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Computerization and Employment in Japanese Banking *

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1. Introduction

As prices of computers have declined rapidly and their quality has improved, computers have become very common in offices. The software for computers increases, the method for using them is improved, and thus office automation is developing. The content of work, the organization of workers, the number of employees etc. are changing with the progress of automation.

It is often said that computers were introduced to reduce the number of employees or to make work more efficient. Research is, however, very scarce on measuring the changes in employment of clerical workers and managerial workers through computerization in Japan. The purpose of this paper therefore is to study the effects of computerization on the employment of clerical workers and managerial workers especially in Japanese banking. Banking was chosen because it is one of the most successful industries on the computerization.

It is generally difficult to classify workers between clerks and managers. Here, I use male workers and female workers as a proxy for managers and clerks, respectively. In Japanese banking, female workers are mainly engaged in work which directly operates computers. They input and prepare data along with servicing customers. Male workers are mainly engaged in work which requires judgment with using information from computers.

Yamakoshi (1987) and Watanabe (1984) (1987) suggested that the number of regular workers has declined, particularly in city banks, with the progress of the so called on-line System. The number of female regular workers has especially decreased. On the other hand, the number of part-time workers and temporary workers is said to increase though we cannot obtain their precise numbers. Here, first, I research the progress of the on-line System, the changes in number of employees and the changes in organization of labour. Secondly, I introduce directly the variables which express the ability of computers and analyze quantitatively the effects of computers on male and female employment.

2. Computers, Clerks and Managers

There are several channels through which computers might affect the employment of clerks and managers. New technology does not only decrease the employment by substitution but also has the effect of increasing employment. According to Osterman (1986), I classify the channels and apply them to banking.

1) Computers and clerks are substitutes in accomplishing a certain job such as customer billing or maintaining current accounts. Banking has such jobs as entry, calculation, counting bank notes, and maintaining customers' record. Hence, a fairly large part of these jobs can be accomplished by computers. The increase of computers, *ceteris paribus*, reduce the number of clerks in this aspect.

2) Workers who work directly with computers are needed. Examples are workers who are engaged in data input, maintenance and management of computers, data process, etc. In Japanese banking, the workers corresponding to these are those who work in the concentrated center for clerical jobs. The increase of computers increases this kind of workers.

3) The prices of products or services decline by using computers and hence the demand for these increase. Computers thus indirectly increase employment. Examples of this phenomena in banking are the progress in automatic money orders, and shortening of time for cashing, deposit and transfers. Furthermore, customers can use Cash-Dispensers in branches of other banks. Consequently people use banks more often than they used to. The progress in the convenience of banking services increases employment, though the number of employees per service decrease.

4) As computers make the clerical and managerial jobs efficient, the demand for clerical and managerial functions increases. Employment in these functions increases. Customers Information Files, Personnel Information Files of Workers, Statistical Files for Management etc. are available and analyzed in head office. Using these files, the managerial functions become effective and the demand for their functions increases.

In banking employment in the head office will increase.

5) Using information efficiently, managerial employees in the higher ranks can make decisions on the tasks which used to be decided on by lower rank employees. This situation also occurs in the managerial tasks in bank branches. Several managerial jobs which were done in each branch can be done in the head office. The number of managerial workers in branches decrease therefore.

We consider the difficulties of adjustment among sectors or the limit of managerial resources as the factors which cause decreasing returns to scale. The management and processing of information by computers make the adjustment among sectors efficient or assist managerial abilities. Computers shift the average cost curve downwards and the optimal size becomes larger. This efficiency raises the demand for managerial labour. The use of computers reduces the managerial cost in various respects. For example, the various management tasks in the branches can be done in the head office and the overall management of personnel and funds becomes more efficient. The operation of reporting for customers also can be done centrally.

Computers simplify some jobs and semi- or unskilled workers can perform the jobs which used to be performed by skilled workers. Although clerical workers needed to be skilled in the use of the Japanese abacus and bookkeeping in banking, they can, recently, accomplish these jobs with easy operations using computers. Japanese banking recently employs many part-time or temporary workers with these changes.

In short, the development in using computers not only induces a displace effect on clerical and managerial workers, but also increases their employment. The impact on employment differs among sectors in the banking firm. Computers make some jobs easier and thereby less-skilled workers can accomplish these jobs.

Differences between jobs of male workers and female workers in Japanese banking recently is not necessarily clear in some areas. There is still, however, separation between them in most jobs. This point is supported by Wakisaka's (1988) hearing research. Female workers are mainly engaged in simple clerical jobs; for example, reception, payment, cashing, entry, classification, etc. Male workers are mainly

engaged in managerial jobs which need decision making, for example, management, loaning, etc. I regard therefore female workers as clerical workers and male workers as managerial workers in the following sections.

3. Development of computerization in banking and employment

I describe the development of the on-line System over time in Japanese banking to identify its relation to employment. There are nine city banks and sixty-four local banks (which belong to the first local bank group) in the Japanese banking system of 1999. City banks are larger and their branches cover the entire country. They introduced the on-line System earlier than other banks. I first describe, accordingly, the development of the on-line System in city banks. The first on-line System began in the latter half of 1960s. This early system simply replaced clerical workers with machines. Deposits, loans, and money orders have their own line. The second on-line System began in the latter half of 1970s. Its purpose was to make the jobs more efficient by reconstructing the procedure of operations and to make the system easy enough for unskilled workers to operate. Its characteristics are as follows:

1. Interlocked operation becomes possible among deposits, loans, money orders, bills etc. Customers' information file is, thereby, enlarged and can be processed.
2. The system is operated on a nationwide scale covering all banks.
3. Automatic machines or terminal machines such as CD (Cash Dispenser) , AD (Automatic Deposit Machine) , ATM (Automatic Teller Machine, Automatic machines for deposit, withdrawal, payment, and transfer etc.) are introduced. Entry, calculation, inquiry, deposit, withdrawal, loan etc. are, thereby, operated automatically. In addition, by adding magnetic stripes to bankbooks and cash cards, customers can operate the terminal machines directly. The changes in the number of CD, AD, and ATM are shown in Table 1. Sumitomo Bank is a city bank belonging to a major city bank group. Joyo Bank is a large local bank. Ikeda Bank is a middle-size local bank. The number of terminal machines have increased rapidly and main machines have moved from CD to ATM. We can find some lags in introduction of machines among banks.

Table1 Changes in Number of CD, AD and ATM

Bank	March,1975		May,1981			March,1988		March,1995	
	CD	AD	CD	AD	ATM	CD	ATM	CD	ATM
Sumitomo	470	167	458	183	363	262	1,430	213	2,714
Joyo	118	1	177	3	26	206	254	69	840
Ikeda	15	0	64	0	3	28	130	5	232

Source:Nippon Kinyumeikan

4. It becomes possible to make statistical files on the activities of branches and information files on all employees. The head office can use these files for administration and management.

5. Network is formed among domestic banks and foreign banks.

The third on-line System began to be constructed after the middle 1980s.

There are many local banks and hence the introduction of computerization varies among them. They are, however, considered introducing the same system as that of city banks with some lags. Then I investigate the changes in employees and organization along with the process of computerization.

3-1. Changes in number of bank employees and male-female ratio

We can see the changes in the number of bank employees (including blue-collar workers) in city banks and local banks in Table 2 and 3. The increase from March 1982 to March 1983 is due to including transferred workers in bank workers since March 1983. The number of bank employees in city banks have declined constantly since 1977 when the second on-line System began progressing. The number, however, rather increased from 1989 to 1994. After 1994, it has decreased because of restructuring by the bad bonds problem. The employees in local banks began decreasing in 1983, later than in city bank. The number increased from 1990 to 1994 and it has decreased since then. This pattern is almost same with that of city banks.

The changes in number of employees are different between male and female in Table 2 and 3. Since male employees in city banks have been almost constant from 1977 to 1989, the main decline in total employees

Table2 Changes in Employees of City Banks

(The end of March, each year)

Year	Total	Male	Female	Female/Male	Number of Banks
1970	153,655	—	—	—	—
1971	157,373	—	—	—	—
1972	162,488	—	—	—	—
1973	169,829	—	—	—	—
1974	174,540	—	—	—	—
1975	180,220	—	—	—	—
1976	183,069	—	—	—	—
1977	183,219	100,374	82,845	0.83	13
1978	180,190	100,625	79,565	0.79	13
1979	179,309	100,555	78,754	0.78	13
1980	175,645	100,219	75,126	0.75	13
1981	172,647	99,767	72,880	0.73	13
1982	171,526	99,740	71,786	0.72	13
1983	176,438	106,664	69,774	0.65	13
1984	172,185	106,678	65,507	0.61	13
1985	166,194	105,576	60,618	0.57	13
1986	160,031	104,547	55,484	0.53	13
1987	157,964	105,348	52,616	0.50	13
1988	154,322	104,712	49,610	0.47	13
1989	152,122	104,086	48,036	0.46	13
1990	152,237	103,814	48,423	0.47	13
1991	152,307	103,762	48,545	0.47	12
1992	154,814	104,328	50,486	0.48	11
1993	157,141	104,237	52,904	0.51	11
1994	158,657	103,669	54,988	0.53	11
1995	155,497	101,988	53,509	0.52	11
1996	148,742	98,973	49,769	0.50	11
1997	139,413	94,576	44,837	0.47	10
1998	128,684	88,318	40,366	0.46	9
1999	124,525	84,752	39,773	0.47	9

Source : Analysisi of Financial Statements of All Banks byFederation of Bankers Associations of Japan, each year

Table3 Changes in Employees of Local Banks
(The end of March, each year)

Year	Total	Male	Female	Female/Male	Number of Banks
1970	108,576	—	—	—	—
1971	112,766	—	—	—	—
1972	119,017	—	—	—	—
1973	127,205	—	—	—	—
1974	133,481	—	—	—	—
1975	141,236	—	—	—	—
1976	147,025	—	—	—	—
1977	151,738	86,781	64,957	0.75	63
1978	155,750	88,544	67,206	0.76	63
1979	158,575	89,952	68,623	0.76	63
1980	158,963	90,744	68,219	0.75	63
1981	161,407	92,155	69,252	0.75	63
1982	164,211	93,445	70,766	0.76	63
1983	166,835	96,709	70,126	0.73	63
1984	165,278	97,141	68,137	0.70	63
1985	167,541	99,658	67,883	0.68	64
1986	165,063	99,589	65,474	0.66	64
1987	162,692	99,601	63,091	0.63	64
1988	160,374	99,175	61,199	0.62	64
1989	158,950	99,042	59,908	0.60	64
1990	158,243	98,989	59,254	0.60	64
1991	158,825	99,379	59,446	0.60	64
1992	161,681	101,094	60,587	0.60	64
1993	164,834	102,224	62,610	0.61	64
1994	168,462	103,538	64,924	0.63	64
1995	167,975	103,583	64,392	0.62	64
1996	165,695	103,167	62,528	0.61	64
1997	162,627	102,573	60,054	0.59	64
1998	158,504	101,446	57,058	0.56	64
1999	155,350	100,195	55,155	0.55	64

Source : same with Table2.

during this period are attributed to the decline in female employees. As a result, the female ratio has declined gradually during this period.

In the case of local banks, we note that Nishinippon Bank is included in local banks since 1985. The male employees have been constant or rather increased slightly, and the female employees began declining after 1983, which is later by about six years than in city banks. The decline from 1983 to 1990 is, however, slower than in city banks. The decline in employees depends upon the decline in female employees while the number of male employees does not change so much.

The movement in the number of bank white-collar workers (excluding blue-collar workers) in three city banks (Sumitomo, Sanwa and Fuji) is described in Table 4-1 to 4-3. Although the male workers increased until 1977 or 1978, they have been almost constant since then. The female workers increased until 1975 or 1976, and have declined since then until the latter half of eighties. The number of female workers is hence less than a half of that of male workers in most of banks in 1990.

The number of female part-time workers, however, increased. The Hakenhou (the law for temporary worker dispatching companies) came into effect in July 1986 and thereby banks can establish affiliated companies to supply workers to the parent bank. The number of temporary workers has increased since then, though it is difficult to obtain exact numbers. According to the "Eighty Years History of the Daiwa Bank", about 1,300 temporary workers worked in Daiwa Bank in March 1988. When we simply add this number to the regular bank workers, the total number is 4,300. Since the regular bank workers were 4,500 in the late 1970s, 4,300 is almost the same so that the workers did not decrease significantly.

3-2. The changes in the number of employees by sector

Table 5 describes the changes in number of employees in Mitsui Bank (Mitsui bank was merged with Taiyo-Kobe Bank. This merger bank becomes Sakura Bank). While the number of branches increased from 167 (including two branch offices and ten oversee branches) in 1978 to 242 (including 37 branch offices and 17 oversee branches) in 1989, the total number of employees in branches has declined continuously for this period. Consequently, the employees per branch have declined rapidly.

Table 4-1 Changes in Clerical Workers of Sumitomo Bank
(The end of March, each year)

Year	Male	Female	Female/Male
1971	7,082	5,203	0.73
1972	7,366	5,441	0.74
1973	7,606	5,886	0.77
1974	8,022	6,864	0.86
1975	8,259	6,462	0.78
1976	8,616	6,760	0.78
1977	8,765	6,851	0.78
1978	8,843	6,437	0.73
1979	8,842	6,170	0.70
1980	8,883	6,043	0.68
1981	8,900	5,673	0.64
1982	8,976	5,575	0.62
1983	9,051	5,175	0.57
1984	9,099	4,722	0.52
1985	8,953	4,255	0.48
1986	8,786	3,808	0.43
1987	10,628	4,847	0.46
1988	10,613	4,849	0.46
1989	10,592	4,445	0.42
1990	10,572	4,913	0.46
1991	10,659	5,028	0.47
1992	10,813	5,413	0.50
1993	10,846	5,932	0.55
1994	10,864	5,918	0.54
1995	10,786	5,676	0.53
1996	10,635	5,119	0.48
1997	10,454	4,489	0.43
1998	10,221	4,336	0.42
1999	10,053	4,446	0.44

Source : Financial Statement

Table 4-2 Changes in Clerical Workers of Sanwa Bank
(The end of March, each year)

Year	Male	Female	Female/Male
1971	6,896	7,909	1.15
1972	7,092	6,529	0.92
1973	7,357	7,163	0.97
1974	7,786	7,510	0.96
1975	8,124	7,749	0.95
1976	8,337	7,752	0.93
1977	8,542	7,498	0.88
1978	8,655	7,274	0.84
1979	8,747	6,927	0.79
1980	8,866	6,802	0.77
1981	9,010	6,825	0.76
1982	9,138	6,780	0.74
1983	9,171	6,163	0.67
1984	9,207	5,508	0.60
1985	9,179	5,131	0.56
1986	9,214	4,801	0.52
1987	9,325	4,413	0.47
1988	9,324	3,980	0.43
1989	9,342	3,660	0.39
1990	9,229	3,546	0.38
1991	9,305	3,825	0.41
1992	9,316	4,079	0.44
1993	9,404	4,412	0.47
1994	9,426	4,892	0.52
1995	9,369	4,912	0.52
1996	9,280	4,543	0.49
1997	9,204	4,191	0.46
1998	9,095	4,147	0.46
1999	9,026	4,297	0.48

Source : Financial Statement

Table 4-3 Changes in Clerical Workers of Fuji Bank
(The end of March, each year)

Year	Male	Female	Female/Male
1971	7,356	6,177	0.84
1972	7,633	6,620	0.87
1973	8,033	7,169	0.89
1974	8,934	7,624	0.85
1975	8,721	8,067	0.93
1976	8,976	8,411	0.94
1977	8,914	7,913	0.89
1978	8,943	7,659	0.86
1979	9,101	7,786	0.86
1980	9,124	7,451	0.82
1981	9,236	7,511	0.81
1982	9,289	7,041	0.76
1983	9,336	6,513	0.70
1984	9,329	5,979	0.64
1985	9,259	5,331	0.58
1986	9,249	4,783	0.52
1987	9,239	4,430	0.48
1988	9,213	4,244	0.46
1989	9,409	4,605	0.49
1990	9,516	4,905	0.52
1991	9,518	4,799	0.50
1992	9,792	5,112	0.52
1993	9,955	5,216	0.52
1994	10,039	5,551	0.55
1995	9,968	5,579	0.56
1996	9,832	5,318	0.54
1997	9,672	4,954	0.51
1998	9,429	4,716	0.50
1999	8,983	4,578	0.51

Source : Financial Statement

Table 5 Employees of Sections in Mitsui Bank

M : male F : female T : total

fiscal year	center for office work			pure head office			head office (total)			branches		
	M	F	T	M	F	T	M	F	T	M	F	T
65	110	81	191	523	333	856	633	414	1047	3652	2434	6086
70	480	699	1179	580	300	880	1060	999	2059	4540	3661	8201
74	666	577	1243	852	334	1186	1418	911	2429	4705	3288	7993
77	772	601	1373	937	371	1308	1709	972	2681	5214	4132	9346
80	633	492	1125	917	311	1228	1550	803	2353	5427	3777	9204
85	581	327	908	1041	272	1313	1622	599	2221	4997	3453	8450
88	647	371	1018	1460	377	1837	2107	748	2855	4417	2618	7035

Source : Nippon Kinyumeikan

Both male and female employees have declined for this period except for male employees in 1980. Since the female ratio in branches declined, however, from 44.2% in 1977 to 37.2% in 1988, the decline in female employees is larger than that of male employees.

Although the increase in small branches is one reason for this decline in employees, the collective operation of routine tasks in centers for office work is the main reason for this decline. "History of Sumitomo Bank" (1985) says "Because of the concentration of work in centers, three-fourth of office work in branches is treated in centers. In spite of the increase of office work in these ten years, the number of office workers in branches has declined."

The employees in the head office have declined from 1977 to 1985, and this decline depends upon the decline in employees in centers for office work. Employees in centers for office work increased from the latter 1960s to the middle 1970s, but they have declined since the latter half of 1970s. On the contrary, the number of male employees for pure functions of head office increased, and the number of female employees declined

until 1988. The fact that the number of male employees in the head office increased corresponds to the increasing demand for functions for adjustment and management by computers making them efficient as mentioned in section two.

In summary, we can find the following features in employment changes.

- 1) The changes in employment in each city bank are similar to those in aggregate employment across city banks. That is, city banks keep pace with each other in employment among city banks .
- 2) Although there are time lags between city bank and local bank, employees per branch began declining from a certain point of time. Female employees have especially declined faster than male.
- 3) Employees in centers for clerical work increased over a long period, but they began declining recently.
- 4) While male employees for pure functions of head office have increased or been constant, female employees in the section are on a downward trend.

4. Cross-sectional analysis using data on local banks

In this section, I try to estimate the employment function of male employees and female employees using cross-sectional data in 1987 fiscal year (from April 1987 to March 1988) on local banks. In analyzing banks, there are many nominal variables which are difficult to deflate to real ones. For example, these are current revenue, amount of deposits, amount of loans etc. Cross-sectional analysis has hence some advantages, because we can use these variables without changing to real terms. Furthermore, the innovation of computers, business machines, and computer software has developed so fast that it is very difficult to compare their ability or function through time. On the other hand, the problem of cross-sectional analysis is whether there are any technological differences among banks after the second on-line System has been established. ATM ratios in the sum of ATMs and CDs are, however, different among local banks, and the ratio ranges from almost 1 to less than 0.3. Technological differences are considered to be still existing among banks.

Male jobs are separated from female jobs as I mentioned in section 2, and they complement each other. Because their numbers have high correlation to each other, I estimate the employment function of males and

females separately. The female-male ratios vary among local banks and the range is from about 1 to about 0.4. I researched such complex production or cost functions as the translog form in Suruga (1989). Since we have, however, difficulties in treatment of computer ability, part-time workers and temporary workers firms, I use a simple double-log form employment function here as follows.

$$\ln N_i = a_0 + a_1 \ln w_i + a_2 \ln PA + a_3 D * \ln PA + a_4 \ln \text{Comp} + a_5 \ln X, \quad (1)$$

where N_i is the number of male or female employees in a bank, w_i is the wage of male or female employees, PA is the number of part-time workers, D is a dummy variable of affiliated firms for temporary workers, Comp is a variable for computers or business machines, and X is output.

Data to estimate equation (1) are collected from the "Yukashoken Houkokusho (Financial Statement) in 1987 fiscal year," of each local bank. Wage is monthly earnings in March including overtime compensations. It was allowed on July 1, 1986 for banks to form affiliated firms which send their employees to the host bank. The dummy variable is, consequently, one if the number of part-time workers changed drastically between March 1986 and March 1987, and zero if it did not change so much.

I adopt three figures as a variable for computers and business machines; that is, the summation of depreciation costs of movable property and rental or lease costs of computers and business machines, the amount of memory of mainframe computers, and ATM ratio in the sum of ATMs and CDs. We can obtain the rental or lease costs of computers and business machines from the "Yukashoken Houkokusho" since 1986 fiscal year. I assume that every bank faces the same price for computers and their related goods and services, and thus I consider the summation of depreciation, rental and leases cost as inputs about computers. The main memory amounts of mainframes are calculated from the "Japanese Banking Directory" in March 1988. ATM ratios are also calculated from the same data source.

I adopt two variables as output, that is, amount of funds which is the total of deposits, credit and certificates of deposit, and current revenue. While profits and the amount of jobs depend upon the amount of funds,

stock variables may include the results of past activities. Hence I also use current revenue.

The results of regressions using data of fifty-eight local banks are presented in Table 6. (I could not obtain the data of six local banks.) I regress the equation using least squares weighted by inverse of output. The adjusted coefficients of determination are measured in the raw equation without weights. Since the regression results using the main memory amount of mainframe computers are almost the same of the results using depreciation, rental and lease cost, I do not present the results in Table 6. I mark ** in the case of significance at the 5% level and * in the case of significance at the 10% level. The results are very similar whether I use funds or current revenue as output.

First, we look at the estimation results using the depreciation, rental and lease cost as computer variable. The dummy variable of temporary worker dispatching firms and output are significant in the regression of male employees. In the regression of female employees, the number of part-time workers is also significant in addition to the two explanation variables. Since the banks which positively use temporary workers firms also use their subsidiaries actively, the dummy variable may have a negative effect on male employees.

Since both output elasticities of male and female employees are less than one, economies of scale exist. Because the output elasticities of females are larger than those of males, the changes in output have a larger effect on female employment. The number of part-time workers are substituted for female employees as expected. Since the elasticity is about 0.4, the average number of female employees is 1,023, and the average number of part-time workers is 212, five part-time workers are needed to perform the same work of one regular female employee on average.

The computer variables are not significant. We can guess a few reasons for this result. The first one is that after the second on-line System was established, it was impossible to substitute employees for computers. The second one is that the important factor of computers is not their size but their soft-ware or how they are used. Wage variables are not significant, either. This implies that banks do not use more employees and less computers even in cheaper labour areas. Employment in banks is determined by regulation of branches and interest rates, and thus their wages

Table 6 Results of Cross-sectional Estimation with Local Banks

	fund		current profit	
	male	female	male	female
constant	- 3.38 (1.13)	- 1.20 (.71)	- 3.20 (1.23)	- 1.98 (1.14)
wage	.377 (1.50)	.0646 (.43)	.247 (1.12)	-.00167 (.01)
part-time worker	.00801 (.71)	-.0397** (2.60)	.00664 (.68)	-.0392** (2.47)
dummy for temporary firm	-.0166** (2.07)	-.0228** (2.17)	-.0230** (2.91)	-.0276** (2.53)
computer	-.0132 (.25)	.0287 (.41)	-.0223 (.50)	.0460 (.64)
output	.605** (11.80)	.746** (10.97)	.651** (14.15)	.760** (10.43)
\bar{R}^2	.942	.923	.956	.917
constant	- 3.55 (1.26)	-.880 (.54)	- 3.30 (1.36)	- 1.71 (1.00)
wage	.376 (1.60)	.0162 (.11)	.243 (1.18)	-.0536 (.35)
part-time worker	.0139 (1.27)	-.0342** (2.25)	.0122 (1.28)	-.0343** (2.15)
dummy for temporary firm	-.0152* (1.98)	-.0208** (2.03)	-.0190** (2.88)	-.0259** (2.41)
ATM ratio	-.113** (2.40)	-.116* (1.74)	-.104** (2.55)	-.106 (1.52)
output	.606** (18.46)	.786** (21.93)	.643** (21.74)	.815** (20.88)
\bar{R}^2	.948	.927	.961	.920

Values in parentheses are absolute values of t-value

are determined by efficiency wages or profits. Hence, wages do not have any effect on employment.

Next, we look at the regression results of ATM ratio in Table 6. The significant variables in the case of ATM ratio are the same as in the case of depreciation, rental and lease cost except for the coefficients of ATM ratio. ATM ratio is particularly more significant on male employment than on female employment. The banks which have higher ATM ratio and accordingly are more computerized reduce male employees more. In the case of female jobs, computers not only directly reduce regular female employees, but also make jobs easier and indirectly reduce employees by replacing them with part-time workers. The direct effects of computers on female employment may be lessened for this reason.

5. Time-series analysis on Joyo Bank

I conduct an empirical analysis using time-series data of Joyo Bank in this section. This bank is the fourth largest bank on amount of deposits among sixty-four local banks at the end of March 1989. Its head office is in Mito city, Ibaraki Prefecture and it has 127 branches in Ibaraki Prefecture and 11 branches in Fukushima Prefecture. According to the "Yukashoken Houkokusho" the on-line System covering all branches was completed in November 1973, and the second on-line System was completed in June 1978.

It is more difficult in time-series analysis to choose and treat data than in cross-sectional analysis as I mentioned in section 4. I adopt the number of branches as outputs and book values of movable property deflated by wholesale prices of electric machinery as a variable for computers. Since Joyo Bank bought most of its computers and did not rent or lease them in March 1989, I chose this bank to analyze the effects of computers on employment. According to the "Japanese Banking Directory", this bank changed its strategies on computers through time. That is, it rented or leased computers during one period but bought them during another period. It may hence be difficult to follow the movement in computer inputs by book values. The data encompasses the seventeen years from 1973 to 1989.

The consumer price indexes used for realizing wages are from the "Annual Report on Consumer Price Index" published by Statistics Bureau,

Prime Minister's Office, the wholesale price indexes of electric machinery are from the "Annual Report on Economic Statistics" published by Bank of Japan, and other observations are from the "Yukashoken Houkokusho".

The estimation results of equation (1) are presented in Table 7. The dummy variables for the on-line System was considered. Since there exists autocorrelation of disturbance terms, I take the first-order autocorrelation into consideration in estimation. I cannot find any significant variables except for the coefficient of branches in male employment.

Next taking into account the lags of adjustment by adjustment costs, I estimate the following partial adjustment model.

$$\ln N_i = b_0 + b_1 \ln N_{i-1} + b_2 \ln X + b_3 \ln PA + b_4 \ln (w_i / r)_{-1} + b_5 t \quad (2)$$

where subscription -1 expresses the variable one period before, r is price of computers, and t is time trend. I adopt the wholesale price of electric machinery as r and number of branches as X . I present the estimation

Table 7 Results of Estimation with Timeseries Data
of Joyo Bank (equation (1))

	male		female	
constant	5.10** (6.77)	5.06** (6.09)	6.66** (4.81)	6.82** (4.66)
wage	.0798 (.54)	.0837 (.54)	-.131 (.37)	-.140 (.38)
part-time worker	-.0449 (.57)	-.0519 (.55)	-.235 (1.22)	-.205 (.94)
moval property	-.00265 (.50)	-.00277 (.49)	.00793 (.73)	.00887 (.77)
branches	.493** (3.15)	.505** (2.78)	.663 (1.70)	.600 (1.37)
dummy for on-line system		-.00422 (.16)		.0229 (.41)
\bar{R}^2	.999	.999	.996	.996

results in Table 8. I use ordinary least squares to estimate the model. Even if I use this model, only the number of employees with one lag is significant in each equation. I need more data to estimate the model on time-series observations.

Table 8 Results of Estimation with Timeseries Data
of Joyo Bank (equation (2))

	male	female
constant	1.35 (.66)	4.73 (1.75)
employee (-1)	.80 (3.07)	1.05 (5.13)
branches	-.017 (.05)	-1.19 (1.68)
part-time worker	.050 (.73)	.057 (.36)
w/r (-1)	.005 (.93)	-.003 (.28)
t	-.0001 (.01)	.033 (1.60)
\bar{R}^2	.954	.925

6. Concluding Remarks

This paper tries to research the employment effects of computers in Japanese banking. In the case of city banks, the decline in employees began at the same time or a few years later when the second on-line System was completed. In the case of local banks there was a lag of about five years between the completion of the second on-line System and the decline in employees. The decline depends upon the decline in female regular employees while the number of male regular employees has been constant. The jobs of female regular employees have been substituted by computers or part-time workers by making the jobs easier.

I also study the employment changes in each sector. While the

employees have declined in branches and concentrated centers for office work, the male employees in pure function of head office have rather increased. This follows from the fact that computers make the functions for adjustment and management at head office more efficient, and the demand for these functions increases.

Using cross-sectional data of local banks, I estimate the employment functions of male and female employees. I obtain the following results from the estimation.

1. Part-time workers are substitutes only for female regular employees.
2. I research the effects of banks' subsidiaries which send their employees to the host bank. The presence of this kind of firms causes male and female employees in banks decline.
3. The elasticity of output to employment is larger in female employment than in male employment.
4. I adopt three observations as computer variables, that is, depreciation, rental and lease cost of computers, memory of mainframe, and ATM ratio. Only ATM ratio has significant negative effects on employment. Their effects is stronger on male employment than female employment. Computers are not only direct substitutes for female work but also make jobs simpler and displace female regular employees with part-time workers. The direct effects of computers on female employees may hence be lessened.
5. Wages do not influence employment. At the time when the second on-line System was completed, there may have been no room to substitute computers for employees according to relative prices differences.

footnotes

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