Janet Hunter, Kota Ogasawara

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Janet Hunter, London School of Economics and Political Science

Kota Ogasawara, Chiba University

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Abstract

Japan's Great Kantō Earthquake of September 1st 1923 devastated the area around Tokyo and the country's main port of Yokohama. This paper uses the earthquake as a case study to inform our understanding of the economics of disasters and the history of market integration. It seeks to test two main assumptions: firstly, that shifting demand and supply curves consequent on a disaster will have some impact on prices; and secondly, that any local changes in the disaster region are likely to be diffused across a wider geographical area. We make use of a unique monthly wholesale price dataset for a number of cities across Japan, and our analysis suggests three main findings: that price changes in the affected areas immediately following the disaster were in most cases reflected in price changes in Japan's provincial cities; that cities further away from the devastation witnessed smaller price changes than those nearer to the affected area; and that the observed pattern of price changes reflects the regional heterogeneity identified by scholars who have worked on market integration in Japan.

I

Japan's Great Kantō Earthquake occurred shortly before noon on 1 September 1923. The epicentre of the 7.9 magnitude shock was just south of Tokyo Bay, and the size and location of the tremor meant that it impacted on the whole of the Kantō plain, including both the capital city of Tokyo and the country's major port of Yokohama. Tokyo was Japan's largest city, with over two million residing in the metropolitan area by 1920, while Yokohama, less than 40 kilometres away, had close on half a million inhabitants. A further four to five million resided in the adjacent more rural jurisdictions across the rest of the Kantō plain, and the region accounted for a significant proportion of the country's total urban population.[1] The earthquake resulted not only in large scale physical destruction and collapse, but in a tsunami in many coastal areas, as well as huge conflagrations in the two main cities. There are estimated to have been well over 100,000 deaths, and total casualties exceeded 140,000.[2]

Most of the academic studies on the disaster have analysed its social and political consequences, or its ideological or artistic construction. We know something about the politics of reconstruction, the imagery and narrative associated with the event, its influence on education, urban planning and seismology. There is a substantial literature on the social unrest and killings of ethnic Koreans and left wing activists that followed the shock.[3] Research on its economic impact, however, has remained more limited. It is acknowledged that the disaster was a key factor in the stop-go financial and monetary policy of Japan in the 1920s, that it also led to financial dislocation, and that it contributed to the occurrence of a major financial crisis in 1927. Recent economic historical research has looked mainly on the

[1] http://www.stat.go.jp/english/data/chouki/02.htm, Table 2-7 Population, Population Density, Population of Densely Inhabited Districts and Area by Prefecture, All Shi and All Gun (1898-2005), accessed 28/07/2016.
[2] For a general outline of the disaster see Naimushō Shakaikyoku, *Great earthquake of 1923.*
[3] See eg. Bates, *Culture of the quake*; Borland, 'Capitalising on catastrophe'; Clancey, *Earthquake nation*; Schenking, *Great Kantō Earthquake*; Weisenfeld, *Imaging disaster*; Smits, *When the earth roars*.

spatial and structural changes that the disaster helped to bring about.[4] Few attempts have been made to apply to Japan's 1923 earthquake the analytical frameworks offered by the economics of disasters, many of which have focussed on the political economy of preparation, response and recovery, and the macroeconomic effects in terms of long term growth.[5] We still know very little, for example, about the dynamics of any interaction between the shock of a natural disaster and the situation of the economy, such as the stage of the business cycle. Extracting the effect of a natural disaster from any macroeconomic data series remains highly problematic.[6] Our understanding of the degree to which institutional quality and existing wealth levels may impact on any return to stability remains limited.

Our focus in this paper is on changes in prices consequent on the 1923 disaster. Dacy & Kunreuther's classic work argues that while macroeconomic theories are more useful in analysing longer term recovery, analysis of markets in the short-term post-disaster recuperation phase is best undertaken using the laws of supply and demand.[7] We might therefore expect, for example, to see rising prices for goods for which the disaster generates a shortfall in supply or increased demand. Evidence from the 1923 earthquake, as well as other major disasters, indicates not only that demand for some goods increased due to reconstruction and relief needs, but also that supplies of many others were affected negatively by destruction of stocks, of transport and information infrastructure, of production capacity, and of human capital.[8] Hallegatte and others have emphasized that transport and utility disruption, as well as production losses and shifts in supply and demand for different goods, mean that in the wake of a major shock prices are no longer in equilibrium, while

[4] For the financial aspect see Nihon Ginkō Hyakunen Shi Hensan Iinkai, *Nihon Ginkō hyakunen shi* vol.3. For the impact of the disaster on agglomeration see Imaizumi, 'Tōkyō-fu kikai kanren kōgyō ', pp.23-4; Okazaki et.al., 'Impact of natural disasters'; Okazaki et.al., 'Creative destruction of Industries'. See also Hunter, 'Extreme confusion'.
[5] See eg. Kellenberg & Mubarak, 'Economics of natural disasters'; Cavallo and Noy, 'Economics of natural disasters'; Toya and Skidmore, 'Economic development'; Cavallo et.al. 'Catastrophic natural disasters'; Neumeyer et.al.,'Political economy'; Barone & Mocetti, 'Natural disasters'; Cassar et.al., 'Trust, risk, and time preferences'; Okuyama, 'Economics of natural disasters'.
[6] Hallegatte & Przyluski, 'Economics of natural disasters'.
[7] Dacy & Kunreuther, *Economics of natural disasters.*
[8] Naimushō Shakaikyoku, *The great earthquake* catalogues these issues.

interruption to crucial intermediate sectors may lead to negative 'network effects' in the economy as a whole. Devastating local disasters of this kind may thus have major ripple effects.[9] In a market-based economy we would therefore anticipate some movement in prices in the affected area due to changes in demand and supply, and also, assuming a certain level of market integration, that any price shocks consequent on the disaster will be communicated outwards from the affected area to other regions. Of course, it may also be the case that in and after a disaster supply and demand curves may shift in unexpected ways. Okuyama has noted that in the first month after the 1995 Kobe earthquake the consumer price index actually decreased slightly, a counterintuitive outcome that was perhaps in part because disasters generate unusual behaviour, such as sympathy and unplanned cooperation.[10] Nevertheless, we seek to test two main assumptions arising out of this literature: that shifting demand and supply curves consequent on a disaster will have some impact on prices, and also that any local changes in the disaster region are likely to be diffused across a wider geographical area.

A number of scholars have analysed the exogenous shocks constituted by climatic and geological disasters and epidemics to explore a range of issues, from health to levels of uncertainty about future events. Many have identified these shocks as 'natural experiments', defined by Diamond & Robinson as 'a situation in which some historical accident or event leads economic, political and social factors to change in some areas while remaining the same in other comparable places'.[11] Our study also explores the impact of an exogenous shock, although we prefer to use the term 'nature's experiment', as suggested by Morgan.[12] In the process of investigating the generation and diffusion of price changes following the

[9] Hallegatte & Przyluski, 'Economics of natural disasters'.
[10] Okuyama, 'Economics of natural disasters'.
[11] Diamond & Robinson (*Natural experiments*, p.2) equate this with a controlled comparison. For other cases used as natural experiments see eg. Baker & Bloom, 'Does uncertainty reduce growth?'; Lin & Liu, 'Does in *utero* exposure to illness matter?'; Schultz & Libman, 'Is there a local knowledge advantage?'; Siodla, 'Clean slate'.
[12] Morgan distinguishes between these two categories in terms of the source of controls, which in the case of nature's (society's) experiment are instantiated in society or nature ('Nature's experiments', p.344).

disaster, we also analysed the speed with which prices reverted to an equilibrium in the wake of the shock, and thereby also contribute to the literature on market integration. This literature has become increasingly rich over recent years, with the majority of studies focussing on Europe and North America. Numerous scholars have explored ways of measuring market integration and tried to devise means of making the best use of the available historical evidence.[13] As has been highlighted, many of these approaches continue to have significant limitations, but there is no doubt that they have allowed us to make significant progress in better understanding changes in the levels and nature of market integration over time.[14] By contrast studies of market integration in Japan remain somewhat limited, and the majority have focussed on price convergence rather than the restoration of equilibrium following a shock (i.e. market efficiency).[15] Much of the existing work has focussed on the rice market, for which the data are the most abundant. Miyamoto's study of the Osaka-Dōjima rice market in the early modern period suggested that markets in the western half of Japan were relatively integrated from the early nineteenth century, but that despite the existence of national trading networks markets in the capital Edo and the eastern half of Japan operated relatively independently from those further west.[16] Bassino's analysis of the functioning of regional markets during famines confirmed Japanese scholars' findings that Japan experienced a comparatively high degree of market integration from the eighteenth century onwards, and that growing market integration in eastern Japan contributed to convergence over time.[17] Mosk has suggested that by the 1920s the balance of power in the nation's economy had decisively shifted towards the east, but there remained a degree of division in market activity between the eastern and western halves of the

[13] This literature cannot be listed in any comprehensive way here, but our approach has been particularly informed by the following: Federico, 'How much do we know'; Ejrnaes & Persson, 'Gains from improved market efficiency'; Fackler & Goodwin, 'Spatial price analysis'.
[14] Federico, 'How much do we know'.
[15] Based on the ideas of Cournot, Federico identifies these as the two key elements in analysis of market integration ('How much do we know', p.474).
[16] Miyamoto, *Kinsei Nihon no shijō keizai*.
[17] Bassino, 'Market integration and famines'.

country.[18] More recently Ito, Maeda & Noda found that Japanese rice markets integrated further from the 1890s, a process that was sustained in the context of the growth of the telegram and local telephone use.[19] Comparing the integration of rice markets in nineteenth century China and Japan, Yao & Zheng found that at both national and regional levels Japan's levels of market integration were higher than those of China, and the disparity between the countries is likely to have widened toward the end of the century.[20] Saitō explored labour market integration using wage data for the early twentieth century, finding that markets for both skilled labour and agricultural workers were comparatively integrated from around 1900, although in the case of unskilled workers the process of integration was slower, and significant regional heterogeneities could be observed in both data sets.[21]

Our analysis of the prices of different goods in the devastated area and in cities in other parts of Japan both before and after the Great Kantō Earthquake suggests three main findings. We find that price changes occurred in the affected areas immediately following the disaster, and those price changes in the Kantō region (in Tokyo or Yokohama) were in most cases reflected in price changes in Japan's major provincial cities. We also find that cities further away from the devastation by and large witnessed smaller price changes than those found in cities nearer to the Kantō area, i.e. that any changes were correlated with geographical distance from the centre of the shock. Finally, there is some evidence that the observed pattern of price changes reflects the regional heterogeneity identified by Saitō and others, particularly in relation to the different historical patterns of market integration in eastern and western Japan. These findings do not mean, of course, that there was no diversity of experience depending on the product or the region, but analysis of this diversity requires further in-depth research. They make clear, however, both that changes in supply and demand consequent on the disaster generated changes in wholesale prices and that these local changes were diffused over a wider geographical area.

[18] Mosk, *Japanese industrial history*.
[19] Ito, Maeda & Noda, 'Market integration'.
[20] Yao & Zheng, 'Comparison of market integration'.
[21] Saitō, 'Kindai Nihon'.

The remainder of the paper is constructed as follows. First we describe the dataset that has been compiled and the methodology used to analyse the dataset. We then provide our results and analyse the findings in light of the two hypotheses we have indicated. A conclusion follows.

II

In order to answer our questions we have assembled a monthly panel dataset of 11 provincial Japanese cities for the period May 1921 to December 1925. The cities used in the analysis are Niigata, Nagoya, Kanazawa, Sendai, Kyoto, Osaka, Kobe, Kōchi, Hiroshima, Otaru and Fukuoka. The location of these cities is shown in Figure 1. Table 1 shows the characteristics of the sample cities, whose average population over the period 1921-1925 varied from 57,000 in the case of Kōchi to over 1.6 million in Osaka. Limitations on available price data mean that we have not been able to include some other cities with smaller populations, but the total population of our sample cities accounts for approximately 56 per cent of the total population of all cities with more than 100,000 inhabitants in 1923, with Tokyo and Yokohama accounting for a further 36 per cent. The sample comprises approximately 47 per cent of Japan's total city population in 1923.[22] Tokyo and Yokohama, which were located near to the centre of the earthquake and bore the brunt of the physical destruction, are excluded from the sample, as they served as the point of origin of any price changes.

Figure 1 and Table 1 about here

The cities in the sample are geographically relatively well distributed throughout the country. The northernmost city in the sample, Otaru, lies around 10 degrees north and east of the southernmost one, Fukuoka. The geospatial distance from Tokyo is 888 kilometres in the case of Fukuoka, and 839 kilometres in the case of Otaru. This rich variation in

[22] Naikaku Tōkeikyoku, *Nihon teikoku jinkō dōtai tōkei 1925*, pp. 254—255.

geospatial location ensures heterogeneity of city characteristics, and allows us to capture the impact of the Great Kantō Earthquake across the Japanese archipelago.

The use of low frequency data, such as annual or quarterly data, is at higher risk of concealing any short run effects in the months immediately after the earthquake.[23] In order to estimate the impact of the earthquake on prices in provincial cities, we have therefore compiled a dataset of monthly wholesale prices of various goods in different categories in thirteen cities (including Tokyo and Yokohama). Greater frequency data (daily or weekly) are not available for a diverse range of goods and locations. We focus on the analysis of prices rather than quantities, because data on product availability are severely limited for the time period in question. The data are drawn from the statistics of wholesale prices (*Oroshiuri bukka tōkeihyō*) compiled by the Statistics Division of the Japanese Ministry of Commerce and Industry in 1926. The Japanese government recognized these thirteen cities as 'main' cities under a ruling in June 1920, and in each case the local chamber of commerce was required to collect and report the wholesale prices of a large number of different goods. The stated objective was to record monthly wholesale prices for a range of goods in the thirteen cities for the convenience of general users.[24]

We have selected seven goods to represent different categories of purchase, notably foodstuffs, export manufactures, construction materials, fuel and agricultural inputs. The foodstuffs are rice and wheat. Rice was the core foodgrain, grown across the main islands; the Tokyo area was highly dependent upon supplies from the northeast mostly brought in by rail.[25] Rice data have been aggregated to include the prices of different grades of rice. Wheat was increasing in importance in urban consumption, but Japan's own production remained limited. For reconstruction goods we selected wood products; most Japanese

[23] Cavallo, Cavallo & Rigobon, 'Prices and supply disruptions', pp.1-2.
[24] The statistical report containing these data is held in the digitized collections of Japan's National Diet Library at http://dl.ndl.go.jp/info:ndljp/pid/1710197. The listed goods include 35 food items, 20 construction materials, 8 kinds of fertilizer/animal feed and 11 'miscellaneous' goods. See Washizaki, 'Meiji Taishō-ki no toshi', p. 8.
[25] Tetsudōshō Unyukyoku, *Tetsudōshō shuyō kamotsu*, pp.2-3; Naimushō Dobokukyoku, *Dainihon teikoku kōwan*, pp.86-92.

buildings were at this time constructed of wood. Since the data for many wood products are incomplete we have used pine boards (planks) as a proxy for wood products more broadly. Wood was produced across most of the archipelago, but particularly in the north east, including Hokkaido and Karafuto (southern Sakhalin). We selected two fuel products: coal, which was produced mostly in Kyushu and in the northeast, and used largely in manufacturing, and charcoal, produced widely across forested areas mainly for domestic use in both cooking and heating. Cotton yarn, which accounted for around seven per cent of the value of Japan's exports in the early 1920s, was selected as an export good, and calcium superphosphate fertilizer as a key input for agriculture, which still accounted for the largest share of Japan's occupied population.[26] Farmers in the early 1920s were highly dependent on inputs of working capital such as fertilizer, whose consumption had risen by over 400 per cent in the three decades up to World War I. The Tokyo region was a centre of fertilizer production.[27] Price data on these goods were collected for Tokyo and Yokohama, and for the eleven provincial cities indicated above. The data cover a period of 56 months from May 1921 to December 1925, that is, for 26 months following the disaster, and slightly more before it.

In selecting the goods we faced a number of data constraints,[28] but we believe that our sample offers a range of marketed goods that may reflect the kinds of price changes that might be expected for goods with different attributes. We recognize that our aggregation of the data for the sample cities may conceal individual city outliers generated by very particular local circumstances, and will consider this problem further below. An additional potential weakness in our data is that we only have information on wholesale prices. Wholesale prices were far easier to control and regulate than were retail prices; they were more likely to be set by the authorities and wholesale transactions mostly took place in

[26] For cotton export share see Miwa and Hara, *Kindai gendai*, p.115. Fertilizer information from Sawai and Tanimoto, *Nihon keizaishi*, p.164.
[27] Consumption figure from Sawai and Tanimoto, *Nihon keizaishi*, p.164. Dainihon Jinzō Hiryō, the largest fertilizer producer, had 3 of its 6 factories destroyed in the earthquake (Tomikashi, 'Kantō Daishinsai', p.12).
[28] These data constraints are noted in Appendix B.

official markets. Retail prices were set by individual retailers, and in 1923 retail in Japan was overwhelmingly populated by individual retailers, small shops with maybe at the most just one or two employees, or making use of family members.[29] Obtaining systematic statistical evidence on retail prices is therefore very difficult, and that which does exist is often incomplete and potentially unreliable. We acknowledge that the potential for divergence between trends in wholesale and retail prices is considerable, and will return to this problem when we consider the findings of our empirical analysis in a broader historical context.

Figure 2 about here

Figure 2 (a-g) shows the prices of the selected goods in Tokyo and Yokohama before and after the disaster, and Figure 2 (h-n) prices in provincial cities. The timing of the disaster is marked on these figures. There are fluctuations in the wholesale prices of all goods in the months both before and after the disaster, fluctuations likely to have been generated by cyclical, seasonal or other factors. Preliminary analysis of these data suggest that Tokyo was relatively well integrated with provincial markets.[30] If we compare the average prices in Tokyo and Yokohama in the months following the disaster with those in the months prior to it, we can see that the prices for most of our sample goods were on average higher in the months after the disaster than before. In the case of rice and wheat, prices were stable or rose only slowly in the first twelve months after the earthquake, which is commensurate with the existence of official attempts to requisition supplies, regulate wholesale rice prices, and encourage imports of essential goods through suspension of tariffs. Rapid initial price rises for cotton yarn, fertilizer and charcoal would be commensurate with the loss of local

[29] The first national census of distribution was only undertaken in 1939, 16 years after the disaster. It showed that over 90 per cent of Japan's retail establishments had four or fewer employees (cited in Francks, *Japanese consumer*, p.114).

[30] Calculation of the correlation coefficients between prices in the Tokyo market and those in provincial cities for the period May 1921 to August 1923 shows them in most cases to be positive and statistically significant. The results of this calculation are provided in the online appendix (Table C.9 in Appendix C5.1).

manufacturing capacity and stocks and, in the case of charcoal, loss of housing and the onset of colder weather. The average prices of pine boards and coal were actually lower after the disaster. The sudden demand for reconstruction materials meant that the price of pine boards rocketed after the earthquake, but the large scale provision of supplies from both domestic and foreign sources (mostly North America) is likely to have been a major factor in bringing prices down to the pre-disaster level by spring 1924. Coal also experienced a sharp immediate price increase; it seems likely that the impact of destruction of stocks and significantly increased shipping costs outweighed any effect of lower demand due to manufacturing destruction.

As noted above, the price data for the provincial cities for the period from May 1921 to December 1925 are provided in Figure 2 (h-n). A similar comparison of the average prices across the eleven cities for each good in the months prior to and following the disaster suggests significant diversity in changes in price in terms of both timing and the product in question. Figure 2 indicates that the average prices of rice, wheat, cotton yarn and calcium superphosphate were all higher in the period after September 1923 than in the period prior to it. The prices of these products began to increase a few months after the disaster, but that of calcium superphosphate had declined again within the year whereas the prices of rice, wheat and cotton yarn were still high a year after the disaster. During the year from October 1924 the price of rice in provincial cities was around 40 yen per 180 litres, approximately 18 per cent higher than the price in August 1923. The price of cotton yarn rose sharply towards the end of 1924 to a level approximately 60 per cent higher than that of August 1923. These findings are consistent with an expectation of rising prices for goods in short supply in the months after the disaster, including foodstuffs, clothing inputs and fertilizer, although the more prolonged increase in prices for foodstuffs and cotton yarn are likely to have been associated with other factors, including the level of the 1924 harvest, some relaxation of the conservative exchange rate policy, and an upturn in the business cycle.

By contrast we find that Figure 2 (k, m, n) also shows that the average prices in provincial cities of pine boards, charcoal and coal were lower after the earthquake than before it. Pine

boards and charcoal experienced short run positive price shocks, but prices had stopped increasing by early 1924, and had fallen to the pre-earthquake level by the spring. The short duration of the price shock in the case of pine boards is again commensurate with the rapid increase in supply that occurred from early 1924, and that for charcoal with greater regional supplies and the passing of the peak demand winter period. The profile for average coal prices in the sample cities, however, is somewhat different from that in Tokyo and Yokohama; there is a significant drop in the average coal price following the disaster, and little evidence of the initial price surge for coal in the disaster region. Thus for almost all these products there seems to have been some kind of positive price shock after September 1923, but the duration of that shock varied considerably, and was in some cases outweighed by significant price declines occurring subsequently.[31] In order to capture more precisely the magnitude of any price shocks from the earthquake, therefore, we will also estimate the baseline specification using an alternative cut-off period.

Our quantitative analysis in the next section relies on measures of sea-route distances between provincial cities and the affected city of Tokyo. Tokyo and Yokohama depended on both railways and marine transport, and the earthquake devastated the area's logistic infrastructure. Tokyo was reported to have lost over 2,000 ships and nearly 800 trains, over a third of its total. In Kanagawa, the prefecture containing Yokohama, the number of freight trains running fell from nearly 15,000 in August 1923 to barely 1,000 in September, with the amount of freight carried collapsing from over 170,000 tons to just under 12,000. Shipping tonnage entering the port of Yokohama fell from nearly 158,000 tons in August to only 6,299 tons in September.[32] All the evidence suggests, however, that while both sea and rail infrastructure took months to recover, rail transport faced particular problems due to the destruction of track and warehousing facilities across the Kantō area, which in turn affected

[31] We also compared the prices in 1923 with those in the same month of the previous year in Figure A.1 of Appendix A. We confirmed that the prices of all commodities after September 1923 were higher than those in 1922.
[32] Tōkyō Shiyakusho, *Tōkyō-shi shinsai*, pp.20-22; Kanagawa-ken Sangyōbu Shōkōka, *Kenka keizaijō*, pp.10-11; Tōkyō Shiyakusho Shōkōka, *Taishō jūninen*, pp.38-9.

railway logistics over a far wider area.[33] It may be suggested, therefore, that at least initially transactions in goods, and their prices, were less likely to depend on rail connections between the affected area and provincial cities, notwithstanding a significant increase in marine freight costs.[34] We have therefore constructed this variable using sea distance. With the exception of Kyoto, all the provincial cities were ports; Kyoto was served by the port of Maizuru, so we added the rail distance from Maizuru to Kyoto to reflect the total distance (details of the documents in Appendix B).[35]

We use control variables representing the demographic, industrial, trade-related and meteorological characteristics of the cities as baseline controls for our empirical analysis. Size of population is included in the control variables to indicate the scale of demand for each commodity,[36] and also the number of factories per 100 population in each prefecture, as prefectures with a larger number of factories were more likely to be affected by any shortages of raw materials and fuel. The total tonnage of steam and sailing ships entering ports in each prefecture and railway freight are used to control for the availability of marine and rail transportation. This variable also acts as a control for the quantity of imports, which is likely to have affected wholesale prices in the cities. Finally, for meteorological variables we use monthly average temperature and monthly average precipitation, which are drawn from the database of the Japan Meteorological Agency (JMA). These variables are included for two reasons: firstly, meteorological conditions are likely to have affected the availability of marine transport, particularly sailing ships; secondly, weather conditions directly influenced the supply of, and demand for, goods such as foodstuffs and charcoal, hence also affecting their prices. Details of the sources of the control variables are provided in Appendix B. Panel

[33] Jiji Shinpōsha Keizaibu, *Daishinsai*, p.179ff.
[34] Jiji Shinpōsha Keizaibu, *Daishinsai*, pp.223-5.
[35] Official reports indicate that the amount of freight from northern Kyoto Prefecture, including Maizuru, into Kyoto city was substantial at the time of the disaster, but it is also likely that Kyoto city had a significant inflow of goods through the port of Osaka. We ran our baseline regression using the sea route distance to Osaka and the railway distance from Osaka to Kyoto, and the results clearly indicated the robustness of our findings reported in Table 3. See Table C13 in Appendix C6.
[36] We also ran regressions weighted by the number of population in each city-year cell. The results were similar to those where the size of population was included as a regressor, reported in Table 3. See Table C.2 in Appendix C.2 for the results.

(C) of Table 2 gives summary statistics of the control variables.

Table 2 about here

III

It was suggested above that the disaster consequent on the Great Kantō Earthquake that struck in the centre of Japan on 1st September 1923 is likely to have impacted on the prices of some commodities and brought a degree of confusion to market transactions in provincial cities across the Japanese archipelago, even though these cities were not directly affected by the physical impact of the earthquake. In effect, we might expect wholesale prices in these provincial cities to have been affected by the enormous physical losses in the central part of Japan and the subsequent disruption caused by the earthquake. In this section, we conduct a quantitative analysis of our 11 provincial city–level monthly panel dataset to test whether or not the occurrence of the earthquake changed the wholesale prices of commodities in the provincial cities. As before, the data cover a period of 28 months both before and after the earthquake, that is, from May 1921 to December 1925.[37]

In light of the two assumptions that we are seeking to test, in this section we ask how far price changes in Tokyo and Yokohama consequent on the disaster were reflected in price changes in Japan's provincial cities, and the extent to which any such price shock was aligned with geographical distance from the capital area. We also ask whether the price changes identified reflect historical patterns of market integration in Japan, in particular the degree of separation observed between the eastern and western parts of the country. To answer these questions, we use the cross-sectional heterogeneity in sea route distance values to distinguish the impact of the earthquake. Our expectation is that cities located closer to Tokyo will be significantly affected by the physical devastation that has occurred in

[37] We confirmed the stationarity in our wholesale price panel dataset. For all wholesale prices of the products used in our analysis, several tests reject the null of unit-root non-stationarity. See Table C.1 in Appendix C.1.

the centre of the country, whereas the cities located further away from the capital will be less affected by the physical devastation caused by the earthquake. For each city, therefore, we use the reciprocal number of sea route distance from Tokyo as an indicator of the closeness to the center of the earthquake and thus, as an indicator of the magnitude of its influence. In order to test the extent to which the earthquake changed the market prices in provincial cities and identify how far the impact of the earthquake varied across these cities, we estimate the following model:

$$Price_{it} = \alpha + \rho Price_{it-1} + \delta Closeness_i \times Post_t + \mathbf{x}'_{it}\boldsymbol{\beta} + \nu_i + \lambda_t + e_{it} \quad (1)$$

where i is the index of the cities from 1 to 11 and t the index of the months from May 1921 to December 1925, 56 months in total.[38] The variable $Price_{it}$ is the price of a certain product, $Closeness_i$ is the reciprocal of sea route distance from Tokyo, $Post_t$ is the indicator variable that equals one after September 1923, $\mathbf{x}_{it}$ is a vector of city characteristics, and e_{it} is a random error term. ν_i and λ_t represent city and month fixed effects, respectively.

The coefficient δ is the focal point of our interest. We expect $\hat{\delta}$ to be positive, which would indicate that the earthquake had a larger positive effect on prices in cities closer to Tokyo. For instance, where rice is the dependent variable, a positive coefficient would indicate that cities located closer to Tokyo experienced a greater increase in the wholesale price of rice after September 1923 than did cities that were located further away. Regarding our identification, we assume that, after taking into account city observables, the variable of interest is exogenous. This assumption would appear to be basically plausible, as it is clear that both the timing of the earthquake and the distances of each city from Tokyo are exogenously determined. Although both demand- and supply- side institutions may also affect the level of prices, we are able to control for those factors using the covariates

[38] Here we follow the specification used in Naidu & Yuchtman, 'Coercive contract enforcement', which uses the interaction term between cross-sectional treatment variation and post event dummy as the key variable of interest.

described in Section II and fixed effects. City fixed effects control for all time-constant factors in each city. These factors include, for example, geographical features affecting transportation costs or productivity in relation to foodstuffs, market institutions such as the regulation of trade practices between producers and merchants, and citizens' preferences for different commodities. Other macroeconomic shocks affecting prices, including government intervention to stabilize markets, as well as any secular trends and seasonal effects on prices during the sample period are controlled for by monthly fixed effects. Finally, we also include a lagged dependent variable into the regressors in order to capture persistence in price. This lagged value of price can also be considered as potentially reflecting cross-city dynamics in price because it may reflect information on predetermined prices in other cities.[39] We employ cluster-robust standard errors in order to deal with heteroskedasticity and serial correlation in the idiosyncratic error term.[40]

Table 3 about here

Our estimates of the baseline model by product categories are reported in Table 3.[41] We will start by discussing the findings for rice, for which, as shown in column (1), the estimated coefficient on *Closeness* × *Post* is 3.038 and statistically significant at the 1 per cent level. This result implies that a one unit increase in the reciprocal of distance results in an increase

[39] Note that the within estimator in a dynamic panel data model becomes consistent as *T* gets larger (see Hsiao, *Analysis of panel data*, pp.82–84). The number of sample periods in our baseline specification is 56-months in total and can thus be considered sufficiently large to bring our parameter of interest close to a true value (see Baltagi, *Econometric analysis*, pp.155–156).

[40] For this technique see e.g. Cameron and Miller, 'Practitioner's guide'. Throughout our empirical analysis, standard errors are clustered at the city level. Although Osaka and Kobe city are located close to each other (see Figure 1) and may be expected to have spatial correlations, our baseline estimates reported in Table 3 are robust to including these two cities in the same cluster. See Table C.3 in Appendix C.2 for the results. In addition to this, we also employed the wild cluster bootstrap method to deal with the issue of the small number of clusters (Cameron et.al., 'Bootstrap-based improvements'). Using this procedure the main results could be confirmed as stable. See Table C.4 in Appendix C.2.

[41] We also conducted a placebo test for the wholesale prices using the period prior to the earthquake to check the robustness of the main findings. See Appendix C.3 for details.

of roughly 3.038 yen per 180 litres in the post-earthquake average wholesale price of rice relative to that before the earthquake. The maximum value of *Closeness* is 0.5 for Nagoya and its minimum value is 0.12 for Kanazawa. Therefore, the impact of the earthquake on the average wholesale price of rice in Niigata is approximately 1.52 yen per 180 litres (0.5 × 3.038), whereas that in Kanazawa is approximately 0.36 yen (0.12 × 3.038). The impact in Hiroshima, which is located at a roughly intermediate point in terms of the sea route distance of the various cities from Tokyo, is estimated to be 0.58 yen per 180 litres (0.19 × 3.038). The large disparity in the impact between Nagoya and Kanazawa would seem to offer support to the hypothesis that cities closer to Tokyo were likely to be more significantly affected by the earthquake, whereas cities further away would be less affected.

To explore the magnitude of any effect in more detail, we then calculated the increase in the price of rice due to the earthquake as a proportion of the total increase in rice prices between the period May 1921-August 1923 and the period September 1923-December 1925. While prices would clearly have been affected by official measures such as temporary price controls and requisitioning, our monthly fixed effects effectively control for the unobserved effects of these measures in each observed month. As shown above, in Hiroshima city the estimated impact of the earthquake on the price of rice was 0.58 yen, but the actual price increase of rice in Hiroshima over this period was 5.42 yen, as it rose from 33.32 yen per 180 litres in the pre-earthquake period to 38.74 yen in the post-earthquake period, meaning that only 10.6 per cent of the total increase in the wholesale rice price in Hiroshima is accounted for by the earthquake. Figure 3 lists these percentage figures for each provincial city in order of distance.[42] These figures suggest that the impact of the earthquake on the price of rice increases the closer a city is to Tokyo. The impact of the disaster on the wholesale price of rice is highest in Nagoya city, which is located at a sea route distance of 201 kilometres from Tokyo city. By contrast, it is lowest in Kanazawa city,

[42] Table C.6 in Appendix C.4 shows the calculation of those magnitudes for each provincial city. The estimates suggest that the increase in the price of 180 litres of rice due to the earthquake diminished by 0.14 yen with every additional 100 km from Tokyo.

which is 867 km from Tokyo. The higher deviation from the trend in the case of Kōchi is likely to be the result of a relatively small increase in price due to the availability of stocks at that time.[43] The average value of these magnitudes is calculated to be 12.5 per cent. Thus for the total period after the disaster the estimated impact on the price of rice was on average not very great, and we will try to break down this period in the following discussion.

Figure 3 about here

If we look at the figures for the other products reported in columns 2–7 in Table 3, we see that the estimated coefficients on *Closeness* × *Post* for wheat, cotton yarn, pine boards, and charcoal are not statistically significant. Statistically significant results are observed only for calcium superphosphate and coal. This supports the suggestion in Section II that the scale and nature of the impact of the earthquake on prices tended to vary not only according to the individual product but also in terms of timing, that is, in terms of the length of the period after the earthquake during which any changes might persist. To explore this further we have estimated our baseline specification using alternative cutoff periods.

Table 4 about here

Table 4 presents the results if the baseline model shown in equation (1) is calculated for each three-month segment after the earthquake. Rows 1-9 of the table show the estimated impacts for each product using the panel datasets starting in May 1921, but setting the post-earthquake period as 3, 6, 9, 12, 15, 18, 21, 24, and 28 months. Thus, the total number of months in each sample is 31, 34, 37, 40, 43, 46, 49, 52, and 56 months, respectively. For all specifications, we include all the control variables as well as city and month fixed effects.

[43] Official reports from Kōchi prefecture record that total rice production in 1922 was 1.5 times the normal yearly production (Kōchi Prefecture, *Kōchiken tōkeisho 1922*, vol.2, pp.10-11), allowing for larger stocks in 1923.

While, as might be expected, persistent effects are observed in relation to the wholesale price of rice, it is also conspicuous that the estimated coefficients for pine boards and charcoal are now positive and statistically significant for the initial three-month period after the earthquake, as shown in the first row of Table 4.

This result is consistent with the overall trend in the time series showing that the sudden increase in prices had largely been halted by the end of 1923, and that prices had begun to decrease around the turn of the year. This implies that in the cases of both wood and charcoal the earthquake accounted for a significant proportion of the rise in price that occurred. If we apply the same calculation used to estimate the average impact on rice, we find that the earthquake accounts for all of the total increase in the price of wood over the three months after September 1923, and half of the increase of the price of charcoal.[44]

In the case of our other products, namely wheat and cotton yarn, no statistically significant effects are observed. This suggests that the earthquake did not have a significant impact on the wholesale prices of these commodities. It seems likely that measures such as tariff suspension on imported goods such as wheat and the fact that much of the nation's cotton yarn was produced in the Osaka area rather than in Tokyo may have contributed to this minimal effect. From the summer of 1924, i.e., one-year after the earthquake, however, the estimated coefficient for calcium superphosphate is positive and statistically significant, while that for coal is also statistically significant, but negative. This implies that the earthquake only affected the prices of fertilizer and coal somewhat later. We may suggest that the agricultural cycle meant that fertilizer would have been more widely used as spring approached, while in the case of coal, which Tokyo obtained primarily from the northern half of Japan, demand only recovered in line with industrial production.

[44] This sudden increase in prices following the disaster is consistent with contemporary reports attributing changes to the sudden upsurge of demand combined with a collapse in supply (Nōshōmushō Sanrinkyoku, *Kantō Daishinsai*). The magnitude of the effect in each provincial city in the case of wood and charcoal is reported in Tables C.7 and C.8 in Appendix C.4. In the case of wood and charcoal, however, the shorter observation period after the earthquake might provide a rough estimate of the magnitude. Several cities have indeed small but negative values, so these cities did not experience a substantial increase in prices soon after the earthquake.

The above results suggest that in the case of rice the impact of the earthquake on the wholesale price was comparatively persistent. We therefore need to consider how quickly rice prices were stabilized, i.e. how rapidly equilibrium was restored following the shock, and how far this process may have been impacted by geographical distance and region. To do this, we employed the same calculation used earlier to illustrate the magnitude of the impact of the earthquake on rice prices in each three-month time-period.[45] We then aggregated the average magnitudes for three geographical zones based on sea route distance from Tokyo: that is, cities located 201-381 kilometres from Tokyo, cities 531-615 kilometres from Tokyo, and cities at a distance of over 735 kilometres. Figure 4 illustrates the proportion of the total price change before and after September 1923 accounted for by the earthquake.[46]

Figure 4 about here

There are two main findings regarding the price of rice. First, the magnitude of the effect of the earthquake declined as the length of time following the event increased. On average, six months after the disaster the earthquake was accounting for approximately 70 per cent of the total increase in rice prices, but by nine months after the earthquake, this share had fallen to approximately 35 per cent. Twelve months after the earthquake, the figure had declined to around 30 per cent. By 21 months after the earthquake the effect of the earthquake on the wholesale price of rice had settled at around 15 per cent of the total price increase. This suggests some convergence towards the pre-shock equilibrium.

Second, the share of the overall price increase accounted for by the earthquake

[45] For instance, in the case of Niigata city we see that over the 12-month period after the earthquake the average wholesale price of rice increased by 2.5 yen, from 31.98 yen per 180 litres in the period between May 1921 and August 1923 to 34.48 yen in the period from September 1923 to August 1924. Since the increase in price due to the earthquake is estimated to be 0.6 yen (1.53 × 0.39), the earthquake accounts for 23.9 per cent (0.6/2.5) of the total price increase. The same calculation was applied to all cities and for all cutoff periods.

[46] The estimated magnitudes in each provincial city are also reported in Figure C.2 in Appendix C.4. We have confirmed that the correlated coefficients among these cities are mostly close to one, suggesting better market integration (Table C.10 in Appendix C5.1).

increased the closer a region was to Tokyo, with prices in the five cities located 201-381 kilometres from Tokyo most significantly impacted. The difference in the magnitude of the effect between these cities and the two cities in the next distance band (531-615 kilometres) is roughly 10 per cent for each cutoff period. The magnitude of the effect in these cities is in turn higher than that in the four most distant cities, those in the range of over 735 kilometres from Tokyo.

Figure 5 about here

In an attempt to explore these changes in the context of the different patterns of east-west market integration, Figure 5 shows the proportion of the increase in the rice price accounted for by the earthquake in six sample cities, three (Sendai, Otaru and Niigata) in north/northeast Japan and three (Nagoya, Kyoto and Fukuoka) in west/southwest Japan. The percentage figures in Figure 4 were calculated on the basis of sea route distance, so we have chosen cities in different regions of Japan located over a similar range of distances. Sendai and Nagoya are both located within 300 km of Tokyo; both are on the Pacific Ocean coast. Niigata and Kyoto are located on the Japan Sea side of the main island and are both considerably further from Tokyo. Otaru and Fukuoka are both very distant from Tokyo, and not situated on the main island of Honshū. As shown in Figure 5, if we compare the two cities nearer Tokyo, i.e., Sendai and Nagoya, the effect of the earthquake appears to be more significant in Sendai. A similar tendency is evident for the two cities further from Tokyo, i.e., Niigata and Kyoto. These results suggest that changes in the rice price due to the earthquake were more conspicuous in the eastern half of Japan. This would be in line with contemporary qualitative accounts suggesting that the north east of the archipelago was more integrated with markets in the devastated Kantō region than were cities further west, which were more integrated with the physically unaffected Kansai region around Osaka.[47]

[47] See eg. Nōshōmushō Shōmukyoku, *Kantō chihō shinsai*.

The findings for Otaru and Fukuoka are less clear, with the earthquake appearing to have a more significant effect on the rice price in Fukuoka, in the southwest, for much of the first year after the disaster. The effect on the Otaru wholesale rice price, while less significant, was, however, much more persistent. The difference in magnitude in the case of Fukuoka may also be associated with the existence of ample stocks.[48]

The quantitative analysis conducted in the first part of this section supports the available evidence indicating that changes in prices in the Kantō region consequent upon the disaster were to some extent reflected in price changes elsewhere in the Japanese islands. It also suggests that cities further away from the area of devastation tended to witness smaller price changes than those experienced by cities nearer to the Kantō region. In order to estimate the overall impact of the earthquake on the prices of goods in provincial cities, we have used dynamic panel data analysis as our main empirical strategy. However, it is also helpful to analyze the relationship between the price shock in Tokyo and the price in each provincial city and to measure the degree of market integration between the Tokyo market and that in each provincial city by using a time-series dataset. Following other studies,[49] we utilize an error-correction approach, meaning that the price shock in the Tokyo market is regarded as the original impact of the earthquake.

For the wholesale price series in Tokyo (x_t) and in a provincial city (y_t), a simple error-correction model can be represented as follows:

$$\Delta y_t = \alpha \upsilon_{t-1} + \gamma \Delta x_t + \varepsilon_t \qquad (2)$$

where υ_{t-1} is the error correction term defined as $\upsilon_t = y_t - \beta x_t$. This term represents the

[48] Total production of rice in Fukuoka Prefecture in 1922 was 1.1 times that of the previous year, resulting in a relatively lower price (Fukuoka Prefecture, *Fukuokaken tōkeisho 1925*, pp.8-9). It seems likely that the presence of stocks limited the extent of price changes, hence increasing the proportion of any price changes accounted for by the earthquake.

[49] Eg. O'Grada, 'Markets and famines'; Bassino, 'Market integration and famines'; Ejrnaes & Persson, 'Gains from improved market efficiency'; Marks, 'Unity or diversity'; Federico, 'How much do we know'.

deviation from the long-run equilibrium of price in the previous month. This implies that such error can be corrected through the error correction coefficient α. Therefore, we expect $\hat{\alpha}$ to be negative because a positive v_{t-1} means that the price in the previous month is out of equilibrium value. In this sense, a larger absolute value of $\hat{\alpha}$ implies faster adjustment. γ is the parameter that captures the short-run behavior in the price change between the two markets. A larger value of $\hat{\gamma}$ suggests that the markets are synchronized. For this analysis, log values of wholesale prices are used throughout.

An error correction model requires a cointegrating relationship between both price series. Accordingly, we first applied the unit root test to each log-wholesale price series and confirmed that the null hypothesis of a unit root was not rejected for most of the log price series for the period before and after the earthquake. However, the results for the residual-based test for cointegration suggest that only the wholesale price of cotton has a consistent cointegration relationship across provincial cities from August 1923 to December 1925. This finding may be in part due to the relatively small number of observations.[50] The fact that in cotton we get a result despite the small number of observations is worth further consideration. We therefore estimated Eq (2) for cotton using the Engle and Granger two-step procedure. We have summarized the discussion on the procedures in Appendix C.5.2.

Table 5 about here

Table 5 presents the response of the provincial cities to price changes for cotton yarn in Tokyo. Note that a large part of the price changes during the sample period was caused by the earthquake of September 1923. Thus, the estimates reported in Table 5 show how far prices in the provincial cities were affected by any price change in Tokyo and how quickly prices converged on their long-run values. Overall, all the estimated coefficients are

[50] This is in line with other historical studies of this kind, for example Bassino, 'Market integration and famines'. For discussion of the power of the error correction model (ECM) cointegration test, see Mantalos & Shukur, '*Size and power* '.

statistically significant and show the expected signs. This implies that the markets were relatively efficiently integrated. In fact, the absolute values of $\hat{\alpha}$ are around 0.7-0.9 in most cases, implying that much of the deviation from the long-run equilibrium of prices was corrected within one month. Table 5 also suggests that neither the speed of adjustment nor the short-run behavior in the price change were significantly influenced by the cities' sea route distances from Tokyo. These results are consistent with those shown in Table 3, in which no statistically significant results for the wholesale price of cotton yarn could be observed even for the very short-run period after the earthquake.

Overall these results for cotton yarn are consistent with what we know of the trading relationships between provincial cities and Tokyo. For instance, the speed of adjustment in relation to Sendai and Otaru is relatively high, while the short-run effects on Nagoya and Otaru are also relatively large. This result may reflect the fact that much of Tokyo's cotton yarn trade had hitherto been with Sendai, Nagoya and Hokkaido. The very small values of both $\hat{\alpha}$ and $\hat{\gamma}$ for Kōchi may be associated with the fact that railway (although not sea) access to Kōchi city was still very limited, while in the case of Fukuoka available evidence indicates that the total volume of trade in cotton thread was relatively small. [51]

IV

This paper has sought to test two main assumptions through an analysis of prices in the wake of Japan's Great Kantō Earthquake of 1923. One is that in a market economy a localized exogenous shock such as that generated by a major natural disaster will alter demand and supply schedules, hence causing price changes. The other is that local price changes in the disaster area are likely to be communicated to a wider geographical area.

The econometric exercises, which explored the price changes for different products across eleven Japanese cities, in addition to the two cities in the devastated area, Tokyo and Yokohama, confirmed that price changes did occur in the affected area immediately following

[51] Tetsudōshō, *Tetsudō yusō*, pp.84-85; Naimushō Dobokukyoku, *Dainihon teikoku*, p.109.

the disaster and were in many cases reflected in price changes in Japan's provincial cities. These findings were most pronounced in the case of rice, the country's core food grain, where our analysis showed that the impact of the earthquake on prices was relatively persistent (though declining over time), and that provincial cities nearer to Tokyo were proportionately more likely to experience larger price changes because of the disaster. In the case of wood, a core reconstruction material, there was an immediate strong impact from the disaster, but this did not persist for very long, while the results for the other products in our sample were not statistically significant.

The price data in Figure 2 suggests that the changes in wholesale prices immediately following the disaster, though relatively short-lived, were in some cases conspicuous. At this time most wholesale transactions in Japan took place in officially sanctioned markets, and were more tightly regulated than retail prices; transactions in the retail sector were largely unregulated and carried out by a myriad of small scale operators. There is a significant amount of contemporary anecdotal evidence suggesting widespread consumer concern about rising retail prices for many essentials. Complaints regarding attempts by retailers to charge as much as they could for goods in short supply were a recurrent feature of official publications as well as newspaper and journal reports from the period. It was in response to this situation that the authorities rapidly moved to issue an anti-profiteering ordinance. Profiteering, according to this ordinance, was identified as selling a good at a price 30 per cent or more above the pre-disaster price; individuals found guilty of profiteering were liable to imprisonment or heavy fines. It is hard to judge how far such draconian regulations limited retail price increases, but they certainly did not stop them completely. Over the two months following the earthquake over 400 individuals were arrested for breaching the regulations.[52] We have no way of knowing whether or not many hundreds more managed to evade the eyes of the police. The 30 per cent price increase criterion also suggests that the authorities expected some retail prices to rise by a considerable margin in the wake of the disaster, and

[52] Keishichō, *Taishō daishinkasai shi*, pp.605, 622.

felt that they had no choice but to tolerate some increase. One analysis of the economic impact of the disaster that appeared early in 1924 cited examples of outrageous profiteering not just from Tokyo and Yokohama, but from the provincial cities of Osaka, Kobe and Nagoya.[53] Chambers of commerce across the country reported increases in the purchase prices of lumber and other construction goods of up to 50 per cent, while others reported significant price falls for products that temporarily failed to find a market, including raw silk and hemp.[54]

Unfortunately, there is no available systematic retail price data that allows us to undertake a quantitative analysis comparable to the one conducted for wholesale prices. There exists at best only *some* retail price data for *some* cities for *some* commodities for *some* time periods. The scant retail price data that are available do not provide a clear message. Statistics on retail prices compiled by the Tokyo Chamber of Commerce, for example, suggest that for rice the ratio of wholesale to retail prices remained relatively constant throughout the period from January 1923 to December 1925, while for charcoal cyclical demand contributed to a widening gap between retail and wholesale prices annually throughout the early 1920s, and 1923/4 was no exception. The average retail prices in 1924 of 47 'daily necessaries' in Tokyo were reported as in most cases being above the 1923 average retail price, but the same was true of most wholesale prices. In the case of rice much of this higher average retail price was accounted for by monthly rises in the second half of 1924, suggesting the importance of seasonal factors.[55] Figure 7 shows some indicative wholesale and retail prices in the three cities of Tokyo, Osaka and Fukuoka. It is apparent that in all cases retail prices were higher than wholesale ones, but the extent of the gap varied considerably and it is hard to draw any clear conclusions regarding the pattern of change and fluctuations.

[53] Jiji Shinpōsha Keizaibu, *Daishinsai*, pp.19-24.
[54] Nōshōmushō Shōmukyoku, *Kantō chihō shinsai*, pp.100, 109-10, 186, 200. This volume contains reports collected from chambers of commerce across the country on the effects of the earthquake on business within their jurisdictions.
[55] Tōkyō Shōgyō Kaigisho, *Tōkyō shōgyō kaigisho tōkei nenpō 1925*, pp.47-52.

Figure 7 about here

The extent to which the actual retail price changes in Tokyo and Yokohama consequent on the disaster, and their diffusion to other parts of the country, were commensurate with the alarmist tone of many contemporary reports is therefore likely to remain unclear in the absence of identification and analysis of suitable retail price data.

Our findings seem to confirm that markets in Japan were relatively well integrated, but that there was some persistence of regional market heterogeneity, in line with the existing literature on market integration in Japan. They indicate that although there was a diversity of experience and timing in relation to the changes, depending on the product and the city, the prices of all our products were soon moving back towards equilibrium following the shock. Despite the diffusion of price instability outwards from the affected Kantō region, that instability was for the most part relatively short-lived, indicating a high degree of market efficiency. These findings are in line with other literature suggesting that most economic indicators were characterized by a relatively rapid reversion to previous trends.[56] In short, the disaster was a short term exogenous shock from which Japan's economy soon recovered.

We have sought in this paper to use the Great Kantō Earthquake of 1923 as a case study that can shed light on the link between market-based interactions, market integration, and the longer-term impact on an economy of this kind of 'nature's experiment'. Further research is needed, however, if we are to understand better the implications of these movements in prices, both in relation to price formation and transmission in the wake of an exogenous shock and in terms of any significance for the study of market integration. We still have insufficient knowledge of the factors that may accelerate or limit the spread and duration of any price changes following a natural disaster of this kind, and, crucially, of any

[56] Eg. Watanabe, 'Tōkyō no shingai'.

implications for the longer-term consequences of such a shock for the economy as a whole. For contemporary disaster studies, understanding these factors is one of the keys to recovery and the building of resilience.

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