	0.889	0.891	0.955	0.886
Chiba	0.800	0.800	0.800	0.816	0.725	0.836	0.899	0.845	0.744	0.744	0.708	0.711	0.704	0.688	0.791	0.723	0.705	0.751	0.727	0.705	0.761
Tokyo	0.973	0.973	0.973	1.000	1.000	1.000	1.000	0.951	0.695	0.695	0.552	0.467	0.504	0.548	0.564	0.557	0.600	0.670	0.670	0.675	0.753
Kanagawa	0.820	0.820	0.820	0.843	0.843	0.885	0.999	1.000	1.000	1.000	1.000	1.000	0.955	0.947	1.000	1.000	1.000	1.000	1.000	0.880	0.941
Niigata	0.689	0.689	0.689	0.691	0.522	0.570	0.575	0.571	0.620	0.620	0.589	0.738	0.655	0.618	0.648	0.646	0.721	0.779	0.863	0.844	0.667
Toyama	0.720	0.720	0.720	0.725	0.589	0.582	0.637	0.600	0.529	0.529	0.497	0.484	0.469	0.466	0.423	0.470	0.633	0.694	0.807	0.804	0.605
Ishikawa	1.000	1.000	1.000	0.910	0.750	0.747	0.752	0.681	0.558	0.558	0.547	0.597	0.579	0.656	0.711	0.736	0.809	0.777	0.759	0.839	0.748
Fukui	0.673	0.673	0.673	0.690	0.486	0.707	0.570	0.545	0.581	0.581	0.511	0.581	0.523	0.499	0.655	0.503	0.534	0.561	0.571	0.671	0.589
Yamanashi	0.806	0.806	0.806	0.717	0.674	0.770	0.709	0.701	0.661	0.661	0.628	0.672	0.645	0.614	0.559	0.568	0.628	0.621	0.651	0.643	0.677
Nagano	0.768	0.768	0.768	0.747	0.633	0.709	0.781	0.750	0.716	0.716	0.601	0.675	0.685	0.690	0.653	0.568	0.613	0.619	0.676	0.689	0.691
Gifu	0.763	0.763	0.763	0.784	0.620	0.773	0.739	0.730	0.924	0.924	0.699	0.722	0.708	0.732	0.642	0.708	0.686	0.673	0.783	0.832	0.748
Shizuoka	1.000	1.000	1.000	1.000	0.932	0.868	0.888	0.969	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.983
Aichi	0.995	0.995	0.995	0.964	0.801	0.892	0.714	0.689	0.885	0.885	0.842	0.991	0.902	0.893	0.984	1.000	1.000	1.000	1.000	1.000	0.921
Mie	0.850	0.850	0.850	0.810	0.701	0.885	1.000	0.777	0.663	0.663	0.658	0.881	0.655	0.830	0.743	0.681	0.726	0.917	0.910	0.721	0.788
Shiga	0.918	0.918	0.918	1.000	0.789	0.995	0.803	0.815	0.672	0.672	0.675	0.789	0.743	0.826	0.784	0.830	0.713	0.786	0.812	0.715	0.809
Kyoto	0.664	0.664	0.664	0.719	0.658	0.667	0.711	0.700	0.617	0.617	0.619	0.644	0.703	0.607	0.650	0.577	0.600	0.635	0.628	0.576	0.646
Osaka	0.691	0.691	0.691	0.669	0.583	0.614	0.648	0.588	0.578	0.578	0.585	0.560	0.627	0.622	0.671	0.635	0.688	0.734	0.705	0.716	0.644
Hyogo	1.000	1.000	1.000	0.688	0.617	0.688	0.691	0.667	0.668	0.668	0.643	0.675	0.681	0.678	0.658	0.639	0.752	0.827	0.878	0.939	0.753
Nara	0.997	0.997	0.997	1.000	0.868	1.000	1.000	0.927	0.825	0.825	0.967	1.000	0.796	0.824	0.901	0.843	0.955	1.000	1.000	0.958	0.934
Wakayama	0.690	0.690	0.690	0.668	0.563	0.546	0.552	0.637	0.649	0.649	0.615	0.721	0.705	0.693	0.687	0.733	0.635	0.746	0.804	0.787	0.673
Tottori	0.780	0.780	0.780	0.942	0.673	0.736	0.834	0.669	0.614	0.614	0.679	0.637	0.693	0.937	0.728	0.629	0.718	0.690	0.671	0.701	0.725
Shimane	0.668	0.668	0.668	0.627	0.540	0.647	0.632	0.617	0.597	0.597	0.581	0.611	0.612	0.690	0.776	0.588	0.623	0.611	0.720	0.702	0.639
Okayama	0.917	0.917	0.917	0.984	0.908	0.832	0.941	0.880	0.920	0.920	0.908	0.867	0.844	0.832	0.863	0.794	0.826	0.872	0.782	0.813	0.877
Hiroshima	0.812	0.812	0.812	0.772	0.667	0.685	0.648	0.793	0.814	0.814	0.893	0.745	0.846	1.000	0.807	0.827	0.810	0.856	0.864	0.917	0.810
Yamaguchi	1.000	1.000	1.000	0.960	0.842	0.825	0.764	0.768	0.659	0.659	0.694	0.608	0.607	0.639	0.555	0.564	0.590	0.627	0.624	0.596	0.729
Tokushima	0.868	0.868	0.868	0.871	0.800	0.799	0.771	0.668	0.654	0.654	0.675	0.737	0.607	0.632	0.601	0.719	0.657	0.695	0.646	0.646	0.722
Kagawa	0.839	0.839	0.839	1.000	1.000	0.914	0.941	1.000	1.000	1.000	1.000	1.000	0.999	1.000	0.991	1.000	1.000	0.907	0.925	0.931	0.956
Ehime	0.793	0.793	0.793	0.793	0.682	0.901	0.881	0.762	0.835	0.835	0.804	0.858	0.739	0.769	0.712	0.847	0.871	0.881	0.928	0.727	0.810
Kochi	0.764	0.764	0.764	0.711	0.552	0.633	0.645	0.568	0.575	0.575	0.570	0.638	0.583	0.677	0.659	0.625	0.649	0.623	0.644	0.610	0.642
Fukuoka	0.936	0.936	0.936	1.000	0.873	0.885	0.894	0.888	0.838	0.838	0.831	0.806	0.837	0.855	0.870	0.898	0.920	0.899	0.898	0.848	0.884
Saga	0.834	0.834	0.834	0.863	0.876	0.816	0.833	0.830	0.804	0.804	0.709	0.953	0.912	0.987	0.959	1.000	0.945	0.901	0.848	0.811	0.868
Nagasaki	0.551	0.551	0.551	0.586	0.628	0.515	0.523	0.519	0.459	0.459	0.433	0.532	0.547	0.499	0.461	0.425	0.458	0.475	0.440	0.413	0.501
Kumamoto	0.853	0.853	0.853	0.879	0.886	0.808	0.841	0.810	0.817	0.817	0.705	0.755	0.709	0.686	0.735	0.732	0.771	0.783	0.819	0.792	0.795
Oita	0.695	0.695	0.695	0.736	0.635	0.663	0.696	0.602	0.564	0.564	0.548	0.686	0.559	0.579	0.566	0.552	0.567	0.583	0.557	0.489	0.612
Miyazaki	0.676	0.676	0.676	0.715	0.784	0.786	0.798	0.848	0.807	0.807	0.798	0.885	0.856	0.958	0.849	0.859	0.857	0.830	0.835	0.772	0.804
Kagoshima	0.742	0.742	0.742	0.662	0.542	0.586	0.555	0.560	0.552	0.552	0.546	0.532	0.547	0.555	0.513	0.516	0.532	0.524	0.582	0.566	0.582
Okinawa	0.599	0.599	0.599	0.654	0.578	0.685	0.702	0.693	0.649	0.649	0.696	0.753	0.637	0.759	0.751	0.781	0.843	0.922	0.831	0.848	0.711
Mean	0.803	0.803	0.803	0.805	0.716	0.761	0.763	0.739	0.710	0.710	0.694	0.733	0.704	0.731	0.716	0.707	0.736	0.755	0.770	0.755	0.746
Std.	0.134	0.134	0.134	0.134	0.147	0.134	0.144	0.146	0.156	0.156	0.158	0.166	0.154	0.165	0.163	0.169	0.160	0.158	0.154	0.146	0.130
Min	0.518	0.518	0.518	0.561	0.481	0.515	0.523	0.493	0.459	0.459	0.433	0.467	0.451	0.465	0.408	0.425	0.455	0.452	0.440	0.413	0.493

Note: Table prepared by the author.

Table 4 Efficiency Assessment of Prefectural Police (BCC)

Prefecture name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Mean
Hokkaido	0.577	0.605	0.596	0.590	0.592	0.660	0.670	0.646	0.618	0.541	0.527	0.572	0.592	0.670	0.653	0.582	0.696	0.692	0.675	0.695	0.622
Aomori	0.713	0.734	0.770	0.752	0.706	0.740	0.676	0.724	0.666	0.743	0.746	0.796	0.787	0.733	0.637	0.655	0.644	0.691	0.714	0.699	0.716
Iwate	0.648	0.647	0.655	0.646	0.672	0.682	0.654	0.687	0.635	0.695	0.727	0.666	0.614	0.613	0.608	0.640	0.645	0.631	0.646	0.667	0.654
Miyagi	0.664	0.892	0.797	0.873	0.754	0.753	0.745	0.742	0.736	0.713	0.753	0.646	0.670	0.686	0.701	0.714	0.748	0.810	0.962	0.881	0.762
Akita	0.711	0.753	0.751	0.784	0.792	0.836	0.832	0.786	0.699	0.744	0.742	0.747	0.764	0.755	0.705	0.713	0.703	0.675	0.708	0.760	0.748
Yamagata	0.673	0.741	0.854	0.793	0.812	0.865	0.824	0.815	0.811	0.793	0.781	0.828	0.854	0.835	0.830	0.787	0.938	0.924	0.913	0.857	0.826
Fukushima	0.771	0.966	0.955	0.948	0.750	0.758	0.775	0.722	0.710	0.645	0.686	0.689	0.626	0.611	0.607	0.603	0.621	0.598	0.713	0.754	0.725
Ibaraki	0.904	0.966	0.942	0.927	0.967	1.000	1.000	1.000	1.000	0.960	0.847	0.988	0.905	0.895	0.902	0.852	1.000	0.987	1.000	0.926	0.948
Tochigi	0.909	0.891	0.950	0.889	0.836	0.916	0.884	0.908	0.894	0.879	0.874	0.888	0.913	0.936	0.908	0.901	0.886	0.941	0.946	0.894	0.902
Gunma	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Saitama	1.000	1.000	1.000	0.914	1.000	0.997	0.968	1.000	1.000	0.989	1.000	1.000	1.000	1.000	1.000	0.929	0.932	0.985	1.000	1.000	0.986
Chiba	0.792	0.883	0.837	0.847	0.814	0.981	1.000	0.959	0.884	0.831	0.778	0.722	0.747	0.735	0.933	0.834	0.748	0.854	0.798	0.724	0.835
Tokyo	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Kanagawa	1.000	1.000	0.993	0.847	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.899	0.987
Niigata	0.666	0.762	0.690	0.694	0.569	0.590	0.602	0.610	0.613	0.658	0.623	0.740	0.692	0.630	0.673	0.668	0.734	0.784	0.878	0.854	0.687
Toyama	0.847	0.831	0.841	0.812	0.785	0.799	0.801	0.786	0.779	0.766	0.754	0.752	0.749	0.737	0.730	0.731	0.781	0.845	0.912	0.927	0.798
Ishikawa	0.906	0.884	1.000	0.939	0.898	0.870	0.865	0.836	0.785	0.761	0.783	0.841	0.858	0.876	0.872	0.879	0.919	0.958	0.909	0.996	0.882
Fukui	0.875	0.870	0.838	0.811	0.815	0.875	0.804	0.810	0.800	0.835	0.788	0.825	0.777	0.773	0.831	0.761	0.745	0.788	0.795	0.851	0.813
Yamanashi	0.997	1.000	1.000	0.961	0.926	0.950	0.922	0.959	0.918	0.911	0.900	0.916	0.918	0.896	0.874	0.879	0.877	0.897	0.903	0.901	0.925
Nagano	0.710	0.732	0.787	0.748	0.687	0.722	0.803	0.788	0.784	0.762	0.659	0.708	0.729	0.715	0.701	0.628	0.671	0.664	0.721	0.728	0.722
Gifu	0.763	0.754	0.785	0.785	0.659	0.773	0.763	0.761	0.838	0.932	0.736	0.744	0.748	0.741	0.689	0.739	0.723	0.692	0.787	0.849	0.763
Shizuoka	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Aichi	0.909	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.995
Mie	0.796	0.839	0.872	0.817	0.777	0.885	1.000	0.822	0.724	0.739	0.745	0.885	0.728	0.840	0.799	0.737	0.778	0.926	0.915	0.766	0.820
Shiga	0.981	0.957	0.976	1.000	0.913	1.000	0.882	0.916	0.892	0.794	0.796	0.880	0.867	0.876	0.878	0.903	0.825	0.877	0.894	0.825	0.897
Kyoto	0.667	0.734	0.677	0.739	0.662	0.720	0.712	0.710	0.660	0.646	0.648	0.687	0.773	0.616	0.676	0.593	0.616	0.681	0.652	0.597	0.673
Osaka	0.791	0.924	1.000	1.000	1.000	1.000	0.810	1.000	0.801	0.857	0.860	1.000	0.964	0.840	0.873	0.695	0.765	0.844	1.000	1.000	0.901
Hyogo	0.862	0.797	1.000	0.689	0.709	0.769	0.762	0.748	0.726	0.752	0.731	0.689	0.728	0.747	0.778	0.741	0.831	0.925	0.927	0.961	0.794
Nara	1.000	1.000	1.000	1.000	0.970	1.000	1.000	1.000	0.968	0.928	1.000	1.000	0.996	0.905	0.970	0.920	0.988	1.000	1.000	1.000	0.982
Wakayama	0.815	0.864	0.820	0.787	0.728	0.708	0.720	0.775	0.711	0.811	0.828	0.872	0.920	0.832	0.825	0.852	0.750	0.843	0.877	0.849	0.809
Tottori	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Shimane	0.857	0.939	0.946	0.874	0.902	0.940	0.963	0.984	0.978	1.000	0.964	1.000	1.000	0.981	0.971	0.889	0.905	0.867	0.964	1.000	0.946
Okayama	0.802	1.000	0.922	0.985	0.843	0.847	0.948	0.885	0.917	0.920	0.917	0.867	0.844	0.852	0.866	0.799	0.838	0.919	0.812	0.844	0.881
Hiroshima	1.000	0.931	0.814	0.777	0.672	0.700	0.650	0.799	0.942	0.831	0.920	0.745	0.911	1.000	0.813	0.834	0.828	0.907	0.889	0.935	0.845
Yamaguchi	0.801	0.879	1.000	1.000	0.927	0.851	0.787	0.903	0.895	0.819	0.854	0.784	0.776	0.704	0.635	0.634	0.629	0.715	0.682	0.636	0.795
Tokushima	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.956	1.000	0.926	1.000	0.986	0.950	0.930	0.918	0.958	0.927	0.947	0.923	0.933	0.968
Kagawa	1.000	1.000	0.947	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.997
Ehime	0.843	0.883	0.851	0.808	0.791	0.910	0.932	0.854	0.872	0.934	0.958	0.908	0.836	0.792	0.803	0.908	0.944	0.917	0.950	0.813	0.875
Kochi	1.000	0.951	0.904	0.855	0.843	0.836	0.829	0.824	0.818	0.891	0.894	0.928	0.953	0.953	1.000	0.925	0.880	0.887	0.872	0.885	0.896
Fukuoka	0.965	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.993	1.000	0.963	0.996
Saga	0.903	1.000	1.000	1.000	1.000	1.000	0.992	0.969	0.997	0.962	0.915	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.987
Nagasaki	0.537	0.563	0.591	0.601	0.697	0.578	0.580	0.611	0.552	0.571	0.540	0.616	0.634	0.568	0.561	0.517	0.555	0.581	0.558	0.537	0.577
Kumamoto	0.832	0.936	0.858	0.880	0.915	0.815	0.867	0.862	0.766	0.916	0.804	0.816	0.819	0.751	0.788	0.791	0.801	0.850	0.877	0.848	0.839
Oita	0.740	0.799	0.798	0.779	0.798	0.789	0.807	0.796	0.785	0.741	0.771	0.831	0.752	0.790	0.745	0.738	0.741	0.759	0.753	0.731	0.772
Miyazaki	0.715	0.780	0.837	0.806	0.874	0.873	0.896	0.870	0.885	0.848	0.854	0.892	0.884	0.959	0.897	0.921	0.937	0.974	1.000	0.985	0.884
Kagoshima	0.711	0.760	0.777	0.670	0.603	0.649	0.625	0.613	0.596	0.607	0.639	0.610	0.642	0.622	0.569	0.567	0.615	0.609	0.666	0.650	0.640
Okinawa	0.614	0.709	0.707	0.707	0.708	0.738	0.742	0.812	0.848	0.786	0.884	0.950	0.820	0.834	0.833	0.858	0.881	0.983	0.851	0.879	0.807
Mean	0.835	0.876	0.880	0.858	0.838	0.859	0.853	0.856	0.841	0.839	0.835	0.851	0.846	0.835	0.831	0.814	0.831	0.860	0.873	0.862	0.849
Std.	0.136	0.121	0.121	0.123	0.134	0.129	0.131	0.123	0.135	0.129	0.132	0.132	0.128	0.135	0.139	0.142	0.135	0.132	0.125	0.127	0.118
Min	0.537	0.563	0.591	0.590	0.569	0.578	0.580	0.610	0.552	0.541	0.527	0.572	0.592	0.568	0.561	0.517	0.555	0.581	0.558	0.537	0.577

Note: Table prepared by the author.

Although there has been general understanding that the high pay level of public officials compared to the private sector is problematic, several empirical studies have recently pointed out that there might also be shortcomings associated with reductions in salary compensation (Ishida and Toume, 2017; Yoneoka, 2020b; Yoneoka and Enatsu, 2022; Yoneoka and Ishida, 2020). The theoretical basis on which such empirical studies are conducted is called the efficiency wage hypothesis (Akerlof, 1970, 1984; Akerlof and Yellen, 1990; Katz, 1986; Shapiro and Stiglitz, 1984; Stiglitz, 1976).[5)]

In general, if the pay level of public officials remains high compared to that of private sector employees, such a disparity should be corrected. However, based on the efficiency wage hypothesis, A high pay level than private sector is seen as a "gift", and will rise the motivation of officials working for the public organization in question, thereby resulting in rising of the level of effort.

Alternatively, it is believed that the purpose of compensating the devalued pay level with money might engender bribery, embezzlement, or some other form of corruption.

Although police spending and expenditure items differ, Kanasaka, Kuramoto, and Akai (2022) demonstrated using prefectural panel data that as corruption by local public officials increases, expenditures on civil engineering tend to increase. The study reveals that civil engineering expenditures tend to be bloated during phases when corruption cases are on the rise. It is quite possible that the same could apply to police expenses. In fact, it has been pointed out that personnel costs account for most police expenditures, which is an important aspect of assessing police efficiency or understanding productivity (Miyara and Fukushige, 2002; Suzuki, 2007, 2016). In light of the points raised above, one must consider that pay levels might affect efficiency when assessing police efficiency.

The DEA framework of Miyara and Fukushige (2002) discussed in the preceding section used only the number of police officers as an input, which can be taken as an implicit assumption that the legal system is structured so that the pay levels of police officers, who are local public officials, do not differ greatly among regions. These points are probably based on a general understanding and perception that the pay levels of local public officials do not differ significantly among regions, based on the existence of guidance and advice from the national government to local areas through the Laspeyres Index, or the existence of systems such as recommendations from the National Personnel Authority and the National Personnel Commission.

However, one earlier study (Oota, 2013) examined the determinants of local public officials' pay. The general perception that there is little difference in the salary compensation of local public officials in Japan because of institutional constraints such as the recommendations of the National Personnel Authority and the National Personnel Commission has made it problematic that the factors determining such compensation have not been clarified.

In light of these changes in the environment surrounding local public officials' pay, earlier studies have actively assessed the determinants of local public officials' pay in Japan. In response to these points, later empirical studies have found not a few differences in the pay levels of local public officials in each region under legal and institutional constraints. Those studies have also analyzed various factors underlying these differences (Ichise, 2017; Ishida, 2015; Kawasaki and Nagashima, 2007; Oota, 2013; Yamamoto and Hayashi, 2016; Yoneoka, 2017, 2019, 2020a, 2021, 2022). Furthermore, it has already been described that this is attributable to pay levels that are used in different regions and which have an effect on the occurrence of corruption and other scandals.

In light of the above, it is necessary to account for changes in pay levels and the corruption of police officers that might occur as a result of such changes, as an issue left unresolved in earlier studies, when evaluating the efficiency of Japan's prefectural police forces. Considering this point, the next section describes the setting and testing of several hypotheses using prefectural panel data.

Ⅲ. Empirical Analysis

1. Hypothesis setting, data to be used

As presented in this section, each of the following hypotheses is established and tested using prefectural panel data of 2005–2019, which are available retrospectively as data.[6)]

Hypothesis 1: Pay levels are one factor affecting the efficiency of police organizations.

Hypothesis 2: Organizational efficiency is lower in prefectural police where corruption incidents have occurred.

Hypothesis 3: Effects of high pay levels on efficiency is stronger in police organizations where corruption incidents have occurred.

Hypothesis 4: Organizational efficiency is lower in prefectural police where bribery and embezzlement for obtaining money occur.

Hypothesis 5: Effects of pay level on organizational efficiency are stronger for prefectural police where incidents of bribery and embezzlement for obtaining money have occurred.

The author's assumptions behind each hypothesis are presented below. In Hypothesis 1, after calculating the respective efficiency values for CCR and BCC using the same analytical framework as that used by Miyara and Fukushige (2002), we assume that high pay levels, which were not considered in this study, are a factor that changes their efficiency. As described in the preceding section, since the beginning of the 2000s, the pay scale for local government officials has changed significantly in the direction of devaluation. This change might have had no small effect on the motivation of police officers to perform their duties. In this case, the efficiency value of the police organization can be expected to be lower because of the devaluation of pay levels.

By Hypothesis 2, along with devaluation of pay levels, incidents of corruption degrade discipline among the police during the performance of their duties, thereby leading to an overall decrease in organizational efficiency. The relation between decreasing salary compensation and the occurrence of corruption has been pointed out by Ishida and Toume (2017) and Yoneoka (2020b).

By Hypothesis 3, changes in pay levels have a stronger effect on organizational efficiency among prefectural police where corruption occurs. In other words, for prefectural police among whom corruption occurs, we expect that the pay levels are a more important factor affecting the efficiency of the organization when compared to organizations within which corruption does not occur.

Hypothesis 4 stipulates that salary compensation changes decrease organizational efficiency because of the occurrence of corruption, especially bribery and embezzlement for obtaining money. The relation between high and low pay levels and the occurrence of corruption such as bribery and embezzlement for obtaining money has been pointed out by Yoneoka and Enatsu (2022).

By Hypothesis 5, changes in pay levels more strongly affect organizational efficiency among prefectural police, where bribery and embezzlement for obtaining money occurs, compared to organizations in which such incidents do not occur. In other words, we expect that in police departments where bribery and embezzlement cases occur, pay levels are a more important factor affecting organizational efficiency.

Through testing each of the hypotheses above, the effects of changes in salary compensation and the occurrence of corruption on the efficiency of police organizations are revealed. They have not been examined in earlier studies.

The descriptive statistics of the data used in the analysis are presented in Table 5. The explained variables in the empirical analysis are the respective efficiency values of CCR and BCC as calculated using DEA. To be more specific about the calculation of each efficiency value, the input is the

Table 5 Descriptive Statistics of Data

	変数名	Number of samples	Mean	Std.	Min	Max	Data source
1	Efficiency value (CCR)	705	0.732	0.156	0.408	1.000	(1)
2	Efficiency value (BCC)	705	0.846	0.131	0.517	1.000	(1)
3	Monthly pay (log)	705	12.706	0.046	12.616	12.848	(2)
4	Incidents of corruption	705	0.126	0.464	0.000	7.000	(3)
5	Incidents of bribery and embezzlement	705	0.108	0.429	0.000	7.000	(3)
6	Incidents other than bribery and embezzlement	705	0.018	0.145	0.000	2.000	(3)
7	Ratio of new hires to total police officers	705	5.238	1.132	0.832	14.027	(2)
8	Ratio of retired police officers to total police officers	705	4.767	0.968	2.764	10.443	(2)
9	Average age of police officers	705	18.664	1.617	16.000	23.000	(2)
10	Population density (log)	705	5.787	0.998	4.203	8.755	(4)
11	Population under 15 years old (%)	705	13.060	1.131	9.834	18.670	(4)
12	Population 65 years old and over (%)	705	26.062	3.907	16.077	37.164	(4)

Note: Data sources from (1) to (4) are the following.
(1) Authors' calculations based on data of the number of police officers, number of arrests for criminal offenses, number of arrests for special crimes, and number of traffic accident cases.
(2) Ministry of Internal Affairs and Communications, "Survey of Salaries of Local Public Officials" (Translated from Japanese)
(3) Ministry of Internal Affairs and Communications, "Survey on the Number of Local Government Officials with Disciplinary, Disciplinary, and Criminal Actions" (Translated from Japanese)
(4) Ministry of Internal Affairs and Communications, "Statistics on Prefectures" (Translated from Japanese)

number of police officers. The output is the number of arrests for criminal offenses, special law offenses, and traffic accidents (negligence).[7)]

The explanatory variable of particular interest is the monthly wage (log).[8)] In addition to this, the number of corruption cases, the number of bribery cases, the number of embezzlement cases, and the number of cases other than bribery and embezzlement are used as explanatory variables, respectively.[9)] The total number of bribery and embezzlement cases and the total number of other cases constitute the total number of corruption cases.

Control variables include the ratio of new hires to the total number of police officers, the ratio of retirees to the total number of police officers, and the average age of police officers. They are used to account for changes in the personnel structure of the police organization over time in the analytical model.[10)] To account for differences in socioeconomic factors among regions, population density (log), percentage of the population under 15 years old, and the percentage of the population over 65 years old are used.[11)]

In estimation, the explained variable is a continuous variable that can take values between 0 and 1. The data have a panel structure. Panel tobit analysis is used, as it was for earlier studies.[12)]

2. Estimation Results

Results of the analyses are presented in Table 6. The difference between the models on this table is that Model 1, Model 2, Model 5, and Model 6 use the efficiency value of CCR as the explained variable, whereas Model 3, Model 4, Model 7, and Model 8 use the efficiency of BCC as the explained variable. Another difference is that Models 2, 4, 6, and 8 examine the cross effects between monthly wages (log) and the number of corruption cases, the number of bribery and embezzlement cases, and the number of non-bribery and embezzlement cases.

With respect to Hypothesis 1, the sign of the estimated number of monthly wages (log) is positive and significant at the 5% level in all of Models 1 through 8. Interpreting these results, we can reasonably infer that pay level is one factor affecting the efficiency of police organizations. Consequently, Hypothesis 1 is supported.

With respect to Hypothesis 2, in Model 1, the

Table 6 Estimation Results

Explained variable	Efficiency Value (CCR)						Efficiency Value (BCC)					
	Model 1			Model 2			Model 3			Model 4		
	Coeff.	Std.	*P*-value	Coeff.	Std.	*P*-value	Coeff.	Std.	*P*-value	Coeff.	Std.	*P*-value
Monthly pay (log)	0.723	0.147	0.000***	0.728	0.146	0.000***	0.324	0.132	0.014**	0.321	0.132	0.015**
Incidents of corruption	-0.013	0.007	0.043**	-0.011	0.007	0.112	0.002	0.008	0.845	0.001	0.008	0.870
Monthly pay (log) × Incidents of corruption				0.349	0.177	0.049**				-0.080	0.181	0.658
Ratio of new hires to total police officers	-0.005	0.004	0.130	-0.006	0.004	0.118	-0.006	0.003	0.046**	-0.006	0.003	0.046**
Ratio of retired police officers to total police officers	0.005	0.004	0.287	0.005	0.004	0.260	0.004	0.004	0.319	0.004	0.004	0.327
Average age of police officers	-0.010	0.005	0.053*	-0.010	0.005	0.049**	-0.012	0.005	0.012**	-0.012	0.005	0.013**
Population density (log)	0.078	0.021	0.000***	0.079	0.021	0.000***	0.077	0.022	0.000***	0.077	0.022	0.000***
Population under 15 years old (%)	0.009	0.013	0.506	0.010	0.013	0.467	-0.004	0.012	0.730	-0.004	0.012	0.737
Population 65 years old and over (%)	0.007	0.003	0.023**	0.007	0.003	0.022**	-0.003	0.003	0.364	-0.003	0.003	0.369
Constant Term	-9.009	1.813	0.000***	-9.088	1.809	0.000***	-3.316	1.631	0.042**	-3.277	1.634	0.045**
/sigma_u	0.138	0.015	0.000***	0.138	0.015	0.000***	0.142	0.017	0.000***	0.142	0.017	0.000***
/sigma_e	0.074	0.002	0.000***	0.073	0.002	0.000***	0.063	0.002	0.000***	0.063	0.002	0.000***
rho	0.778	0.039		0.778	0.039		0.836	0.033		0.836	0.033	
Log likelihood	628.267			630.206			575.744			575.843		
Wald chi2	52.720			56.870			26.380			26.540		
Prob > chi2	0.000			0.000			0.001			0.002		
Left-censored observations	0			0			0			0		
Right-censored observations	64			64			169			169		
Observations	705			705			705			705		

Note: In the table, * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level.

sign of the estimated coefficient on the number of corruption incidents is negative and significant at the 5% level. In Model 3, the number of corruption incidents is not significant at the 5% level. Interpreting these results, it is not necessarily the case that police organizations with corruption incidents are less efficient, although this finding depends on the assumptions made in calculating the respective efficiency values for CCR and BCC. By virtue of the information presented above, Hypothesis 2 is partially supported.

With respect to Hypothesis 3, in Model 2, the sign of the estimated coefficient of the interaction term between monthly wages (log) and the number of corruption incidents is positive and significant at the 5% level. For Model 4, the interaction term between monthly wages (log) and the number of corruption incidents is not significant at the 5% level. Interpreting these results, the effects of pay levels on organizational efficiency are not necessarily stronger for prefectural police with corruption incidents, although that finding depends on the assumptions made in calculating the respective efficiency values for the CCR and BCC. Based on the discussion presented above, Hypothesis 3 is partially supported.

With respect to Hypothesis 4, in Model 5, the sign of the estimated coefficient on the number of incidents of bribery and embezzlement is negative and significant at the 5% level. The number of occurrences other than bribery and embezzlement cases is not significant at the 5% level. In Model 7, neither the number of incidents of bribery and embezzlement nor the number of incidents of bribery and embezzlement other than bribery and embezzlement is significant. Interpreting these

Table 6 Estimation Results

Explained variable	Efficiency Value (CCR)						Efficiency Value (BCC)					
	Model 5			Model 6			Model 7			Model 8		
	Coeff.	Std.	*P*-value	Coeff.	Std.	*P*-value	Coeff.	Std.	*P*-value	Coeff.	Std.	*P*-value
Monthly pay (log)	0.720	0.147	0.000***	0.716	0.147	0.000***	0.322	0.132	0.015**	0.313	0.133	0.019**
Incidents of bribery and embezzlement	-0.014	0.007	0.050**	-0.011	0.007	0.137	0.000	0.009	0.972	0.000	0.009	0.977
Incidents other than bribery and embezzlement	-0.005	0.021	0.826	-0.006	0.024	0.799	0.010	0.021	0.617	0.006	0.023	0.807
Monthly pay (log) × Incidents of bribery and embezzlement				0.452	0.185	0.014**				-0.018	0.190	0.924
Monthly pay (log) × Incidents other than bribery and embezzlement				-0.226	0.844	0.789				-0.408	0.827	0.622
Ratio of new hires to total police officers	-0.005	0.004	0.131	-0.005	0.004	0.122	-0.006	0.003	0.046	-0.006	0.003	0.047**
Ratio of retired police officers to total police officers	0.005	0.004	0.282	0.005	0.004	0.251	0.004	0.004	0.328	0.004	0.004	0.330
Average age of police officers	-0.010	0.005	0.053*	-0.010	0.005	0.051*	-0.012	0.005	0.012**	-0.012	0.005	0.013**
Population density (log)	0.078	0.021	0.000***	0.078	0.021	0.000***	0.076	0.022	0.000***	0.076	0.022	0.000***
Population under 15 years old (%)	0.009	0.013	0.508	0.009	0.013	0.471	-0.004	0.012	0.738	-0.004	0.012	0.733
Population 65 years old and over (%)	0.007	0.003	0.024**	0.007	0.003	0.024**	-0.003	0.003	0.358	-0.003	0.003	0.355
Constant Term	-8.970	1.814	0.000***	-8.921	1.815	0.000***	-3.297	1.632	0.043**	-3.181	1.648	0.054*
/sigma_u	0.138	0.015	0.000***	0.137	0.015	0.000***	0.142	0.017	0.000***	0.142	0.017	0.000***
/sigma_e	0.074	0.002	0.000***	0.073	0.002	0.000***	0.063	0.002	0.000***	0.063	0.002	0.000***
rho	0.778	0.039		0.779	0.039		0.836	0.033		0.836	0.033	
Log likelihood	628.182			631.218			575.852			575.976		
Wald chi2	52.540			59.040			26.540			26.790		
Prob > chi2	0.000			0.000			0.002			0.005		
Left-censored observations	0			0			0			0		
Right-censored observations	64			64			169			169		
Observations	705			705			705			705		

Note: In the table, * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level.

results, one is unable to infer that the prefectural police in which bribery and embezzlement incidents for obtaining money are less efficient organizations, although this finding depends on the assumptions made in calculating the respective efficiency values for CCR and BCC. Based on the points presented above, Hypothesis 4 is partially supported.

With respect to Hypothesis 5, the sign of the estimated coefficient of the interaction term between monthly wages (log) and the number of incidents of bribery and embezzlement is positive and significant at the 5% level in Model 6. Results for the number of incidents other than bribery and embezzlement incidents are not significant at the 5% level. In Model 8, neither the number of incidents of bribery and embezzlement nor the number of incidents of bribery and embezzlement other than bribery and embezzlement are significant. Interpretation of these results indicates that it is not necessarily the case that police departments in which bribery and embezzlement incidents for obtaining money are less efficient organizations, although this inference depends on the assumptions made in calculating the respective efficiency values for CCR and BCC. In light of the findings presented above, Hypothesis 5 is partially supported.

In summary, the results of the analysis

indicate that Hypothesis 1 is supported. Hypotheses 2–5 are partially supported.

Ⅵ. Conclusion

As described in this paper, using panel data of prefectural police during 2005–2019, which are available as data, we conducted a police efficiency assessment by DEA. Subsequently, we analyzed factors affecting the efficiency of the organization.

The results of empirical analyses reveal that pay levels are among the factors which affect the efficiency of police organizations. Furthermore, we found that, among prefectural police affected by corruption, especially bribery and embezzlement for obtaining money, the effect of salary compensation on organizational efficiency might be stronger, albeit only in the CCR model. In light of the points raised above, we conclude that pay levels are an important factor for improving the efficiency of police organizations.

In earlier domestic studies that have analyzed prefectural police, efficiency evaluation by DEA has been conducted either by inputting the number of police officers as an input without considering salaries or by inputting the number of police officers as a personnel cost. In addition, positive outputs such as the number of criminal arrests were often used. However, in practice, the outputs produced by police activities are not necessarily the only positive outputs. For example, if salaries are decreased, if collusion with targets of investigation occurs for obtaining money, or if police expenditures are bloated, it can be expected that the probability of corruption will increase. These expectations are also based on theoretical arguments surrounding the efficiency wage hypothesis. But, to date, police efficiency evaluations have been conducted while the arguments that incidents of corruption affect the efficiency of police organizations have been overlooked in existing research. In addition, based on earlier studies examining the relation between public officials' salaries and corruption, no report describes a study of efficiency evaluation by DEA. This study is a novel empirical analysis from a perspective that differs significantly from those of existing studies.

In sum, the conclusions reached from the empirical analysis of this paper have filled in some gaps left by discussions in various existing studies of the salaries of public officials and corruption and misconduct, as well as in the evaluation of police efficiency. Therefore, this study makes a certain academic contribution to the field.

Finally, the remaining issues that must be addressed are the following. Although the empirical analyses presented in this report have shown the importance of considering pay levels or even the occurrence of corruption in assessing police efficiency, the analyses have not gone so far as to conduct a DEA-based analysis with several recombination of inputs and outputs. It is conceivable that, by setting pay levels in the inputs and the number of corruption incidents in the outputs, an revaluation of police efficiency could be conducted and conclusions that differ from those of earlier studies could be obtained. In fact, in earlier foreign studies, not only the number of police officers but also personnel costs or police expenses other than personnel costs were set as the input. In light of this, some room exists to evaluate police efficiency by DEA from new perspectives, such as combining inputs that have not been considered in existing studies, including such financial variables or the number of police officers and pay levels, or by including the number of corruption cases in the outputs.

The empirical analyses described herein have not fully addressed these points in setting and testing hypotheses. Based on the results obtained from this study, we intend to deepen our research further in the future.

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Notes

1) DEA, an analytical method developed by Charnes et al. (1978), is useful for conducting efficiency evaluations using multiple inputs and multiple output variables simultaneously. Specifically, it measures the efficiency frontier based on the best performing entity. Then it uses that frontier as one criterion to evaluate the efficiency of other entities. In DEA, an entity is considered to have a production function that uses inputs to produce outputs. The DEA then evaluates the efficiency value of that entity's activities. The efficiency value of the entity's activities is subsequently defined as the output–input. The efficiency value is calculated to be between 0 and 1. Tone (1993) presents theoretical details related to the analytical method.

2) Aside from empirical analyses using DEA, Suzuki (2007, 2016) presents an analysis of the production efficiency of prefectural police.

3) The number of police officers was obtained from the "Survey of salaries of local public officials" by the Ministry of Internal Affairs and Communications, and the number of arrests for criminal offenses, special law offenses, and traffic accidents (negligence) was obtained from the "White paper on police" by the National Police Agency.

4) CCR is a data envelopment analysis model developed by Charnes–Cooper–Rhodes. The relative efficiency between economic agents at a given point in time is evaluated. Also, BCC is a data envelopment analysis model developed by Banker–Charnes–Cooper, by which the efficiency measured based on CCR tends to be lower when the activities of each entity involve economies of scale. The BCC allows for variation.

5) Empirical studies of the negative relation between the pay level and corruption of public officials based on the efficiency wage hypothesis as a theoretical base have been conducted extensively in other countries. Le et al. (2013), Herzfeld and Weiss (2003), Goel and Nelson (1998), and Van Rijckeghem and Weder (2001) are among those who argue that the efficiency wage hypothesis holds.

6) The data period used for empirical analyses is 2005--2019 because of restrictions on the retroactivity of data on corruption. Data on corruption are based on a public information request made by the author to the Civil Service Division, Local Administration Bureau, Ministry of Internal Affairs and Communications.

7) In testing each of the hypotheses in this paper, inputs and outputs are set as in the DEA analysis framework of Miyara and Fukushige (2002). Regarding data limitations, although data on the number of police officers by department are not publicly available, the numbers of police officers of the respective prefectural police forces are available from the "Survey of Pay and Compensation of Local Public Officers" from the Ministry of Internal Affairs and Communications. Therefore, conducting an analysis using the number of police officers by department corresponding to a particular type of crime, as in earlier studies done overseas, is not possible. For this reason, we use the number of arrests for criminal offenses, special law offenses, and traffic accidents (negligence) from the National Police Agency's "White Paper on Police" as outputs that can be obtained irrespective of the department in the organization. However, as Suzuki (2007, 2016) and others have pointed out, the possibility exists that the number of arrests increases as the number of crimes increases. Although the empirical analyses described in this paper do not address this issue, it is one that should be examined in future studies.

8) Monthly pay (log) is defined as the average monthly pay, adjusted by the consumer price index (CPI), and following the methods used by Ichise (2017) and Yoneoka (2019).

9) For data on corruption, the analysis covers corruption cases by local police officers, who are classified as local public officials. In a police organization, police officers who hold the rank of inspector or higher are national public officers, but their share of the total number of police officers is

negligible at about 0.2% (Ichise, 2014). In addition, the survey of corruption published annually by the Ministry of Internal Affairs and Communications is limited to local police officers. Considering these points, this study applies an empirical analysis after excluding the number of police officers with national public officer status from analyses.

10) This is true because the efficiency of police organizations is expected to be affected by changes in personnel composition.

11) This is true because the efficiency of police organizations is expected to be affected by socioeconomic factors in the region.

12) Umemura and Ogawa (2006) or Ogawa and Tanahashi (2007), who apply DEA to analyze the public sector in Japan, use a tobit analysis in which data are pooled and calculated efficiency values are used as explained variables. Based on these earlier studies, a panel tobit analysis will be used. Given the definition of the explained variable in the empirical analysis in this paper, an ordered tobit analysis might also be applied, but this remains as an issue to be examined in the future.

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