

The Samurai Bond: Credit Supply and Economic Growth in Pre-War Japan

Sergi Basco
UAB

John P. Tang
ANU

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Motivation

- Research question
 - Effect of credit supply on real economic activity.
 - Does it have aggregate and/or redistributive effects?
 - Does it depend on country characteristics?
 - Is it persistent over time?
- This paper focusses on pre-war Japan:
 - Quasi-natural experiment: the samurai bond (1876).
 - Government replaced hereditary pensions to samurai with bond.
 - Bonds worth half GDP and six times government revenues.
 - Exploit variation in bond value per capita between prefectures.
 - Interaction with productivity-enhancing technologies (railways).

Preview of the results

- Persistent long-run redistributive effects of credit supply shock...
 - depend on early access to railways stations.
- Redistribution of real income between and within regions
 - areas with both higher bond value per capita and stations per capita
 - faster income growth in tertiary sector (up to 1940)
 - slower income growth in primary sector (up to 1940)
- Structural transformation:
 - credit supply shock facilitated the reallocation of workers from the primary to the secondary and tertiary sector.
 - it had a less persistent effect (until 1890).

Preview of the results (cont'd)

- Improvement of financial institutions as (partial) transmission channel:
 - similar effects when using total bank capital instead of bond value.
- Role of Samurai on Industrialization:
 - samurai bank capital contributed to faster secondary income growth pre-WWI.
 - no effect on neither other sectors nor at aggregate level
- Robust to exclude wealthiest samurai:
 - wealthiest samurai were (mainly) located in Tokyo, which could bias our results.
 - without 5% bonds (received by wealthiest samurai), we obtain same results.

Road Map

- Related Literature
- The Samurai Bonds
- Data Description
- Empirical Results
- Concluding Remarks

Related Literature

- Financial development and economic growth:
 - Levine (2005), King and Levine (1993), Rajan and Zingales (1998), Guiso et al. (2004) and Mian et al. (2017).
- Railways economics:
 - other countries: Summerhill (2005), Attack et al. (2008), Herranz-Loncan (2011) and Donaldson (2018).
 - Japan: Tang (2014) and Yamazaki (2017).
- Japan:
 - Harootunian (1960), Yamamura (1967, 1974), Davis and Weinstein (2001), Hayashi and Prescott (2008), Fukao et al (2015), Perkins and Tang (2017) and Fukao and Paul (2017).

The Samurai Bond

- Samurai were a hereditary class of warriors that were the de facto rulers during the Edo period (1603-1867).
- Samurai represented around 5% of the population.
- 1868: Meiji Restoration - Samurai lost their monopolies on political and military power.
- 1876: Japanese government replaced their hereditary pensions with government bonds.
- Pension conversion was universal, compulsory, and resisted:
 - *"The effect of [the 1876 pension commutation law] was instantaneous and manifested itself in an epidemic of samurai riots and lawless demonstrations against the government"* (McLaren 1979, p. 562).
- Samurai riots culminated in the unsuccessful 1877 Seinan rebellion.
- We exploit bond value per capita variation across prefectures:
 - exogenous to existing or anticipated local economic activity.

Data sources

- Ministry of Finance (1904):
 - Bond values
- Fukao et al (2015): Regional Inequality and Industrial Structure
 - prefectural output: 1874-1940.
- Chuo Shoin (1995): Ekimei Jiten
 - railways station data: 1872-1912.
 - cf Tang (2014, 2017).

Data description

- Bond interest rate decreasing with income of samurai.

TABLE I—SAMURAI PENSION COMMUTATION SCALES, 1876

Original Annual Income Value (yen) ^a	Conversion Factor ^b	Bond Interest (%) ^c
70,000 yen or higher	5.0	5
60,000 to 70,000	5.25	5
50,000 to 60,000	5.5	5
40,000 to 50,000	5.75	5
30,000 to 40,000	6.0	5
20,000 to 30,000	6.25	5
10,000 to 20,000	6.5	5
7,000 to 10,000	6.75	5
5,000 to 7,000	7.0	5
2,000 to 5,000	7.25	5
1,000 to 2,000	7.5	5
900 to 1,000	7.75	6
800 to 900	8.0	6
700 to 800	8.25	6
600 to 700	8.5	6
500 to 600	8.75	6
450 to 500	9.0	6
400 to 450	9.25	6
350 to 400	9.5	6
300 to 350	9.75	6
250 to 300	10.0	6
200 to 250	10.25	6
150 to 200	10.5	6
100 to 150	11.0	6
75 to 100	11.5	7
50 to 75	12.0	7
40 to 50	12.5	7
30 to 40	13.0	7
25 to 30	13.5	7
Below 25	14.0	7

Data description (cont'd)

- Bond value per capita heterogeneous across prefectures.

TABLE II—SAMURAI BOND DISTRIBUTION BY PREFECTURE

	5 percent	6 percent	7 percent	Total ^b	Per capita ^c
Japan ^a	31,412,405	25,003,741	108,242,785	173,844,631	5.68
Aichi	27,815	935,810	4,982,120	5,945,745	4.71
Akita	0	216,910	2,515,130	2,732,040	4.42
Aomori	0	68,840	1,602,315	1,671,155	3.41
Chiba	0	279,310	1,465,980	1,745,290	1.39
Ehime	15,570	683,025	4,108,920	4,807,515	5.90
Fukuoka	34,850	1,945,165	676,140	8,741,465	8.14
Fukushima	0	20,740	1,171,980	1,192,720	1.75
Gifu	19,480	402,755	1,650,485	2,072,720	2.69
Gunma	0	646,795	1,779,590	2,426,385	4.05
Hiroshima	26,470	327,050	1,820,130	2,173,650	1.73
Hokkaido	43,345	730	185,595	236,300	1.56
Hyogo	9,290	516,130	3,212,560	3,737,980	2.74
Ibaraki	0	113,151	2,025,530	2,138,681	3.01
Ishikawa	206,780	3,524,630	8,813,805	12,545,215	17.64
Iwate	0	30,975	914,820	945,795	1.30
Kagoshima	84,895	242,355	4,351,275	13,146,225	15.62
Kanagawa	0	44,645	967,670	1,012,315	1.44
Kochi	292,585	2,578,055	5,763,650	9,110,350	16.63
Kumamoto	14,295	2,310,420	3,560,705	5,885,420	5.93
Kyoto	0	464,115	1,934,690	2,398,805	2.62
Mie	9,060	424,075	1,403,505	1,836,640	2.27
Miyagi	0	5,470	1,273,330	1,278,800	2.58
Nagano	0	268,740	2,116,420	2,385,160	2.40
Nagasaki	247,160	1,905,985	5,863,435	8,016,580	11.57
Niigata	0	101,080	2,300,335	2,401,415	1.57
Oita	0	373,720	2,604,435	2,978,155	4.11
Okayama	0	216,920	2,758,210	2,975,130	3.25
Osaka	0	124,375	1,061,860	1,187,045	1.16
Saitama	0	356,200	965,590	1,321,790	1.91
Shiga	8,665	366,220	2,149,105	2,531,845	4.22
Shimane	42,930	1,208,645	3,841,395	5,092,970	8.14
Shizuoka	0	1,225	3,838,490	3,839,715	4.43
Tochigi	0	44,290	652,745	697,035	1.06
Tokyo	30,261,480	2,157,555	7,208,285	39,846,950	40.42
Wakayama	23,325	740,515	2,070,915	2,834,755	4.84
Yamagata	0	279,410	3,072,000	3,351,640	5.00
Yamaguchi	13,835	1,058,930	5,432,035	6,518,215	7.52
Yamanashi	0	12,150	42,295	54,445	0.14

Data description (cont'd)

- Japan experienced a shift from primary to secondary and tertiary sector.

TABLE IV—PRE-WAR PREFECTURAL OUTPUT AND LABOR, 1874-1940

	1874	1890	1909	1925	1940
<i>All Prefectures</i>					
Gross Prefectural Product	83,976	113,156	175,413	311,803	519,881
Per capita income	113.2	127.8	152.7	214.5	285.5
Primary (%)	48.5	42.4	40.6	30.8	21.3
Secondary (%)	7.1	11.0	15.0	19.4	32.3
Tertiary (%)	44.3	46.5	44.4	49.8	46.4
Labor force (thou)	470.4	500.0	499.6	586.4	717.8
Primary (%)	70.1	60.0	57.8	50.9	47.6
Secondary (%)	12.7	20.8	20.6	23.0	25.0
Tertiary (%)	17.1	19.2	21.6	26.1	27.4
<i>Bond Prefectures^a</i>					
Gross Prefectural Product	91,211	125,076	198,592	357.5	601,687
Per capita income	113.9	131.0	157.8	221.5	292.394
Primary (%)	49.1	42.1	39.3	29.8	20.8
Secondary (%)	7.3	11.3	15.3	19.6	32.9
Tertiary (%)	43.6	46.6	45.4	50.6	46.3
Labor force (thou)	569.4	605.2	604.8	709.9	868.9
Primary (%)	70.9	60.3	57.4	50.3	46.9
Secondary (%)	12.7	20.8	20.8	23.3	25.5
Tertiary (%)	16.4	18.9	21.8	26.5	27.6

Empirical Results

- Our baseline specification is a cross-section OLS model:

$$\Delta GPPpc_{it} = \beta_0 + \beta_1 \ln GPPpc_{it-1} + \beta_2 BondPC_{i0} + \beta_3 BondPC_{i0} * StationPC_{i1} + \beta_n Covariates_{it} + \delta_t + z_{it},$$

- $GPPpc_{it}$ = real output by prefecture i and year t ,
 - $BondPC$ = real bond value per capita by prefecture i and year 1876,
 - $StationPC_{i1}$ = rail stations per capita by prefecture i and year 1885,
 - $Covariates_{it}$ = prefecture level i effects in year t ,
- We include population (market size), student enrollment share (human capital), and population density (urbanization).
 - Standard errors clustered by prefecture.

Empirical Results

- Credit supply shock did not have short-run aggregate effects on output....

TABLE V—BOND VALUE OUTPUT GROWTH REGRESSIONS, 1874-1890

DV: $\Delta \ln(\text{Output per capita})$	A	B	C	D
<i>All sectors</i>				
$\ln(1876 \text{ bond value per capita})$	-0.048 (0.029)		-0.060* (0.035)	-0.055* (0.029)
1885 rail stations per thou		0.036 (4.051)	2.628 (10.039)	-6.990 (7.570)
Interaction of bond value and rail access			5.280 (7.846)	-0.980 (5.848)
Average total effect	0.014 (0.009)	0.0001 (0.010)	0.017 (0.019)	0.0001 (0.015)
R-squared	0.144	0.052	0.168	0.457
F-statistic	1.64	1.14	1.67	4.11***

Empirical Results

- ... but it had redistributive effects between and within prefectures.
 - Areas with higher value bonds and railways had faster (slower) tertiary (primary) income growth.

TABLE V—BOND VALUE OUTPUT GROWTH REGRESSIONS, 1874-1890

DV: $\Delta \ln(\text{Output per capita})$	A	B	C	D
<i>Primary sector</i>				
Ln(1876 bond value per capita)	-0.075 (0.064)		-0.035 (0.039)	0.012 (0.036)
1885 rail stations per thou		-18.653*** (5.542)	-42.244*** (10.350)	-46.982*** (7.486)
Interaction of bond value and rail access			-27.159*** (9.719)	-26.687*** (7.192)
<i>Secondary sector</i>				
Ln(1876 bond value per capita)	0.002 (0.075)		-0.004 (0.053)	-0.059 (0.054)
1885 rail stations per thou		28.328** (10.888)	34.195 (24.718)	15.025 (25.534)
Interaction of bond value and rail access			6.282 (20.654)	-0.577 (19.128)
<i>Tertiary sector</i>				
Ln(1876 bond value per capita)	-0.080*** (0.024)		-0.109*** (0.023)	-0.102*** (0.027)
1885 rail stations per thou		1.995 (4.762)	11.225*** (3.141)	11.084*** (4.025)
Interaction of bond value and rail access			14.729*** (2.709)	11.679*** (3.359)

Empirical Results (cont'd)

- The short run redistributive growth effects extended up to 1940.

TABLE VI—BOND VALUE OUTPUT GROWTH REGRESSIONS, ALL PERIODS

DV: $\Delta \ln(\text{Output per capita})$	1874-1890	1874-1909	1874-1925	1874-1935	1874-1940
<i>Primary sector</i>					
Ln(1876 bond value per capita)	0.012 (0.036)	0.030 (0.021)	0.031 (0.020)	0.037** (0.017)	0.025 (0.015)
1885 rail stations per thou	-46.982*** (7.486)	-29.154*** (8.392)	-19.212*** (6.278)	-15.697*** (4.970)	-9.365** (4.410)
Interaction of bond value and rail access	-26.687*** (7.192)	-20.817*** (7.379)	-15.084** (5.624)	-13.634*** (4.424)	-9.086** (3.899)
Average total effect	-0.083*** (0.015)	-0.052*** (0.013)	-0.036*** (0.009)	-0.031*** (0.008)	-0.018** (0.007)
R-squared	0.763	0.577	0.456	0.459	0.380
F-statistic	13.39***	15.09***	14.94***	42.10***	22.22***
<i>Tertiary sector</i>					
Ln(1876 bond value per capita)	-0.102*** (0.027)	-0.075** (0.034)	-0.056*** (0.018)	-0.039** (0.018)	-0.027** (0.013)
1885 rail stations per thou	11.084*** (4.025)	9.906** (4.449)	7.884** (3.142)	3.019 (2.918)	1.541 (2.410)
Interaction of bond value and rail access	11.679*** (3.359)	9.987** (3.837)	11.638*** (2.330)	6.505*** (2.315)	4.551** (1.829)
Average total effect	0.041*** (0.010)	0.033*** (0.012)	0.020** (0.008)	0.010 (0.008)	0.005 (0.006)
R-squared	0.520	0.408	0.547	0.680	0.668
F-statistic	8.84***	10.99***	28.16***	80.47***	78.88***

Empirical Results (cont'd)

- Financial development as (part) of transmission mechanism:
 - bank capital represents less than half of bonds value,
 - bank capital already included in tertiary sector.
- We expect negative and similar effect on primary income growth.

TABLE VII—BANKING CAPITAL REGRESSIONS, ALL PERIODS

DV: $\Delta \ln(\text{Output per capita})$	1874-1890	1874-1909	1874-1925	1874-1935	1874-1940
<i>Primary sector</i>					
$\ln(1884 \text{ banking capital per capita})$	-0.009 (0.031)	-0.024 (0.018)	-0.026 (0.016)	-0.027* (0.015)	-0.020 (0.014)
1885 rail stations per thou	-3.250 (3.993)	3.894 (3.677)	3.183 (3.958)	2.935 (3.879)	2.728 (3.434)
Interaction of banking capital and rail access	-35.468*** (7.013)	-27.862*** (7.177)	-17.425** (7.258)	-12.816* (6.455)	-7.781 (5.572)
Average total effect	-0.077*** (0.008)	-0.048*** (0.008)	-0.030*** (0.006)	-0.022*** (0.006)	-0.012** (0.006)
R-squared	0.807	0.643	0.487	0.469	0.384
F-statistic	28.97***	20.24***	31.05***	31.02***	20.45***

Empirical Results (cont'd)

- Samurai banks had a positive effect on early industrialization but not overall growth effect (or in other sectors).

TABLE VIII—SAMURAI BANK CAPITAL REGRESSIONS, ALL PERIODS

DV: $\Delta \ln(\text{Output per capita})$	1874-1890	1874-1909	1874-1925	1874-1935	1874-1940
<i>All sectors</i>					
Ln(1884 samurai bank capital per capita)	-0.031 (0.037)	-0.008 (0.022)	-0.009 (0.016)	-0.003 (0.017)	0.0005 (0.013)
1885 rail stations per thou	6.882 (8.948)	1.715 (5.692)	4.146 (4.667)	-0.548 (5.033)	-0.935 (4.122)
Interaction of banking capital and rail access	5.112 (3.556)	1.614 (2.084)	3.108* (1.684)	0.930 (1.930)	-0.395 (1.553)
Average total effect	0.067 (0.091)	0.017 (0.056)	0.015 (0.040)	0.002 (0.042)	-0.006 (0.034)
R-squared	0.383	0.330	0.456	0.463	0.451
F-statistic	4.01***	8.01***	9.60***	18.15***	19.17***
<i>Secondary sector</i>					
Ln(1884 samurai bank capital per capita)	-0.123 (0.076)	-0.090* (0.046)	0.001 (0.036)	0.001 (0.032)	0.014 (0.025)
1885 rail stations per thou	82.341*** (21.294)	42.770** (16.204)	16.971 (13.235)	8.818 (10.779)	4.681 (8.555)
Interaction of banking capital and rail access	30.779*** (8.072)	17.890*** (5.670)	6.894 (4.675)	4.389 (3.767)	2.070 (2.989)
Average total effect	0.347* (0.190)	0.234** (0.115)	0.004 (0.091)	-0.004 (0.081)	-0.033 (0.064)
R-squared	0.441	0.258	0.129	0.095	0.212
F-statistic	10.44***	8.31***	10.69***	4.04***	12.59***

Empirical Results (cont'd)

- Robust to exclude wealthiest samurai (5% coupon bonds).

TABLE IX—HIGH COUPON BOND VALUE REGRESSIONS, ALL PERIODS

DV: $\Delta \ln(\text{Output per capita})$	1874-1890	1874-1909	1874-1925	1874-1935	1874-1940
<i>Primary sector</i>					
Ln(1876 high coupon bond per capita)	0.014 (0.040)	0.031 (0.021)	0.031 (0.019)	0.037** (0.016)	0.025 (0.015)
1885 rail stations per thou	-52.139*** (15.322)	-29.955** (12.584)	-21.085** (8.436)	-18.340*** (6.302)	-12.163** (5.118)
Interaction of bond value and rail access	-26.394** (12.551)	-18.802* (10.292)	-14.877** (6.706)	-14.348*** (4.884)	-10.515*** (3.861)
Average total effect	-0.085*** (0.020)	-0.050*** (0.015)	-0.035*** (0.011)	-0.031*** (0.008)	-0.019** (0.007)
R-squared	0.703	0.537	0.442	0.456	0.382
F-statistic	10.15***	13.53***	15.20***	30.29***	21.52***
<i>Tertiary sector</i>					
Ln(1876 high coupon bond per capita)	-0.102*** (0.027)	-0.075** (0.033)	-0.056*** (0.017)	-0.038** (0.018)	-0.027** (0.013)
1885 rail stations per thou	12.806*** (4.670)	12.654** (4.837)	10.309*** (3.338)	4.718 (2.841)	2.466 (2.421)
Interaction of bond value and rail access	12.088*** (3.823)	11.415*** (3.861)	12.458*** (2.189)	7.294*** (1.826)	4.866*** (1.516)
Average total effect	0.044*** (0.010)	0.035*** (0.011)	0.021*** (0.008)	0.011 (0.008)	0.006 (0.006)
R-squared	0.526	0.416	0.548	0.681	0.668
F-statistic	10.35***	12.33***	51.23***	82.09***	79.20***

Empirical Results (cont'd)

- Credit supply shock facilitated the structural transformation of Japan.

TABLE X—LABOR SHARE GROWTH REGRESSIONS BY BOND VALUE, ALL PERIODS

	1874-1890	1874-1909	1874-1925	1874-1935	1874-1940
DV: Δ secondary/primary labor force					
Ln(1876 bond value per capita)	-0.078 (0.054)	-0.089* (0.050)	-0.068* (0.037)	-0.051* (0.030)	-0.051* (0.028)
1885 rail stations per thou	76.371*** (16.498)	20.918 (27.909)	10.500 (15.948)	7.251 (10.388)	1.498 (9.255)
Interaction of bond value and rail access	77.911*** (15.187)	21.798 (25.586)	15.464 (14.137)	12.271 (8.984)	5.721 (7.964)
Average total effect	0.104*** (0.021)	0.048 (0.036)	0.024 (0.024)	0.016 (0.018)	0.011 (0.016)
R-squared	0.611	0.738	0.706	0.726	0.716
F-statistic	15.03***	38.97***	46.93***	45.95***	43.47***
DV: Δ tertiary/primary labor force					
Ln(1876 bond value per capita)	-0.171** (0.064)	-0.161** (0.064)	-0.136*** (0.049)	-0.110** (0.043)	-0.087** (0.034)
1885 rail stations per thou	33.812*** (10.019)	11.771 (18.302)	3.680 (11.968)	9.652* (5.344)	7.920* (4.249)
Interaction of bond value and rail access	35.973*** (9.718)	18.883 (15.930)	11.491 (10.928)	17.371*** (4.833)	15.229*** (4.003)
Average total effect	0.084*** (0.021)	0.050* (0.028)	0.033 (0.021)	0.032** (0.015)	0.024** (0.012)
R-squared	0.462	0.439	0.413	0.407	0.483
F-statistic	9.68***	22.41***	33.60***	44.16***	50.73***

Concluding Remarks

- Limits to structural transformation may have delayed the industrialization of Japan (Hayashi and Prescott, 2008).
- We showed that the credit supply shock facilitated this structural transformation.
 - Prefectures with higher bond value per capita and initial railway stations shift experienced faster (slower) growth in tertiary (primary) sector income.
 - We documented the same result for the reallocation of labor.
- The effects of credit supply depend on country characteristics.
 - consistent with fundamentals location constraints emphasized in Davis and Weinstein (2001).
- Future work:
 - firm dynamics: bubbly or more resilient firms?
 - investigate the effect on inequality within the region.