Table.1: Characteristics of sample cities (1921-1925)

Name of cities (in order of distance)	Average population (hundred)	Longitude (degrees)	Latitude (degrees)	Geospatial distance from Tokyo (100 kilometres)	Area classifications	Sea route distance from Tokyo (100 kilometres)	Closeness (reciprocal)
Niigata	1,051	139.04	37.92	2.55	East	7.68	0.13
Nagoya	6,923	136.91	35.18	2.65	West	2.01	0.50
Kanazawa	1,470	136.66	36.56	2.95	West	8.67	0.12
Sendai	1,337	140.87	38.27	3.02	East	2.99	0.33
Kyoto	6,692	135.77	35.01	3.70	West	8.59	0.12
Osaka	16,134	135.50	34.69	4.03	West	3.67	0.27
Kobe	6,865	135.20	34.96	4.30	West	3.59	0.28
Kochi	570	133.53	33.56	6.18	West	3.81	0.26
Hiroshima	1,773	132.46	34.39	6.81	West	5.31	0.19
Otaru	1,206	140.98	43.19	8.39	East	7.35	0.14
Fukuoka	1,306	130.40	33.59	8.88	West	6.15	0.16

Notes: The geospatial distances between each city and Tokyo city are calculated using the spheroid (GRS80) of the Geospatial Information Authority of Japan (GIAJ) based on the information on longitude and latitude of each city (Appendix B describes the details of this Application Programming Interface of the GIAJ). Closeness is the reciprocal number of the marine distance. For instance, in the case of Niigata city, Closeness is calculated as 1/7.68.

Sources: Data on latitude and longitude are from the database of the GIAJ (see Appendix B). Data on the number of population between 1921 and 1925 are from Naikaku Tōkeikyoku, *Nihon teikoku jinkō dōtai tōkei* 1924-1926. The marine distances between each city port and Tokyo city port are from Suirobu, *Kyorihyō*.

Table.2: Summary Statistics

	Entire period			Before the earthquake			After the earthquake		
	Observation	Mean	Std.Dev.	Observation	Mean	Std.Dev.	Observation	Mean	Std.Dev.
Panel (A): Wholesale prices									
Rice, yen per 180 litres	616	36.1	5.10	308	33.38	4.72	308	38.84	3.87
Wheat, yen per 180 litres	608	19.32	3.40	307	17.98	2.17	301	20.70	3.85
Cotton yarn, yen per 60 kilograms	616	97.59	15.56	308	85.92	8.82	308	109.25	11.57
Pine board, yen per one piece	613	2.33	0.68	307	2.49	0.59	252	4.38	1.88
Calcium superphosphate, yen per 37.5 kilograms	609	1.73	0.29	302	1.71	0.31	307	1.76	0.27
Coal, yen per ton	616	20.50	4.33	308	21.53	4.34	308	19.47	4.08
Charcoal, yen per ton	616	90.27	17.33	308	92.70	17.39	308	87.84	16.95
Panel (B): Key variables									
Sea route distance from Tokyo, 100 km	616	8.75	3.65						
Reciprocal of sea route distance	616	0.14	0.07						
Post earthquake dummy	616	0.50							
Panel (C): Control variables									
Population (annual), thousands	616	398.87	441.81	308	372.34	385.8	308	425.22	490.72
Tonnage (annual), thousand tons	616	8843.54	9633.86	308	8551.34	9597.05	308	9135.74	9677.31
Railway freight (annual), thousand tons	616	281.01	229.57	308	269.79	221.60	308	292.23	237.11
Factories (annual), per 100 people	616	0.73	0.32	308	0.77	0.33	308	0.70	0.30
Monthly average temperature, Celsius	616	13.98	8.66	308	14.66	8.80	308	13.30	8.48
Monthly average precipitation, millimetres	616	114.19	114.56	308	153.37	125.91	308	129.02	100.69
Monthly average atmosphere pressure, hectopascal	616	1014.59	4.37	308	1014.30	4.52	308	1014.89	4.21

Notes: Closeness is the reciprocal number of the sea route distance. Post earthquake dummy is an indicator variable that equals one for the period after September 1923. Tonnage is the total tonnage of both steamships and sailing ships in the ports in each prefecture. Railway freight is the total volume of freight in the stations in each provincial city. Factories is the number of factories with more than five workers in each prefecture per 100 city population.

Sources: Online database of the JMA; Naikaku Tōkeikyoku, *Nihon teikoku jinkō* 1924-1926; Naikaku Tōkeikyoku, *Nihon teikoku* 1924-1927; Nōshōmushō Tōkeika, *Kōjō tōkeihyō* 1923-1927; Shōkōmushō Tōkeika, *Kōjō tōkeihyō 1924*-25; Suirobu, *Kyorihyō* 1919; Tetsudōshō, *Tetsudōshō* 1924-1927. Appendix B describes the data sources in more detail.

Table 3: Baseline estimates for May 1921 to December 1925, by product

	Dependent variable						
	(1) Rice	(2) Wheat	(3) Cotton yarn	(4) Pine board	(5) Calcium superphosphate	(6) Coal	(7) Charcoal
Closeness×*Post*	3.038***	0.742	-4.872	-0.044	0.254**	-2.625**	-1.114
	(0.716)	(1.152)	(4.999)	(0.298)	(0.100)	(0.864)	(6.644)
F-statistic *p*-value on joint significance of covariates	0.000	0.000	0.000	0.000	0.000	0.000	0.000
R-squared	0.9746	0.9517	0.9820	0.9117	0.9459	0.9806	0.9403
Number of observations	605	594	605	600	594	605	605

Notes: Observations are at the city-month level. The unit of all wholesale prices is yen. *Closeness* is the reciprocal of the marine distance from Tokyo (100 km) described in Table 1. *Post* is an indicator variable that equals one for periods after September 1923. Lagged dependent variable, all control variables, city- and year-fixed effects are included in all specifications. *** and ** represent statistical significance at the 1% and 5% levels, respectively. Cluster-robust standard errors are in parentheses.

Table 4: Baseline estimates for alternative cutoff period

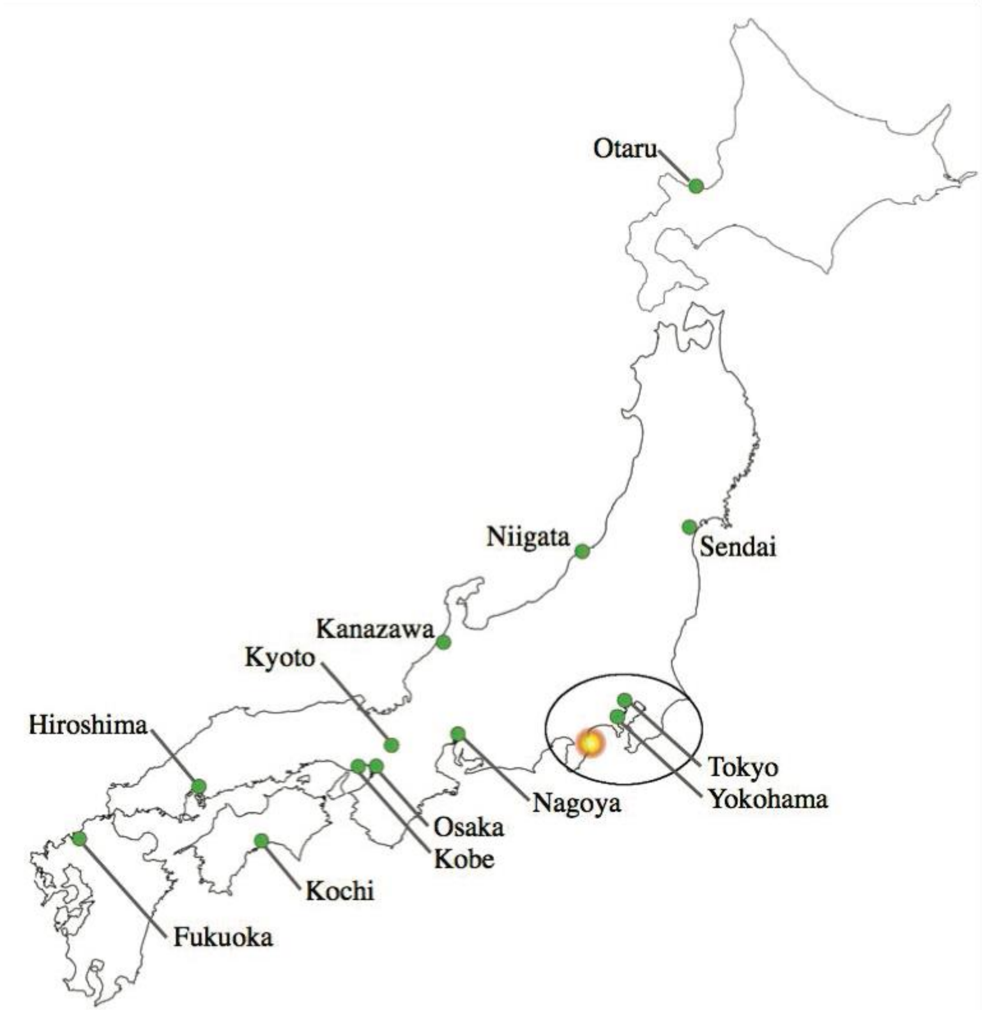
		Rice		Wheat		Cotton yarn		Pine board		Calcium superphosphate		Coal		Charcoal	
Cutoff period	Post-earthquake period	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.
May 1921-Nov 1923	3-month: Sep 1923-Nov 1923	3.505**	(1.405)	-0.433	(1.479)	0.859	(3.067)	1.340**	(0.593)	0.260	(0.254)	-0.850	(1.517)	26.993*	(12.688)
May 1921-Feb 1924	6-month: Sep 1923-Feb 1924	2.942***	(0.720)	-1.389	(1.226)	-1.677	(4.692)	0.310	(0.336)	0.290	(0.227)	-0.739	(1.493)	14.689	(9.229)
May 1921-May 1924	9-month: Sep 1923-May 1924	2.475**	(0.820)	-1.446	(1.187)	-5.919	(3.596)	0.226	(0.417)	0.250	(0.214)	-0.750	(1.455)	5.000	(5.144)
May 1921-Aug 1924	12-month: Sep 1923-Aug 1924	2.891***	(0.804)	-0.836	(0.901)	-3.812	(3.837)	0.239	(0.385)	0.253	(0.184)	-1.854	(1.233)	6.172	(5.974)
May 1921-Nov 1924	15-month: Sep 1923-Nov 1924	2.717***	(0.704)	-0.041	(0.940)	-3.715	(4.117)	0.282	(0.344)	0.238	(0.146)	-2.358**	(0.986)	8.417	(7.322)
May 1921-Feb 1925	18-month: Sep 1923-Feb 1925	2.693***	(0.583)	0.256	(0.846)	-5.351	(4.004)	0.232	(0.324)	0.250*	(0.128)	-2.567**	(0.939)	3.177	(8.164)
May 1921-May 1925	21-month: Sep 1923-May 1925	2.875***	(0.595)	-0.359	(0.758)	-5.201	(4.724)	0.170	(0.319)	0.264*	(0.122)	-2.601**	(0.880)	0.418	(8.120)
May 1921-Aug 1925	24-month: Sep 1923-Aug 1925	2.766***	(0.614)	0.346	(1.177)	-5.239	(4.793)	0.028	(0.317)	0.274**	(0.110)	-2.758**	(0.958)	-0.374	(7.864)
May 1921-Dec 1925	28-month: Sep 1923-Dec 1925	3.038***	(0.716)	0.742	(1.152)	-4.872	(4.999)	-0.044	(0.298)	0.254**	(0.100)	-2.625**	(0.864)	-1.114	(6.644)

Notes: Observations are at the city-month level. The unit of all wholesale prices is yen. The number of observations for the periods from May 1921 to November 1923, to February 1924, to May 1924, to August 1924, to November 1924, to February 1925, to May 1925, to August 1925, and December 1925 are 330, 363, 396, 429, 462, 495, 528, 561, and 605, respectively. The estimates for the period from May 1921 to December 1925 are those shown in Table 3. Lagged dependent variable, control variables, and city- and month-fixed effects are included in all specifications. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Cluster-robust standard errors are in parentheses.

Table 5 Results for cotton yarn: error correction model

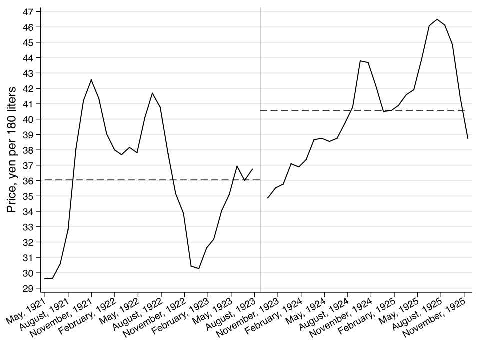
Cities	α		γ	
	Estimate	Std. Err.	Estimate	Std. Err.
Osaka	-0.703	(0.160)***	0.780	(0.079)***
Kobe	-0.679	(0.154)***	0.727	(0.088)***
Kyoto	-0.683	(0.147)***	0.720	(0.084)***
Nagoya	-0.742	(0.178)***	0.829	(0.092)***
Hiroshima	-0.789	(0.182)***	0.797	(0.111)***
Kanazawa	-0.806	(0.149)***	0.720	(0.084)***
Sendai	-0.919	(0.150)***	0.746	(0.060)***
Otaru	-0.870	(0.165)***	0.845	(0.097)***
Fukuoka	-0.488	(0.161)***	0.653	(0.132)***
Niigata	-0.715	(0.153)***	0.682	(0.086)***
Kochi	-0.617	(0.154)***	0.649	(0.094)***

Notes: The number of months is 28 (from August 1923 to December 1925) in all equations. *** represents statistical significance at the 1% level.

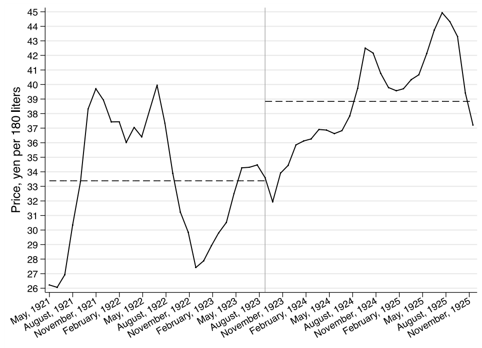


Otaru
Niigata
Sendai
Kanazawa
Kyoto
Hiroshima
Tokyo
Yokohama
Nagoya
Osaka
Kobe
Kochi
Fukuoka

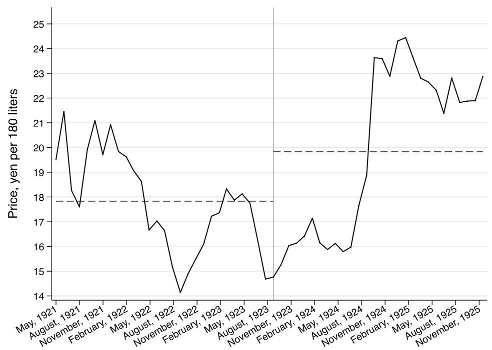
Figure 1



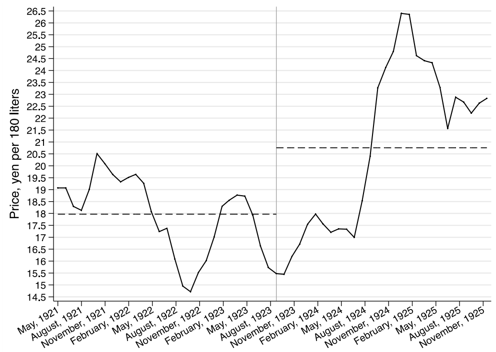
(a) Rice in Tokyo and Yokohama, yen per 180 litres



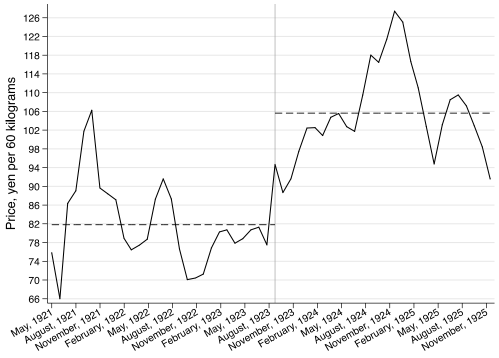
(h) Rice in provincial cities, yen per 180 litres



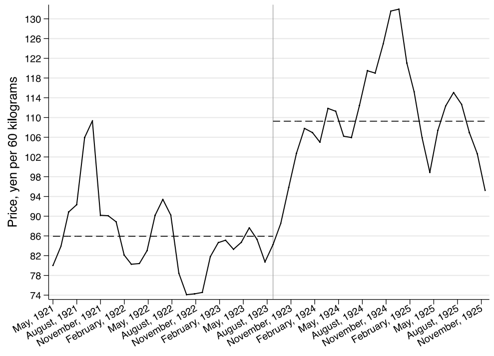
(b) Wheat in Tokyo and Yokohama, yen per 180 litres



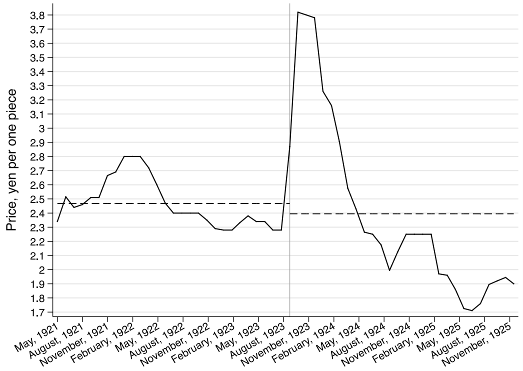
(i) Wheat in provincial cities, yen per 180 litres



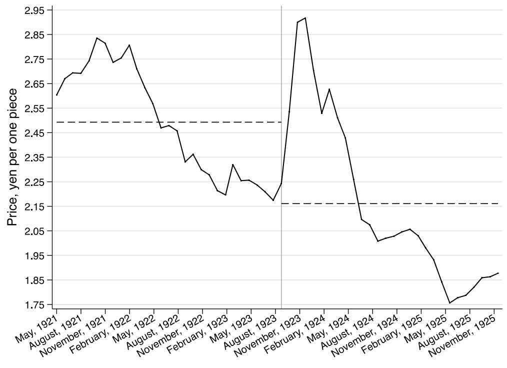
(c) Cotton yarn in Tokyo and Yokohama, yen per 60 kg



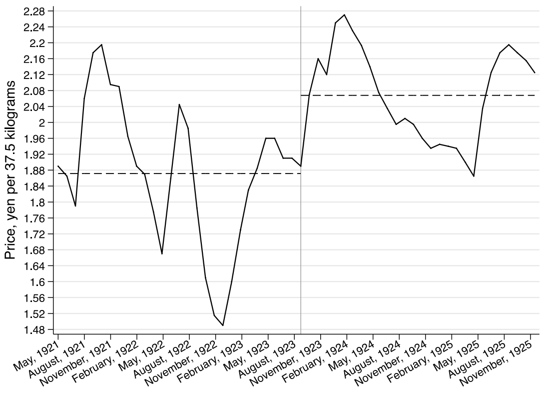
(j) Cotton yarn in provincial cities, yen per 60 kg



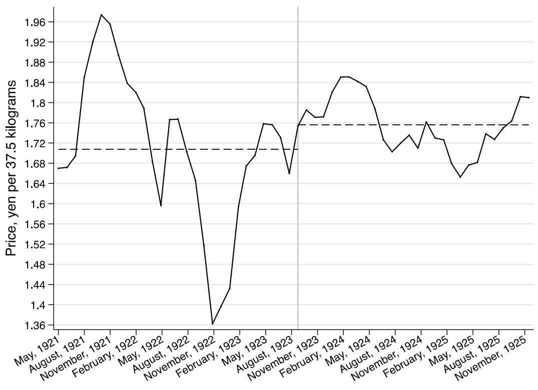
(d) Pine board in Tokyo and Yokohama, yen per one piece



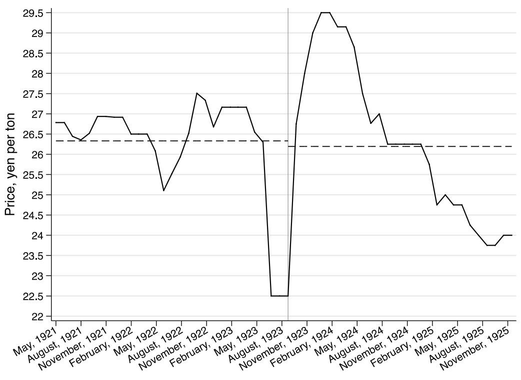
(k) Pine board in provincial cities, yen per one piece



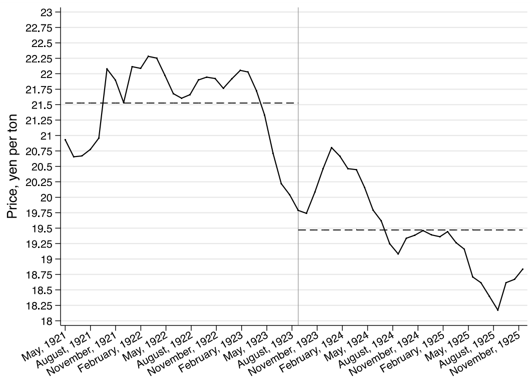
(e) Calcium superphosphate in Tokyo and Yokohama, yen per 37.5 kg



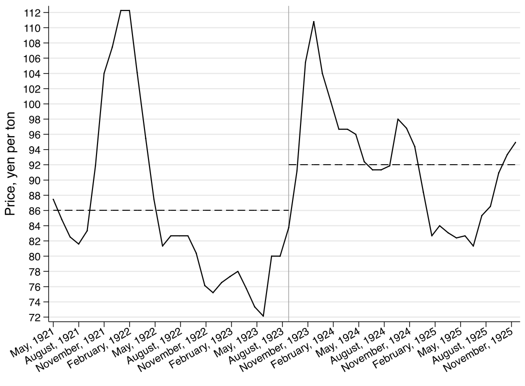
(l) Calcium superphosphate in provincial cities, yen per 37.5 kg



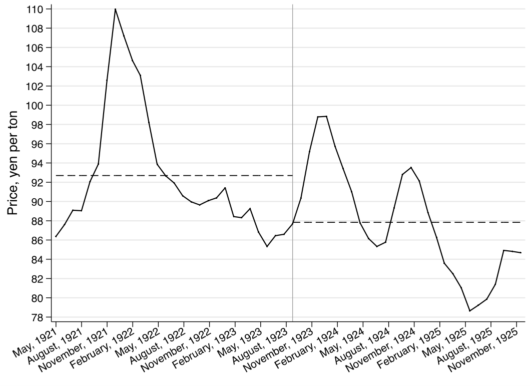
(f) Coal in Tokyo and Yokohama, yen per ton



(m) Coal in provincial cities, yen per ton



(g) Charcoal in Tokyo and Yokohama, yen per ton



(n) Charcoal in provincial cities, yen per ton

Figure 2 Time series plots of average prices of products
in Tokyo and Yokohama (first column) and in provincial cities (second column)

Notes: The average prices of products in Tokyo and Yokohama are shown in Figure (a), (b), (c), (d), (e), (f), and (g). The average prices of products in provincial cities are shown in Figure (h), (i), (j), (k), (l), (m), and (n). The gray vertical line shows September 1923. Dotted lines show the average price of each product before and after the earthquake. Appendix B describes the details of the price series. The anomalous value for the price of coal in July to September 1923 is explained by missing data for Yokohama. Source: Shōkōmushō Tōkeika, *Oroshiuri bukka tōkeihyō* (See Appendix B).

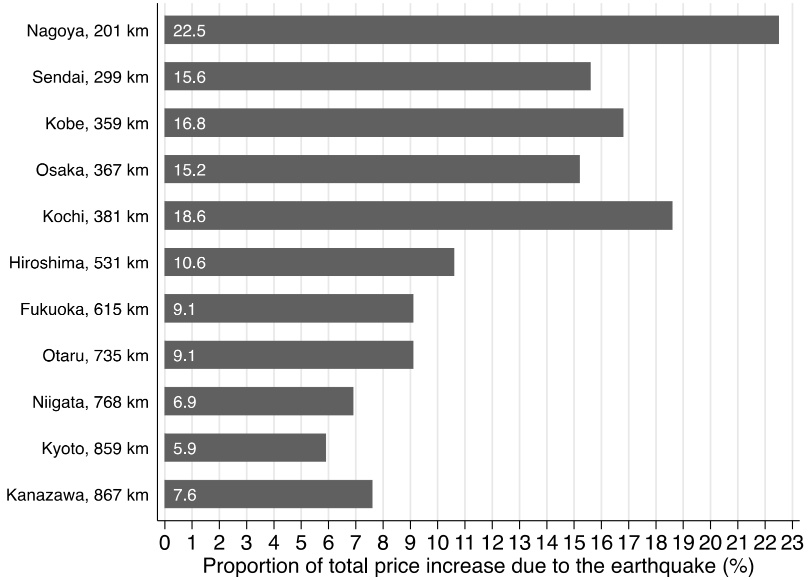


Figure 3: Impact of the earthquake on wholesale price of rice in provincial cities by sea route distance from Tokyo

Notes: The length of the bar shows the estimated increase in price due to the earthquake as a proportion of the total increase in price from the period May 1921-August 1923 to the period September 1923-December 1925, calculated using our baseline estimate reported in Table 3. Both the increase in price caused by the earthquake and the total increase in price between the period up to August 1923 and the period after September 1923 in each provincial city are reported in Table C.6 in Appendix C.

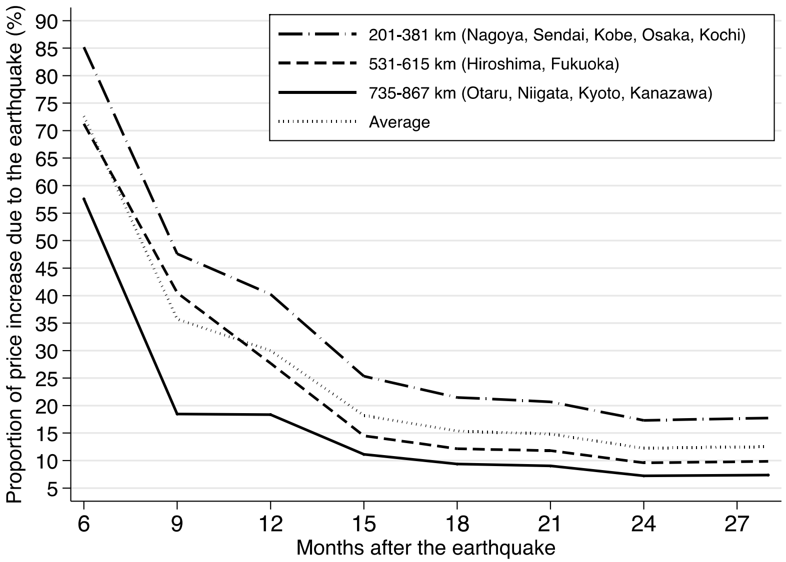


Figure 4: Proportion of increase in rice price due to the earthquake,

by distance

Notes: The lines show the estimated increase in price due to the earthquake as a proportion of the total increase in price from the period May 1921 - August 1923 to the period after September 1923 in each area (see Figure C.2 in Appendix C.4 for the magnitude in each individual provincial city). The post-earthquake periods are set at 6, 9, 12, 15, 18, 21, 24, and 28 months, respectively.

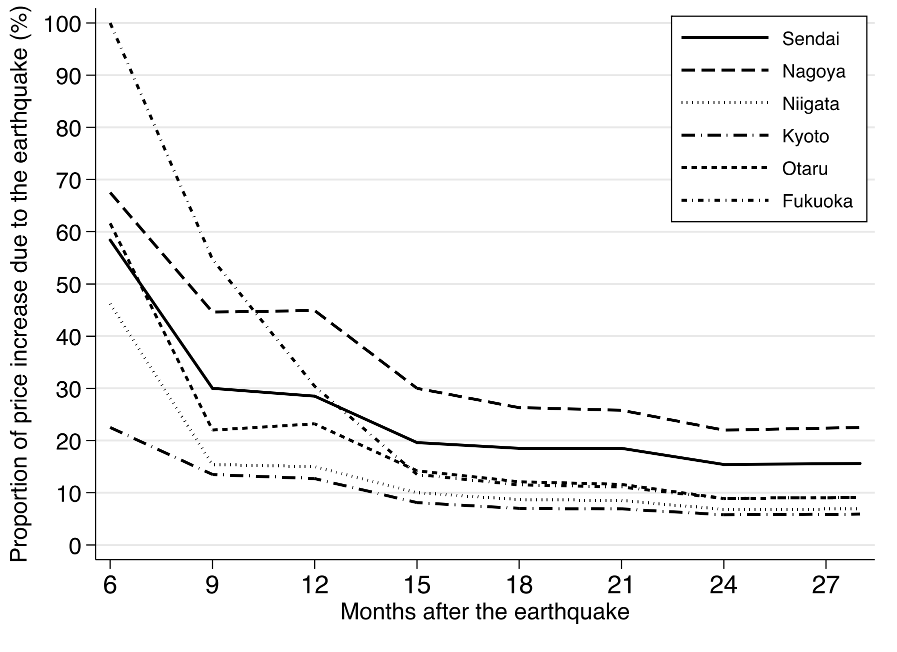
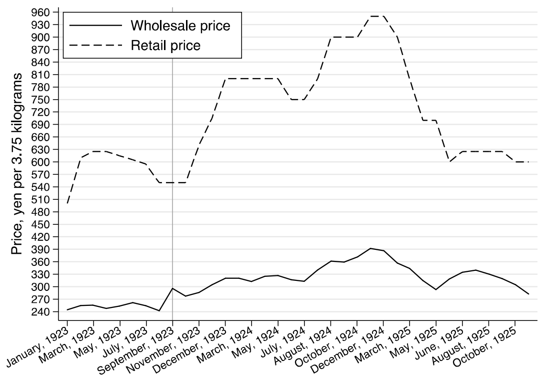


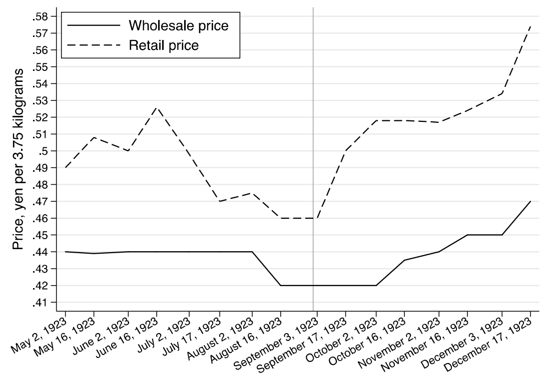
Figure 5: Proportion of increase in rice price due to the earthquake:

Comparison of northeastern and southwestern cities

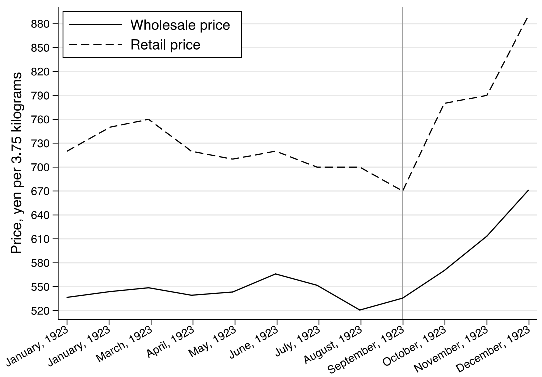
Note: The lines show the increase in price due to the earthquake as a proportion of the total increase in price from the period May 1921 - August 1923 to the period after September 1923 in northeastern (Sendai, Niigata, and Otaru) and in southwestern (Nagoya, Kyoto, and Fukuoka) cities.



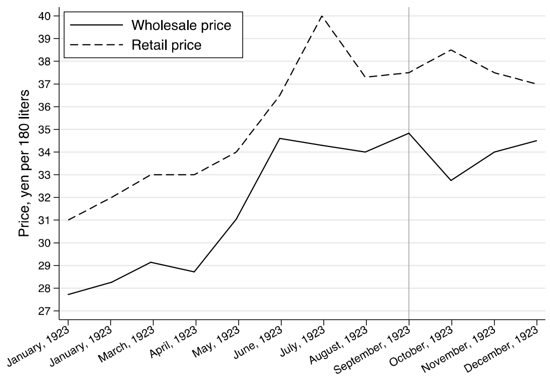
(a) Cotton yarn in Tokyo, yen per 3.75 kg



(b) Charcoal in Osaka, yen per 3.75 kg



(c) Cotton yarn in Fukuoka, yen per 3.75 kg



(d) White rice in Fukuoka, yen per 3.75 kg

Figure 6: Observed disparities between wholesale and retail prices

in Tokyo, Osaka, and Fukuoka city

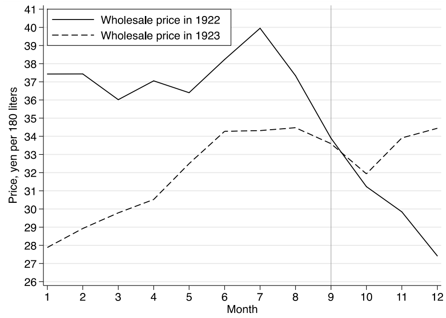
Notes: The end point of the period in each graph is determined by the availability of data. Tokyo city is included in the devastated area. The geospatial distances from Tokyo to Osaka and

Fukuoka city are 403 km and 888 km, respectively. The grey vertical line shows September 1923. The solid line shows the retail price, and the dashed line the wholesale price.

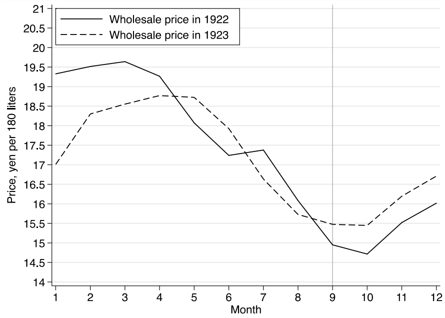
Sources: Tōkyō Shōgyō Kaigisho, *Tōkyō shōkō kaigisho tōkei nenpō*; Ōsaka Shōgyō Kaigisho, *Tōkei nenpō*; Hakata Shōgyō Kaigisho, *Hakata shōgyō kaigisho tōkei nenpō*.

Online Appendices

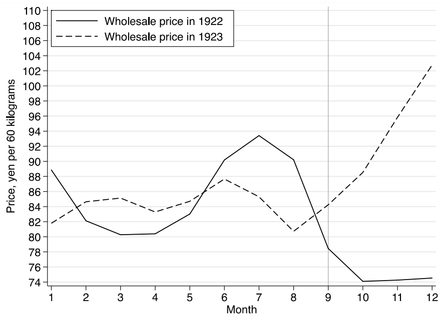
Appendix A Background appendix



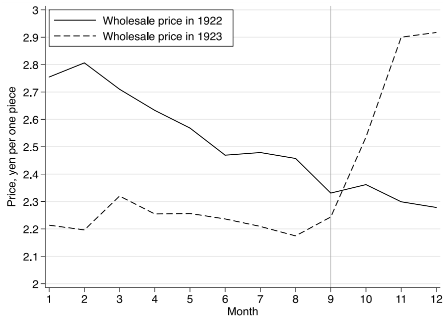
(a) Rice, yen per 180 litres



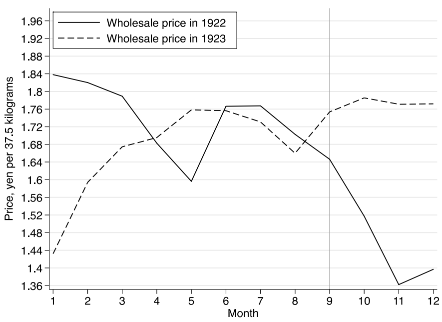
(b) Wheat, yen per 180 litres



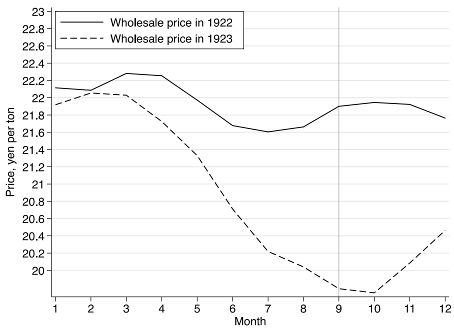
(c) Cotton yarn, yen per 60 kg



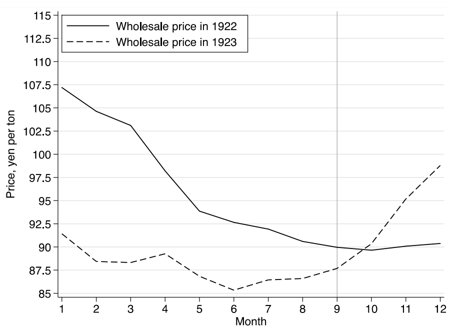
(d) Pine board, yen per one piece



(e) Calcium superphosphate, yen per 37.5 kg



(f) Coal, yen per ton



(g) Charcoal, yen per ton

Figure A.1 Comparison of average wholesale prices in provincial cities 1922-23

Notes: The gray vertical line shows September 1923.
Source: Shōkōmushō Tōkeika, *Oroshiuri bukka tōkeihyō.*

Figure A.1 illustrates the average wholesale price of products in provincial cities in 1922 and in 1923. Since 1922 did not experience any extreme events like the earthquake, the price series in 1922 can be considered as the trend in a normal year. As shown in Figure A.1, a clear increase in prices after September 1923 can be observed for rice, cotton yarn, pine board, and fuels. The price of calcium superphosphate declines from the summer in 1922, while the price in 1923 does not show such a decreasing trend.

Appendix B Data appendix

A. Wholesale and retail prices

The data on wholesale prices are from the *Oroshiuri bukka tōkeihyō* (Tables of statistics of wholesale prices) published by the Statistical Section of the Ministry of Commerce and Industry in 1926. The digital archive is available in the National Diet Library Digital Collections (http://dl.ndl.go.jp/info:ndljp/pid/1710197). The cities reported in this document are Tokyo, Yokohama, Niigata, Nagoya, Kanazawa, Sendai, Kyoto, Osaka, Kobe, Kochi, Hiroshima, Otaru, and Hakata. This document recorded monthly wholesale prices for several goods in these cities for the convenience of general users (see Introduction to this statistical report). For Tokyo city, the price of rice in September 1923 is missing from the data. This missing value was linearly interpolated when we applied the error correction model in Section III. For Yokohama city, the price of rice from July 1923 to September 1923, the prices of wheat, cotton yarn, pine board, and calcium superphosphate from July 1923 to February 1923, the price of coal from July 1923 to September 1923, and the price of charcoal from 1923 to October 1923 are not available. In the empirical analyses, rice includes brown rice (1st, 2nd and 3rd grades) and white rice. The data on retail prices are from several documents that were issued by the local chambers of commerce in each city. The information on retail prices in Tokyo city is from the *Tōkyō shōgyō kaigisho tōkei nenpō* (Annual statistical report of Tokyo Chamber of Commerce) for 1925 published by the Tokyo Chamber of Commerce in 1927. The information on retail prices in Osaka city is from the *Tōkei nenpō* (Annual statistical report) for 1923 published by Osaka Chamber of Commerce in 1923. The information on retail prices in Hakata (part of Fukuoka city) is from the *Hakata shōgyō kaigisho tōkei nenpō* (Annual statistical report of Hakata Chamber of Commerce) for 1924 published by Hakata Chamber of Commerce in 1924.

B. Geospatial and sea route distances between Tokyo and provincial cities

We calculated the minimum distances between each city and Tokyo city using the spheroid (GRS80) of the Geospatial Information Authority of Japan (GIAJ) based on the information on the longitude and latitude of each city. The Application Programming Interface is publicly available on http://vldb.gsi.go.jp/sokuchi/surveycalc/agreement.html (in Japanese). The data on latitude and longitude are obtained from the database of the GIAJ; these data are publicly available at http://www.gsi.go.jp/KOKUJYOHO/kencho/kenchobl.html.
We calculated the sea route distances for marine transportation between the nearest

port of each provincial city and the port of Tokyo using the *Kyorihyō* (Distance table) published by *Suirobu* (Hydrographic Department) in 1919. The ports at Osaka, Kobe, Sendai, Otaru, Niigata and Kochi had the same names as the cities they served. Nagoya port was Taketoyo, Hiroshima's Kure, Kanazawa's Funaki and Fukuoka's Hakata. Since Kyoto city was inland, and served by the port at Maizuru, the railway distance from Maizuru to Kyoto was added to obtain the total distance. Data on railway distance is fromTetsudō Kōnin Unsō Toriatsukai Kumiai chūōkai, *Zenkoku tetsudō saikin mairuhyō* (1920). The railway distance from Osaka to Kyoto used in Appendix C.6 was also obtained from this document.

C. Covariates

The annual data on population are from *Nihon teikoku jinkō dōtai tōkei* (Vital statistics of the Empire of Japan; VSEJ) (1921—1925 editions) published by the Statistics Bureau of the Cabinet between 1924 and 1926. The data on the number of factories are taken from *Kōjō tōkeihyō* (Table of statistics of factories; TSF) (1921—1925 editions) published by the Statistical Section of the Ministry of Agriculture and Commerce (1923, 1924 and 1925) and the Statistical Section of the Ministry of Commerce and Industry (1926 and 1927). The annual data on total tonnage are from *Nihon teikoku tōkei nenkan* (Statistical yearbook of the Empire of Japan; SYEJ) (volumes 42 to 46) published by the Statistics Bureau of the Cabinet between 1924 and 1927. The annual data on railway freight are from *Tetsudōshō tōkei shiryō* (Statistical materials of the Ministry of Railways) (1920-1925 editions) published by the Ministry of Railways between 1924 and 1927. For meteorological variables, monthly average temperature, monthly average precipitation, and monthly atmospheric pressure are from the database of the Japan Meteorological Agency (JMA), at http://www.data.jma.go.jp/gmd/risk/obsdl/index.php. Since meteorological observation stations are located in each large city, we replicate missing data on the observations in 2 of the 12 cities by using the nearest meteorological observation station. Sendai city in Miyagi prefecture is represented by the data for Shiogama city in the same prefecture, while Otaru city in Hokkaido prefecture is represented by the data for Sapporo city in the same prefecture.

Appendix C Empirical appendix

C.1 Results for panel unit root tests

Table C.1 presents the results of unit root tests for wholesale prices used in the empirical analyses.

Table C.1: Results of unit root tests for wholesale prices

	Wholesale prices						
	Rice	Wheat	Cotton	Pine	Calcium	Coal	Charcoal
Test statistics			yarn	board	superphosphat		

P-statistic *p*-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Z-statistic *p*-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
L^*-statistic *p*-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
P_m-statistic *p*-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of cities	11	11	11	11	11	11	11
Number of observations	56	55.3	56	55.7	55.4	56	56

Notes: The results of Fisher-type panel unit-root tests based on augmented Dickey-Fuller (ADF) tests are reported in this table. Fisher-type unit-root tests are used because of the lack of balance and finite number of panels of our sample. See Choi (2001) for the details of the tests. The null hypothesis is that all the panels contain unit roots, whereas the alternative hypothesis is that at least one panel is stationary. In all specifications, the process under null hypothesis is assumed to be a random walk with drift. The demeaned data are used to deal with the effect of cross-sectional dependence. The number of lagged differences in the ADF regression equation is set as one. The results presented herein are not affected by the number of lagged differences.

C.2 Sensitivity checks

Table C.2 presents the results from the regression weighted by the number of people in each city-year cell. Table C.3 presents the results if Osaka and Kobe city are regarded as being in the same cluster. Table C.4 shows the results using the wild cluster bootstrap *t*-procedure to deal with the small number of clusters.

Table C.2: Baseline estimates for May 1921 to December 1925, by product
: regressions weighted by number of people in each city-year cell

	Dependent variable						
	(1) Rice	(2) Wheat	(3) Cotton yarn	(4) Pine board	(5) Calcium superphosphat	(6) Coal	(7) Charcoal
Closeness×Post	2.863***	0.459	-4.623	-0.088	0.250**	-2.611**	-2.175
	(0.705)	(1.101)	(4.931)	(0.321)	(0.102)	(0.893)	(6.280)
F-statistic *p*-value on joint significance of covariates	0.000	0.000	0.000	0.000	0.000	0.000	0.000
R-squared	0.9761	0.9525	0.9827	0.9075	0.9470	0.9801	0.9424
Number of observations	605	594	605	600	594	605	605

Notes: Observations are at the city-year level. The unit of all wholesale prices is yen. *Closeness* is the reciprocal of the marine distance from Tokyo (100 km) described in Table 1. *Post* is an indicator variable that equals one for periods after September 1923. Lagged dependent variable, all control variables, city- and year-fixed effects are included in all specifications. *** and ** represent statistical significance at the 1% and 5% levels, respectively. Cluster-robust standard errors are in parentheses. All regressions are weighted by the number of people in each city-year cell.

Table C.3: Baseline estimates for May 1921 to December 1925, by product
: Osaka and Kobe city in the same cluster

	Dependent variable						
	(1) Rice	(2) Wheat	(3) Cotton yarn	(4) Pine board	(5) Calcium superphosphate	(6) Coal	(7) Charcoal

Closeness×Post	3.038***	0.742	-4.872	-0.044	0.254**	-2.625**	-1.114
	(0.677)	(1.158)	(5.039)	(0.297)	(0.101)	(0.868)	(6.678)
F-statistic *p*-value on joint significance of covariates	0.000	0.000	0.000	0.000	0.000	0.000	0.000
R-squared	0.9746	0.9517	0.9820	0.9117	0.9459	0.9806	0.9403
Number of observations	605	594	605	600	594	605	605

Notes: Observations are at the city-year level. The unit of all wholesale prices is yen. *Closeness* is the reciprocal of the marine distance from Tokyo (100 km) described in Table 1. *Post* is an indicator variable that equals one for periods after September 1923. Lagged dependent variable, all control variables, city- and year-fixed effects are included in all specifications. *** and ** represent statistical significance at the 1% and 5% levels, respectively. Cluster-robust standard errors are in parentheses. Osaka and Kobe city are in the same cluster.

Table C.4: Bootstrap technique for issue of small number of clusters

	Dependent variable						
	(1) Rice	(2) Wheat	(3) Cotton yarn	(4) Pine board	(5) Calcium superphosphate	(6) Coal	(7) Charcoal
Closeness×Post	3.038**	0.742	-4.872	-0.044	0.254*	-2.625*	-1.114
Wild bootstrap *p*-value	[0.0492]	[0.5724]	[0.4376]	[0.8932]	[0.0672]	[0.0816]	[0.8948]
F-statistic *p*-value on joint significance of covariates	0.000	0.000	0.000	0.000	0.000	0.000	0.000
R-squared	0.9746	0.9517	0.9820	0.9117	0.9459	0.9806	0.9403
Number of observations	605	594	605	600	594	605	605

Notes: Observations are at the city-year level. The unit of all wholesale prices is yen. *Closeness* is the reciprocal of the marine distance from Tokyo (100 km) described in Table 1. *Post* is an indicator variable that equals one for periods after September 1923. Lagged dependent variable, all control variables, city- and year-fixed effects are included in all specifications. ** and * represent statistical significance at the 5% and 10% levels, respectively. Wild bootstrap *p*-value with 5,000 replications are reported.

C.3 Falsification tests using alternative cutoff period

We conducted a placebo test for wholesale prices using the period prior to the earthquake to check the robustness of the main findings described in Section III. It is possible that for the period *before* the earthquake, given the existence of a relatively integrated economy, the wholesale price in cities nearer the Kantō area may not have been significantly different from that in cities further away from the Kantō area. In other words, if the coefficient on the interaction term between *Closeness* × *Post* was estimated to be statistically significant using the pre-earthquake period, this key variable in our baseline specification may correlate with other factors that might have affected wholesale prices, such as unobserved time-varying transportation costs across the sample of cities.

The estimates are reported in Table C.5. Three placebo treatment periods are indicated, namely March 1922–August 1923, September 1922–August 1923, and March 1923–August 1923. These treatment periods have been chosen systematically as they respectively cover six months, twelve months and 18 months before the incidence of the earthquake. This means, for example, that in columns 1-2 relating to the 18-month treatment period, we use the interaction term between the marine distances and an indicator variable that equals one for the months from March 1922 to August 1923. The same applies to the estimates listed in columns 3-4 and 5-6 for the other treatment periods. We see that the estimated coefficients do not differ significantly from zero for almost all specifications. In other words, when it comes to marine distance the differences in the prices of rice and pine boards appear only over the sample period after the earthquake. This result confirms that no unobserved factors have disturbed our main results.

Table C.5: Baseline estimates for alternative cutoff period: falsification tests

	Dependent variable						
	(1) Rice	(2) Wheat	(3) Cotton yarn	(4) Pine board	(5) Calcium superphosp hate	(6) Coal	(7) Charcoal
Panel A: Placebo treatment period: March 1922-August 1923							
Closeness×*Post*	0.118	0.146	-2.672	-0.025	0.123	-1.560	-15.000
	(2.092)	(1.461)	(7.003)	(0.309)	(0.124)	(1.240)	(12.576)
R-squared	0.9624	0.9100	0.9393	0.9389	0.9405	0.9763	0.9198
Number of observations	297	295	297	295	288	297	297
Panel B: Placebo treatment period: September 1922-August 1923							
Closeness×*Post*	-0.634	0.359	-3.267	-0.070	0.309*	-1.003	-3.661
	(1.871)	(0.775)	(7.743)	(0.274)	(0.160)	(1.250)	(7.320)
R-squared	0.9625	0.9101	0.9393	0.9389	0.9414	0.9762	0.9191
Number of observations	297	295	297	295	288	297	297
Panel C: Placebo treatment period: March 1923-August 1923							
Closeness×*Post*	-1.316	-0.139	-2.132	0.487	0.063	-0.238	12.136
	(2.018)	(0.309)	(5.403)	(0.316)	(0.143)	(1.788)	(11.573)
R-squared	0.9625	0.9100	0.9392	0.9394	0.9404	0.9762	0.9194
Number of observations	297	295	297	295	288	297	297

Notes: Observations are at the city-month level. The unit of all wholesale prices is yen. *Closeness* is the reciprocal of the marine distance from Tokyo (100 km) described in Table 1. *Post* in the panels A, B, and C are an indicator variable that equals one for periods from March 1921-August 1923, from September 1922-August 1923, and March 1923-August 1923, respectively. Lagged dependent variable, control variables, and city- and month-fixed effects are included in all specifications. * represents statistical significance at the 10% level. Cluster-robust standard errors are in parentheses.

C.4 Calculating the magnitude

Table C.6 presents the calculated magnitude of the impact of the earthquake on the wholesale price of rice in each provincial city. The price effect of the earthquake shown in Column 6 is calculated as the proportion of the total increase in price due to the earthquake, i.e., the baseline estimate multiplied by *Closeness* in each provincial city in relation to the average increase in the price of rice between the period before August 1923 and the period after August 1923. If we regress the calculated increase in price due to the earthquake shown in Column 2 in Table C.6 on the sea route distance of the 11 cities, we obtain the following estimated equation; $\widehat{Price}_i = 1.4387 - 0.0014 Distance_i, SE = 0.0002, R^2 = 0.8393$. This implies that an additional 100 km increase in distance decreases the wholesale price of rice by 0.14 yen. A similar calculation is applied for the wholesale price of pine boards and charcoal. Tables C.7 and C.8 present the calculated magnitudes of the impact of the earthquake on the wholesale prices of pine board and charcoal, respectively. Figure C.2 illustrates the increase in the wholesale price of rice due to the earthquake as a proportion of the total increase in price for each cut-off period. The estimates presented in Table 4 are used for the calculations.

Table C.6: Magnitude of impact of the Great Kanto Earthquake on wholesale price of rice in provincial cities

Name of cities (in order of sea route dist.)	[A] Increase in price due to the earthquake (3.038×Closeness, yen)	Average price of rice, yen			Price effect of the earthquake ([A]/[B] %)
		Before August	After September	[B] Increase	
Nagoya	1.51	33.18	39.93	6.75	22.4
Sendai	1.02	31.70	38.13	6.43	15.8
Kobe	0.85	35.06	40.12	5.06	16.7
Osaka	0.83	35.28	40.68	5.40	15.3
Kochi	0.80	31.54	35.77	4.23	18.9
Hiroshima	0.57	33.32	38.74	5.42	10.6
Fukuoka	0.49	32.27	37.61	5.34	9.3
Otaru	0.41	33.39	38.08	4.69	8.8
Niigata	0.40	31.98	37.71	5.73	6.9
Kyoto	0.35	35.97	42.10	6.13	5.8
Kanazawa	0.35	33.54	38.35	4.81	7.3
Average	0.69	33.38	38.84	5.45	12.7

Notes: The increase in price due to the earthquake is calculated as the estimated coefficient of *Closeness*×*Post* in the baseline specification (i.e., equation 1 in Section III) multiplied by *Closeness* in each provincial city. *Closeness* is the reciprocal number of the sea route distance listed in Table 1. The magnitude of the effect of the earthquake on the wholesale price of rice is the increase in price due to the earthquake as a proportion of the total increase in price from the period from May 1921 to August 1923 to the period after September 1923 to December 1925.

Table C.7: Magnitude of impact of the Great Kanto Earthquake on wholesale price of pine boards in provincial cities

Name of cities (in order of sea route dist.)	[A] Increase in price due to the earthquake (3.038×Closeness, yen)	Average price of pine boards, yen			Price effect of the earthquake ([A]/[B], percentage points)
		Before August	After September	[B] Increase	
Nagoya	0.44	2.35	2.81	0.46	96.3
Sendai	0.36	2.29	2.73	0.44	82.6
Osaka	0.25	3.05	3.76	0.71	36.1
Hiroshima	0.17	2.33	2.43	0.10	100.0
Fukuoka	0.16	1.65	1.75	0.10	100.0
Niigata	0.67	2.18	2.27	0.09	100.0
Average	0.34	2.31	2.63	0.31	100.0

Notes: Kanazawa, Kyoto, Kobe, Kochi, and Otaru city are excluded because those cities experienced a decline in wholesale price of pine board. The increase in price due to the earthquake is calculated as the estimated coefficient of Closeness×Post in the baseline specification (i.e., equation 1 in Section III) multiplied by *Closeness* in each provincial city. *Closeness* is the reciprocal number of the sea route distance listed in Table 1. The magnitude of the impact of the earthquake on the wholesale price of pine boards is the increase in price due to the earthquake as a proportion of the total increase in price from the period from May 1921 to August 1923 to the period after September 1923 to November 1923. The magnitude of the impact of the earthquake on the wholesale price is censored at one hundred.

Table C.8: Magnitude of impact of the Great Kanto Earthquake on wholesale price of charcoal in provincial cities

Name of cities (in order of sea route dist.)	[A] Increase in price due to the earthquake (3.038×Closeness, yen)	Average price of charcoal, yen			Price effect of the earthquake ([A]/[B], percentage points)
		Before August	After September	[B] Increase	
Nagoya	8.91	112.97	128.27	15.30	58.2
Osaka	4.32	92.85	93.78	0.93	100.0
Otaru	3.24	67.71	84.18	16.46	19.7
Average	5.49	91.18	102.07	10.90	50.4

Notes: The magnitude for Niigata, Kanazawa, Sendai, Kyoto, Kochi, Hiroshima, and Fukuoka city could not be calculated as those cities experienced a decline in wholesale price of charcoal. The increase in price due to the earthquake is calculated as the estimated coefficient of Closeness×Post in the baseline specification (i.e., equation 1 in Section III) multiplied by *Closeness* in each provincial city. *Closeness* is the reciprocal number of the sea route distance listed in Table 1. The magnitude of the impact of the earthquake on the wholesale price of charcoal is the increase in price due to the earthquake as a proportion of the total increase in price from the period from May 1921 to August 1923 to the period after September 1923 to November 1923. The magnitude of the impact of the earthquake on the wholesale price is censored at one hundred.

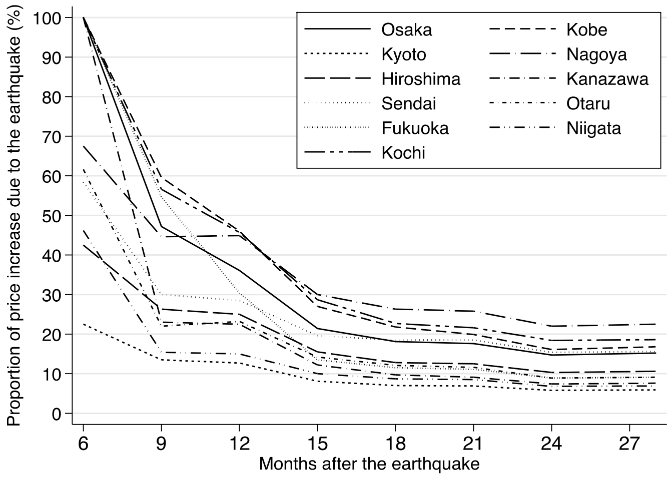


Figure C.2: Increase in rice price due to the earthquake as a proportion of the total increase in price

Notes: The solid lines show the increase in price due to the earthquake as a proportion of the total increase in price from the period May 1921-August 1923 to the period after September 1923 in each provincial city. We set 100% as the maximum magnitude of the impact of the earthquake on the wholesale price. The post-earthquake periods are set at 6, 9, 12, 15, 18, 21, 24, and 28 months, respectively.

C.5 Regional market integration

C.5.1 Correlation coefficients

In our main analysis in Section III we assume that regional markets were relatively well integrated in early 1920s Japan. This argument, as noted in Section 1 of our paper, would seem to be supported by a number of studies. Nevertheless, in order to provide evidence on market integration for our analytical samples, we calculated the correlation coefficients between our central market of Tokyo and each provincial city, and these are shown in Table C.9. Overall, as we expected, the correlation coefficients are statistically significantly and positive for most cases for the period before the earthquake, i.e. May 1921 to August 1923, with the exception of coal. This suggests that our assumptions regarding the wholesale price of these items are basically valid except in the case of the price of coal. This would be consistent with coal being less likely to be shipped between different parts of the country. This finding is largely unchanged for the period after the earthquake, i.e., September 1923 to December 1925. The correlation coefficients for the price of coal after the disaster turn out to be statistically significant and positive in most cases.

Table C.9 Correlation coefficients: degree of market integrations between Tokyo and provincial cities

City	Rice	Wheat	Cotton	Pine board	Calcium superphosphate	Coal	Charcoal
May 1921 to August 1923							
Osaka	0.9707***	0.9502***	0.9016***	0.6014***	0.8249***	0.1224	0.8957***
Kobe	0.9369***	0.9114***	0.9417***	0.5991***	0.9110***	0.0722	0.7852***
Kyoto	0.9796***	0.7726***	0.9491***	0.6167***	0.8853***	-0.0349	0.7563***

Nagoya	0.9182***	0.9584***	0.9286***	0.3479†	0.8945***	-0.3545†	0.7350***
Hiroshima	0.9299***	0.8104***	0.8680***	0.7318***	0.8630***	-0.0898	0.5373***
Kanazawa	0.9538***	0.9279***	0.7906***	0.7650***	0.7082***	0.0600	0.7531***
Sendai	0.9503***	0.5749***	0.9436***	0.8825***	0.2841	-0.0997	0.5122***
Otaru	0.9713***	0.7351***	0.8003***	0.1012	0.6219***	0.3523†	-0.3716†
Fukuoka	0.9461***	0.9228***	0.9485***	0.7269***	0.9426***	0.0069	0.7167***
Niigata	0.9541***	0.9256***	0.9492***	0.6797***	0.7545***	0.2447	0.6774***
Kochi	0.9174***	0.8690***	0.9471***	0.5053***	0.7992***	0.0564	0.3750**
September 1923 to December 1925							
Osaka	0.9741***	0.9878***	0.9534***	0.6992***	0.7074***	-0.5937***	0.8199***
Kobe	0.9590***	0.9847***	0.9402***	0.7965***	0.7507***	0.0570	0.7581***
Kyoto	0.9780***	0.9469***	0.9414***	0.9621***	0.3229†	-0.2413	0.8169***
Nagoya	0.9727***	0.9792***	0.9531***	0.8124***	0.0495	0.9174***	0.7215***
Hiroshima	0.9763***	0.9623***	0.9292***	0.8981***	0.5967***	0.8795***	0.7048***
Kanazawa	0.9583***	0.9922***	0.9437***	0.6665***	0.5402***	0.7860***	-0.4426**
Sendai	0.9647***	0.9577***	0.9645***	0.9628***	0.8217***	0.7354***	0.7198***
Otaru	0.9666***	0.9441***	0.9544***	0.9163***	0.2721	0.2474	0.4914***
Fukuoka	0.9719***	0.9694***	0.8676***	0.7735***	0.6270***	-0.8363***	0.5265***
Niigata	0.9709***	0.9777***	0.9392***	0.9562***	0.5754***	0.8407***	0.3681†
Kochi	0.9092**	0.8964***	0.9214***	0.8237***	-0.1702	0.3778**	0.6469***

Note: ***, **, and † show statistically significant at the 1%, 5%, and 10% levels, respectively.

Table C10 presents the correlation coefficients for the price of rice among cities grouped by distance as used in Figure 4. The coefficients calculated are statistically significantly and positive and in most cases close to one. This supports the evidence that rice markets in these cities are well integrated for our sample periods.

Table C10: Correlation coefficients for the price of rice among cities by distance group

Panel (a): Cities 201-381 km far from Tokyo					
	Nagoya	Sendai	Kobe	Osaka	Kochi
Nagoya	1				
Sendai	0.9228***	1			
Kobe	0.9472***	0.9216***	1		
Osaka	0.9544***	0.9602***	0.9801***	1	
Kochi	0.9333***	0.8940***	0.9665***	0.9559***	1
Panel (b): Cities 531-615 km far from Tokyo					
	Hiroshima	Fukuoka			
Hiroshima	1				
Fukuoka	0.9667***	1			
Panel (c): Cities 735-867 km far from Tokyo					
	Otaru	Niigata	Kyoto	Kanazawa	
Otaru	1				
Niigata	0.9797***	1			
Kyoto	0.9780***	0.9718***	1		
Kanazawa	0.9780***	0.9692***	0.9797***	1	

Note: *** shows statistically significant at the 1% level.

C.5.2 Results for the error correction model

To estimate the error correction model, we applied the unit root test to each log-wholesale price series identified in Section III. According to the lag order determined by Schwarz Bayesian information criterion, there are only three cases (out of 77 cases) that reject the null hypothesis of a unit root at the 1% significance level (results not reported). For the period from May 1921 to August 1923 and August 1923 to December 1925, there are only four and four cases rejecting the null hypothesis at the 1% level. We then test for cointegration using the residual-based augmented Dickey-Fuller method (Engle and Granger 1987).

Table C.11 Results for the residual-based test for cointegration

City	Rice	Wheat	Cotton	Pine board	Calcium superphosphate	Coal	Charcoal
May 1921 to December 1925							
Osaka	−	+	+	−	−	−	+
Kobe	−	+	+	−	−†	−	+
Kyoto	−	+	+	−	−	−	+
Nagoya	−	+	+	−	+	+	−
Hiroshima	−	+	+	−	−	+	−
Kanazawa	−	−	+	−	−	−	−
Sendai	−	−†	+	+	−	−	−†
Otaru	−	−	+	+	+	−	−
Fukuoka	−	+	+	−	+	−	−
Niigata	−	−	+	−†	−	−	+
Kochi	−	+	+	−	−	−	−
May 1921 to August 1923							
Osaka	−	+	−†	+	−	−	−
Kobe	−	−†	−	−	−	−	−
Kyoto	−†	−	−	−	−	−	+
Nagoya	−	−	−	−	−	−	−
Hiroshima	−	+	−	−	−	−	−
Kanazawa	−	+	−	−	−	−	−
Sendai	−		−	−	−	−	−
Otaru	−	−	+	+	−	−	−
Fukuoka	−	−	−	−†	−†	−	−
Niigata	−	−	−	−	−	−	+
Kochi	−	−	−	−	−	−	−
August 1923 to December 1925							
Osaka	−	+	+	−	+	−	−
Kobe	−	−†	+	+	−	−	−†
Kyoto	−	−	+	−	−	−	+
Nagoya	−	−	+	−	−	−	−
Hiroshima	−	−	+	−	−	−	−
Kanazawa	−	+	+	−	−	−	−
Sendai	−	−	+	−	+	−	−
Otaru	−	−	+	−†	−	−	−
Fukuoka	−	−	−†	−	−†	−	−
Niigata	−	−	+	−	−	−	−†
Kochi	−	−	+	−	−	−	−

Note: + sign means that the null hypothesis of the non-cointegrating relationship is rejected at the 5% significance level. † shows the null of non-cointegration is rejected at the 10% significance level.

Table C.11 presents the results for the tests for cointegration for three different sample periods. The null hypothesis is that there is a no-cointegrating relationship in the log wholesale price series between Tokyo and each provincial city. In the table, the city-price series cells with positive signs indicate a cointegrating relationship with the Tokyo market. Overall, the wholesale prices of cotton show a clear cointegrating relationship both across the full sample period and in the period from August 1923 to December 1925 (highlighted in grey).

However, we could not find any consistent cointegrating relationships in the pre-earthquake period from May 1921 to August 1923 for the other products. This implies that any cointegrating relationships across the full sample strongly reflect the cointegrating relationship in the post-earthquake period. In other words, an estimation using the full sample may be disturbed by including a noisy pre-earthquake price series. In light of these results, although we present the results for the full sample and subsample from August 1923 to December 1923 in this appendix, we highlight the results for the period from August 1923 to December 1925 in the main text (Section III). In addition to this, the results for rice, wheat, pine board, calcium superphosphate, coal and charcoal do not indicate a consistently cointegrated relationship. Since we seek to compare the estimates across different provincial cities to compare market integration, we therefore run the ECM regression only for the cotton wholesale price series. The Engle and Granger two-step procedure, which uses the lagged predicted residual ($\hat{\upsilon}_{t\text{-}1}$) obtained in the first step in the second stage regression, is used for the estimation. For the regressions using the full sample, we include a post-earthquake dummy in all regressions to control for potential structural change after the earthquake.

Table C.12 presents the estimates for α and γ of the error correction model reported in Eq 2 in the main text. Looking at the results for the full sample, the estimates for α are negative and statistically significant in all cases. By contrast, the estimates for γ are statistically significant and positive. These are consistent with our results for the post-earthquake subsample shown in the same table. Despite this consistency, it is appropriate to rely on the results for the post-earthquake subsample given the significant cointegrating relationships in this subsample discussed above.

Table C.12 Results for the error correction models

Period	Cities	α		γ	
		Estimate	Std. Err.	Estimate	Std. Err.
May 1921 to December 1925	Osaka	-0.647	[0.141]***	0.847	[0.074]***
	Kobe	-0.616	[0.131]***	0.818	[0.064]***
	Kyoto	-0.594	[0.127]***	0.780	[0.060]***
	Nagoya	-0.702	[0.129]***	0.782	[0.064]***
	Hiroshima	-0.917	[0.136]***	0.712	[0.082]***
	Kanazawa	-0.488	[0.132]***	0.735	[0.092]***
	Sendai	-0.698	[0.128]***	0.784	[0.051]***
	Otaru	-0.265	[0.084]***	0.743	[0.066]***
	Fukuoka	-0.499	[0.125]***	0.757	[0.073]***
	Niigata	-0.607	[0.129]***	0.742	[0.060]***
	Kochi	-0.597	[0.125]***	0.726	[0.059]***
August 1923 to December 1925	Osaka	-0.703	[0.160]***	0.780	[0.079]***
	Kobe	-0.679	[0.154]***	0.727	[0.088]***
	Kyoto	-0.683	[0.147]***	0.720	[0.084]***
	Nagoya	-0.742	[0.178]***	0.829	[0.092]***
	Hiroshima	-0.789	[0.182]***	0.797	[0.111]***
	Kanazawa	-0.806	[0.149]***	0.720	[0.084]***
	Sendai	-0.919	[0.150]***	0.746	[0.060]***
	Otaru	-0.870	[0.165]***	0.845	[0.097]***
	Fukuoka	-0.488	[0.161]***	0.653	[0.132]***
	Niigata	-0.715	[0.153]***	0.682	[0.086]***
	Kochi	-0.617	[0.154]***	0.649	[0.094]***

Notes: Post-earthquake dummy is included in the regression using the period May 1921 to December 1925. *** represents statistical significance at the 1% level.

C.6 Sensitivity of variable definition

In Section III, we used Maizuru port as the main port for Kyoto. However, it is also possible that Osaka port was the main port for Kyoto. We therefore redefined the distance to Kyoto as the sea route distance to Osaka plus the railway distance from Osaka city to Kyoto city. See Appendix B for the details of documents. Table C.13 presents the results. It is clear that the results are largely unchanged and close to those reported in Table 3. This confirms that our main results are robust against using an alternative definition of sea route variable.

Table C.13: Alternative definition of distance variable

	Dependent variable						
	(1) Rice	(2) Wheat	(3) Cotton yarn	(4) Pine board	(5) Calcium superphosphate	(6) Coal	(7) Charcoal
Closeness×*Post*	3.181***	0.633	-5.195	-0.091	0.238**	-2.264**	-0.091
	(0.641s)	(1.100)	(4.578)	(0.288)	(0.093)	(0.818)	(6.560)
F-statistic *p*-value on joint significance of covariates	0.000	0.000	0.000	0.000	0.000	0.000	0.000
R-squared	0.9746	0.9517	0.9820	0.9117	0.9458	0.9806	0.9403
Number of observations	605	594	605	600	594	605	605

Notes: Observations are at the city-month level. The unit of all wholesale prices is yen. *Closeness* is the reciprocal of the marine distance from Tokyo (100 km). *Post* is an indicator variable that equals one for periods after September 1923. Lagged dependent variable, all control variables, city- and year-fixed effects are included in all specifications. *** and ** represent statistical significance at the 1% and 5% levels, respectively. Cluster-robust standard errors are in parentheses.

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