The Japanese Textile Sector and the Influenza Pandemic of 1918-1920

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Abstract: The ongoing global pandemic has brought into sharp relief the possible interactions between the epidemiology of a virus, the structure of the economy and society that becomes exposed to it, and the actions chosen by government, individuals, and communities to combat it or ameliorate its economic impact. Surprisingly, there has not been sufficient research on these economic and policy interactions of the 1918-1920 influenza pandemic - the deadliest pandemic of the 20th century. The focus of much of the research has been on the pandemic's mortality and other demographic impacts. This paper focuses on Japan, which as a minor participant, was not directly affected by World War I. We exploit the diversity of experiences with the pandemic and its attendant policy responses across Japanese prefectures; and investigate the importance of the pandemic's toll (measured by excess mortality), and of non-pharmaceutical policy interventions (NPIs), in determining the pandemic's economic impact. We do so by focusing on the production and employment in the textile sector, given the availability of data and the general importance of the textile sector for emerging economies (as Japan was at the time). We investigate the role of NPIs in ameliorating the economic costs for the sector during the pandemic years (1918-1920), and indeed find that the implemented NPIs were effective in ameliorating the pandemic's economic consequences, rather than worsening them. In this case, there was no trade-off between money and life, but rather the two were complimentary.

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1. Introduction

The 1918-1920 Influenza pandemic, a disease that spread to almost every place in the world, with the notable exception of some small islands, is widely known as the costliest pandemic in modern times. Its death toll is sometimes estimated to be 50 million people or more. It was first reported in early 1918 in Kentucky (US) with this first wave reaching much of the world by mid-year. This first wave was not much different, in terms of mortality, to a standard influenza, but the second and third waves, in 1919-1920, proved much deadlier. These waves also reached most of the world, including Japan.[1] Still during the past century there has not been that much research on the economics of the 1918-1920 Influenza pandemic. Most of the existing economic research on the Influenza pandemic has been focused mostly on the pandemic's impacts on epidemiology/demography, including the impact of economic variables such as trade networks on the disease's spread - for surveys of this literature, see Arthi and Parman (2021), Athukorala and Athukorala (2020), Beach et al. (2021), and Noy and Uher (2021). The one notable exception, in Economics, has been a burgeoning literature on the 'foetal origins' hypothesis that followed from a seminal paper by Almond (2006).[2]

This dearth of economic research has obviously changed since the emergence of COVID-19 in January 2020 in China and its spread across the world, making it the costliest pandemic since 1918-1920. The COVID-19 pandemic has brought into sharp relief the interactions between the epidemiology of the virus itself, the structure of the economy and society that becomes exposed to it, and the actions chosen by government and adopted by individuals and communities to combat it or ameliorate its economic impact. The diverse experience across countries in 2020 has clearly shown that the impact of a pandemic is not determined only by the genomics of the virus and the ways it interacts with its human hosts. Rather, the economic impact of the pandemic is maybe primarily a function of the characteristics of the economic system that becomes exposed to it, and the deliberate actions, successful or otherwise, pursued by the authorities. In light of these observations, we aim to contribute to the existing literature in two ways.

[1] A fourth wave, in mid 1920, reached only a few regions, and after that the H1N! influenza virus disappeared until a second pandemic in 1977.

[2] This literature asserts the importance of in-utero conditions on the development of children and their eventual characteristics as adults. It does so by focusing on the cohorts of children that were exposed to the pandemic while in-utero (Almond and Currie, 2011; Almond et al., 2018).

The first, and the most obvious, is that we focus on Japan, a country whose economic experience with the 1918-1920 pandemic has scarcely been researched, while several works examined the pandemics demographic impacts (e.g., Chandra, 2013; and Chandra and Yu, 2015). Arguably, Japan provides a particularly useful case study as it did not participate in the First World War, so that the war, and its end, has had a relatively minor impact on its economy. Thus, it is easier to identify the impact of the pandemic on the Japanese economy as separate from the impact of the war and the demobilization that followed its end in many other countries. Furthermore, Japan has detailed high-frequency and spatially disaggregated data on many of the aspects we would like to investigate (unlike most other countries that did not take part in this global conflict).

Our second contribution is to investigate the importance of policy interventions in determining the economic impact of the pandemic. In 1918-1920, medical knowledge was very rudimentary, so pharmaceutical interventions intended to vaccinate, ameliorate symptoms, or cure, were at best benign, and at worst damaging (Hobday and Cason, 2009). However, enough was already known about the ways in which respiratory infectious diseases spread that the non-pharmaceutical interventions (NPIs) that were pursued were more likely to be effective (Aiello et al., 2010). Indeed, most of the NPIs that were pursued in 1918 are very similar to those used in 2020. Still, most of the previous research on the 1918 pandemic has looked at the effectiveness of NPIs in preventing the spread of the disease itself (mostly using US data, e.g., Markel et al., 2007), while we investigate the role of NPIs in affecting (worsening or ameliorating) the economic cost of the pandemic.[3]

In principle, the authorities are often reluctant to use NPIs fearing that they will be damaging to the economy. These damages can arise because NPIs that communicate the risk create fear in the community, or because NPIs lead to changes in behaviour (e.g., lockdowns and social distancing mandates) and therefore to declines in economic activity. In contrast with these concerns, we find that the NPIs implemented during Japan's 1918-20 pandemic were actually effective in ameliorating the economic consequences of the pandemic.

In the next section we describe the literature on the economics of the 1918 pandemic, in Section 3 we discuss the historical background and Japan's experience during the 1918-1920 event, while Section 4 describes the data that we collected about this period. Section 5 provides details on our preferred measure of the depth of the pandemic – excess mortality; and Section 6 explains the

[3] A few papers have looked at the efficacy of NPI in the US case especially noteworthy are Correia et al. (2020) and Velde (2020).

empirical specifications we estimate. Section 7 is focussed on our empirical results, while the last section concludes with some remarks about future work we plan to pursue.

2. Economic Consequences of the Pandemic Influenza 1918-20

The economic literature on the 1918-1920 pandemic mostly focused on two topics: (1) a microeconomic assessment of the long-term adverse impacts of the pandemic for individuals that were exposed to it (primarily in-utero); and (2) a macro analysis of the aggregate impact of the pandemic on specific countries or economic sectors.

The first strand largely started with Almond (2006), who used US census data to compare cohorts who were in-utero during the peak of the pandemic to cohorts born just before or after. He finds a range of adverse impacts associated with being exposed in-utero to the second half of 1918 (and interprets that as the impact of the pandemic). Brown and Thomas (2018), however, argue that the Almond (2006) results assume that the pandemic cohort is otherwise very similar to other 'nearby' cohorts, and show that this assumption does not hold up.[4]

For other countries, Lin and Liu (2014) conduct a similar investigation to Almond (2006) and find a similar set of adverse outcomes, using data from Taiwan; and Nelson (2010) finds the same for Brazil. Ogasawara (2018) focuses on a subset of children in Japan, and argues that in-utero exposure resulted in decreased development (as measured by height). Building on this 'foetal origins' work, Cook et al. (2019) have looked at the second and third generations (the children and grandchildren of those who were exposed in utero). They find negative impacts that persist into the next generations, using data similar to Almond (2006).

The second strand of the economic literature, a smaller one, is more closely related to our efforts here. It focuses on the aggregate (macro)economic impacts of the pandemic.[5] Barro et al. (2020), using a cross section of countries and controlling for other concurrent events (e.g., the mortality

[4] Beach et al, (2018) find support for the Almond (2006) results - a significant adverse impact on high-school graduation rates, and thus disagree with the critique of Brown and Thomas (2018). Bridgman and Greenaway-McGrevy (2021) also weight on to this debate, finding no association between NPIs and economic activity.

[5] A recent set of papers, written by economists, also looks at the impact of non-pharmaceutical intervention policies on mortality. We do not describe it here in detail. Most of it focuses on the US, where detailed city/state information about mortality and about implemented NPIs has been collected – see Markel et al. (2007); Hatchett et al. (2007); Correia et al. (2020); Lilley et al. (2020); and Barro (2020).

associated with the first World War), find a negative and very substantial adverse impact. Guimbeau et al. (2020) do a similar analysis for districts in the Brazilian city of Sao Paulo; Dahl, et al. (2020) pursue the same approach for municipalities in Denmark, and Karlsson et al. (2014) examine the cross-sectional dynamics of Sweden's regional economies, and Carillo and Jappelli (2021) do the same for Italian regions. Bodenhorn (2020) focuses, similarly, on the Southern United States. Gallardo-Albarrán and de Zwart (2021), in another recent contribution, focus on the impact of the influenza pandemic on the agricultural sector – in their case sugar cane production in Indonesia (then a Dutch colony). All attempt to quantify the aggregate economic decline associated with the pandemic by controlling for the severity of the pandemic itself (measured by patient or mortality caseload).[6]

Correia et al. (2020) is the paper closest to ours, but only in terms of the questions it poses. It focuses on the US, and we focus on Japan – a country with an obviously very different economic development path both before and after the pandemic. They investigate the impacts of NPIs on economic activity in US cities after the second wave of the flu pandemic. Below, we include some information about the differences between the data they use, and what we have. However, it is already important to point out that they look mostly at economic activity in the years following the pandemic, using biennial data from the Census of Manufactures.[7] Their primary focus is therefore on whether the NPIs that were enacted had a negative impact on post-pandemic economic activity; they do not find any. These results are most likely also applicable elsewhere. We focus on the impact of NPIs on real time economic activity while the pandemic was still ongoing. Our goal is to provide a quantification of two aspects of the economic costs of the pandemic: the direct impact of excess mortality on economic activity, and the direct impact of NPIs on economic activity (i.e., not on the indirect impact of NPIs on economic activity through their impact on the risk of sickness and death). It might also be useful to emphasize that we are focused on a very different

[6] Our experience with the recent COVID-19 event, however, suggests that the economic decline is not only a function of the epidemiology of the event (i.e., the number of patients or deaths). In the case of the 1918-1920 pandemic, only mortality data is available, so that in all these papers it is reported mortality data that is correlated with the economic dependent variable that is examined. Another example is Garrett (2009) which examines the impact of mortality (from the War and from the pandemic) on wages in the United States.

[7] This census data is available for 1914, 1919, 1921, 1923….As such, it is very different from our higher-frequency, prefecture-specific measure of economic activity in the textile sector.

country, in a different stage of its development, and one which was not heavily involved in the global war that had just ended before the pandemic arrived.

3. Background

3.1 The Japanese economy

Three aspects of the Japanese economy around 1900-1920, all typical for a rapidly developing country, are noteworthy due to their relevance to the research undertaken here. First, the textile sector was a major industry in Japan during that time period (Saxonhouse, 1974; Nishikawa and Abe, 1990; Takamura, 1971; Ishii, 1972). According to the Census of Manufacture of 1920, 42% of all output in manufacturing was in textiles (by far the largest sector), while only 16% was associated with the second largest sector, machinery. Japan started exporting at the end of the 1850s, and silk and textiles quickly became major export products (see Yamazawa and Yamamoto, 1974; Okubo, 2007 and 2008).[8] In particular the silk-reeling industry grew rapidly in the very early period. The growth of the silk weaving industry in the United States generated a high demand for silk. By adopting machine-reeling technologies, the Japanese silk reeling industry was able to provide the demand coming from the United States (Nakabayashi, 2003).

The cotton-spinning industry was also becoming a major industry. After Osaka Bouseki, Co. was founded in 1882, several large-scale companies were started and successfully produced high-quality textile products by introducing advanced foreign technology and machines. These were efficiently produced in some specific regional clusters and exported via the railways and nearby ports, without resorting to long supply chains (e.g. Arimoto et al. 2014, Nakabayashi, 2003 for silk-reeling industry, Abe 1989 for cotton-spinning industry). These short-supply chains can easily be explained by Japan's topography, and are also important for our spatial estimation strategy.

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[8] This opening up started in 1858 when the US–Japan Treaty of Army and Commerce forced Japan to trade and open several ports. Bernhofen and Brown (2005) argued that Japan experienced a dramatic change in economic structure with this opening of trade, inducing the formation of industrial clusters. More relevant here, Japan started exporting silk and tea in this early period. Trade increased substantially over time since then, with the process accelerating during the Meiji Restoration (1870s-1880s). At that time, the government introduced foreign technology for the development of manufacturing and founded a large government silk reeling factory in 1872 (e.g. Tomioka Silk Mill in Gunma prefecture). In 1882, Osaka Bouseki, Co. was founded by private funding and developed cotton spinning industry. The major textile industries of the time were silk reeling and weaving as well as cotton spinning and fabric manufacturing. In the 1912-1921, share of silk in total export is 22.6% and of textile products is 33.8% (see Okubo, 2008).

Second, this period saw substantial industrialization and development of manufacturing. Abe et al. (2017) note that the share of manufacturing was less than 30% in 1900 but had risen to 44% by 1925. Labour productivity substantially increased in manufacturing sectors, and industries such as textiles, mining, construction, and heavy manufacturing (chemical and machinery) doubled their productivity during that time. Third, urbanization increased substantially with over 20% of the population living in urban areas by 1925 (Abe et al., 2017). This urbanization was accompanied by industrial agglomeration, with some industries concentrating geographically in specific regions. This increasing degree of concentration fostered agglomeration economies and increased income in urban areas (Yuan et al., 2009; Fukao and Settsu, 2017).

Third, given our focus on the policy reactions to the pandemic, it is also worthwhile to point out the political and social circumstances prevailing at the time of the pandemic. Public health policy was underdeveloped in Japan. Resources for national educational programs and improved facilities were not yet provided by the centre. Despite this, dealing with public health challenges such as tuberculosis became a source for considerable social debate after 1900 (Hunter, 1993).

Public health was viewed as a part of social policy. Because of the upheavals of the 1910s in Europe, and as a response to the rise of socialism and social democracy in Europe and elsewhere, social policies became important in Japan. The Law of Factories was enacted in 1911 and came into force in 1916. It prohibited child labour and long working hours of young female workers and specified the compensation for the families of sick or dead workers.[9] However, for certain sectors such as silk-reeling, the law allowed for an extension of working hours and thus many workers in silk-reeling continued to work for long-hours (Nakamura and Molteni, 1994).

The local public health administration was the responsibility for the Department of Police in each prefecture. The police were also responsible for enforcement, so policies and their implementation differed substantially across prefectures. It is only in 1938 that the Ministry of Welfare was founded, and public health became the responsibility of the central government.

[9] The Law targeted all factories with more than 15 regular workers. It prohibited child labor, less than age 12. For young female workers and workers less than age 15, the Law prohibited their night work and working for more than 12 hours per day. It also specified holiday and intermission during the working day. The Law was revised in 1923.

3.2. Textile sectors and the pandemic

As was the case in other countries, textiles firms were very labour intensive, and many young female workers were hired to work in the factories (Hunter, Ch.4-5, 2003; Nakamura and Molteni, 1994). These female workers came mainly from poorer households in rural areas. Once hired for a textile factory, they lived in densely occupied dormitories nearby, with poor hygiene and long work hours, as described in reports such as *Joko Aishi* (Hosoi, 1925), *Nihon no Kasou Shakai* (Yokoyama, 1898) and Ishihara (1913). Tuberculosis and diseases of the digestive and reproductive organs were common among female workers (Nakamura and Molteni, 1994). It was widely acknowledged that tuberculosis was made worse by poor nutrition and overwork (Ministry of Internal Affairs, 1926). The difficult conditions in the crowded dormitories and factories resulted in widely spread diseases. Perhaps unsurprisingly, during the pandemic, the textile sector experienced the largest numbers of the sick and dying within manufacturing.

In Japan, the influenza started in August 1918 and spread widely after October. 23.8 million out of 55.5 million (the total population in Japan) were infected and the estimated number of deaths is said to be approximately 390 thousand people, though our estimates of excess mortality suggest a higher number. The main sources of information about the Japanese experience in 1918-20 are newspaper articles, as well as Hayami (2006, 2010). Newspapers often reported the number of deaths, obituaries of famous people, and disease outbreaks occurring in schools, military bases, mines, and textile factories. According to Hayami (2006, p. 103), "the flu did not spread out to a specific place but spread to many places simultaneously." However, the speed, the number of infections, and the death rates, were all different across different prefectures.

There were many reported outbreaks among female workers in the textile factories and dormitories. The first newspaper report of the influenza in Japan, Shin Aichi Newspaper on September 20th, 1918, is about a group of 'strangely-sick', mostly female, workers in a cotton spinning mill, Dainihon Cotton Spinning, Co. Ogaki factory in Gifu prefecture (Hayami, 2006, p.99).[10] In Kyoto, both female and male workers for Toyo Cotton Spinning Co., Fushimi factory, were infected in large numbers around the beginning of October 1918 (Hayami, 2006, p. 125). Hayami (2006, pp. 136-138) states that the most seriously affected region was the silk reeling area in Nagano prefecture

[10] Fitting the general pattern of the pandemic's spread in Japan, the second reported cluster, a few days later, was in a military base.

(particularly Suwa County). On November 6th 6 workers died in one day in a reeling mill. On November 11th an M 6.1 earthquake hit the area (Omachi Earthquake), which led to the collapse of more than 300 buildings. This led to a further spread of the influenza virus. Other silk reeling mills in the Suwa area could no longer hire female workers, as potential workers were reluctant to become exposed, and thus the factories faced labour shortages. In Hyogo prefecture, Kobe Newspaper reported on October 24th, 1918 the first case of infection in the prefecture, in Nihon Woollen, Co. Subsequently, many employees in other textile factories in the prefecture were infected. (Hayami, 2006 pp. 125-126).

In the beginning of the second wave in October 1919, according to Jomo Newspaper (November 4th, 1919), Jomo Muslin, Co. in Gunma prefecture, a big textile company, had many infected workers, 97 hospitalised patients, and 7 deaths (Hayami, 2006, pp. 215-216). Apart from the evidence in the newspaper articles reported by Hayami (2006), several incidents of spread in Metropolitan Tokyo, were reported by Tokyo Asahi Newspaper. A newspaper article from December 20th, 1919 (Tokyo Asahi Newspaper) reported that Fuji Gas Cotton Spinning, Co., in Yokohama City had 500 patients. The flu pandemic spread in January 1920 again all over Japan. Another newspaper article reported that many factories in Tokyo City were shut down (Tokyo Asahi Newspaper on January 10th, 1920). The Metropolitan Police Department sent warning messages to all 170 thousand factory workers in Tokyo (Tokyo Asahi Newspaper on January 11th, 1920). According to another article a few days later, Kanegafuchi Cotton Spinning Co. located in Tokyo city had 320 workers hospitalized (out of 3,600 workers). The hospital run by the company was full. Many female workers died before their parents in rural areas received telegrams about their critical condition. The mills were in a chaos: "Female workers were seized with a panic to see the death of their colleagues. Many female workers politely asked their employers to let them go back to their hometowns. The employer was very upset and refused to allow their parents, who wanted to pick them up, to meet them. Some female workers solicited aid from the police to go home." (Tokyo Asahi Newspaper, January 21st, 1920)

The spatial spread of the pandemic is important for any empirical investigation of its impact. At that time railways were already well developed in Japan. One potential way the pandemic spread was through inter-prefectural migration of labour. This was not peculiar to the pandemic but was typical for pre-WWII epidemics in Japan (Tang, 2017). As noted earlier, young women in rural areas were employed by factories in nearby urban industrial areas, mostly in textiles. As documented by Hanashima and Tomobe (2012), 82% of female factory workers were employed in the textile sector in 1924 in Japan and, for example, almost 90% of factory workers in Nagano prefecture were female and specialized in silk-reeling. The average duration of a role was around 2 years and 80-90% of female workers lived in dormitories. Workers who lived in these dormitories often became infected by diseases such as tuberculosis and then went back to their hometowns, thus infecting their families. Hanashima and Tomobe (2012) concluded that this resulted in the spread of infectious diseases from urban to rural areas. Additional sources for spatial spread were schools and military bases. As many newspaper articles reported, many schools and military bases over Japan had clusters of infection and were shut down.

Another channel of spread, more specific to the pandemic influenza, was via travel. For instance, many schools often organized long-distance school excursions. People also went to Shrines to pray for recovery from the flu (e.g., from Osaka prefecture to Kobe-Suma in Hyogo prefecture). Many travellers took crowded trains for these pilgrimages and spread the disease across regions (Hayami, 2006, p.198). In Nagano prefecture, a report described how people who visited Ise Shrine (Mie prefecture) took the flu back to their hometown, in Suwa County (Hayami, 2006, p.203).

3.3. The government response to the pandemic

The Japanese central government undertook some measures against the pandemic, but no economic policies, such as fiscal spending or job protection programs, were implemented. The Ministry of Internal Affairs (1922) recorded all the NPI policies that were implemented in great detail. In the beginning of the first wave, the central government sought to gather information on the developing situation from each prefecture, but information was only partial. Thus, on January 23rd, 1919, the head of the Department of Hygiene in the Ministry of Internal Affairs gave formal notification to the governors of each prefecture; each prefecture was asked to report: (1) the total number of patients and deaths; (2) monthly number of deaths in 1917 and 1918 (pre-pandemic); (3) the medical treatments available for patients; and (4) the current situation (Ministry of Internal Affairs, 1921, p. 117).

In January 1919, the Department of Hygiene in the Ministry of Internal Affairs also started notifying the public with the Instruction for Preventing Influenza ("Hayari Kaze Yobo Kokoroe"). The notification informed people how contagious the flu was and how people can prevent infection. It recommended that the public: (1) start implementing social distancing; (2) stop going to gathering spots such as movie theatre and trains; (3) use masks or handkerchiefs when sneezing;

(4) often gargle with salt water or lukewarm water; (5) self-quarantine for people who are infected (a separate room, stay indoors); and (6) general advice regarding cleanliness, the airing of bedclothes in the sun, etc.

In the second wave, on October 22nd, 1919, the head of the Department of Hygiene in the Ministry of Internal Affairs formally notified the governor of each prefecture to tell people to wear masks in public places, and decline customers who did not wear masks to enter movie theatres, trains, and buses. On January 16th, 1920, the Minister of Internal Affairs gave formal (and stronger) notification to the governor of each prefecture that: (1) Each prefecture must implement policies against the flu. 2) Tell people to wear masks. If enough masks are not available, the authorities must find ways to supply them. 3) Tell people not to attend gatherings without masks. 4) Promote vaccinations and gargle. 5) Make appropriate medical treatments available. 6) Promote cooperation with schools, factories, hospitals, social associations, and entrepreneurs (Ministry of Internal Affairs, 1922, p.127).[11]

3.4. Notification Policies in Prefectures

In essence, all government policies against the pandemic were social distancing policies, with prefecture governments implementing diverse versions of these. Following an order from the Ministry of Internal Affairs, all prefectures advised caution about the spread of the pandemic, provided guidelines for prevention, and suggested the sick seek immediate medical treatment. Medical teams were organized to deal with patients in rural areas and areas where clusters emerged. They organized hospitals to accept patients. Our interest is motivated by prefectural variations in public notification policies. The central government declared the general notification that should be issued, while detailed policies and implementations accompanying it were decided by each prefecture. Thus, various policy schemes were adopted across prefectures.

One should note that at that time, before the advent of radio in Japan, ways of getting information to the public were limited. Mostly, this relied on local newspapers, news reels shown at movie

[11] In the United States, in contrast, local city governments had, in some cases, implemented more aggressive and interventionist policies that actively prohibited many social activities (large gatherings, etc.) – see Markel et al. (2007) for details. Correia et al. (2020) use this NPI data in their work on the economic impact of NPIs in US cities.

theatres, pamphlets distributed by city offices, and street posters.[12] This provision of information was also viewed as important to correct any misleading or factually mistaken views about the epidemic and the way it spreads.[13]

According to the Ministry of Internal Affairs (1922) the period with the most aggressive notification campaigns to facilitate the adoption of preventive measures started in January 1920. Each prefecture made its own choices, but these notifications included explanations of how people can prevent infection, how people should react if they are infected, and how the sick should be cared for. Below are some examples for the different notification policies.

In Osaka prefecture, "…A warning notification was made in collaboration with Osaka City office and sent to all households to let people know of preventive measures in the first wave. The Association for Hygiene of Osaka prefecture reprinted 3,500 copies of the notification issued by the government and posted it in major places in Osaka city. Big signboards for advertisement were made and set at more than 100 places in Osaka city. In the second wave, a warning notification made by the prefecture was printed in 35,000 copies, and was distributed at public places such as theatres, 'yose' (houses for comic storytellers), bath places, barbers, companies, and factories. The notification issued by the Ministry was also reprinted. Portable cards with the notification were also printed and distributed at railways and trams...." (Ministry of Internal Affairs, 1922, p. 189-190).

In Hyogo prefecture "warning notification was distributed in newspapers. To allow people to understand the risk thoroughly, the prefecture made some films on preventive measures and told theatre owners to play the movies at theatres." (Ministry of Internal Affairs, 1922, p. 190).

In Kochi prefecture, a "pamphlet for explaining how to make masks at home was made. 100,000 copies were printed and distributed to all households. The public notification included some

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[12] Literacy rates were already very high in turn-of-the-century Japan (around 80-90%). There is already a mandatory test, at this time, that all age 20+ males need to take, which includes subjects like reading and language.

[13] Some medical research institutes in Japan, such as Kitazato Research Institute, developed vaccines. However, the impact of the vaccination campaigns is unclear and, when used, they were likely ineffective (Ministry of Internal Affairs, 1922, pp. 344-358). After all, the influenza virus was only identified in 1933 and the first vaccine for influenza made from a dead virus was only developed in the 1940s. The data for vaccination rates are not complete, so it is impossible to empirically assess their economic impact (since even an ineffective vaccine may have economic impacts). We do have information on vaccinated programs for poor people. This intervention had no identifiable economic impact. We refer to vaccinations as a non-pharmaceutical policy intervention, since its therapeutic value was most likely negligent.

illustrations, and pictures were also printed in 2,000 copies and posted at major places. In particular, the prefectural office stressed the wearing of masks, which was thought to be feasible and relatively effective." (Ministry of Internal Affairs, 1922, p.196).

More generally one should note that behind these heterogeneous prefecture-level notification policies several aspects were common. First, the health policies were mainly handled by local government and the police in each prefecture. Second, the flu pandemic was heterogeneous in magnitude and depth. The death rates, infection rates, and the speed the flu spread, were all different. Third, Japan is not a very large country, but the Japanese prefectures are substantially different in topology, climate, and even culture. People's attitudes are therefore somewhat different. In addition, medical conditions and transportation networks were different across prefectures and even across counties in the same prefecture.

3.5 Response to NPI in Factories

What were the reactions to these interventions within the textile industry? Many textile companies took measurements to improve working conditions. Many factory owners recognized how important it was, and specifically that they should attempt to protect workers from the pandemic. For example, the President of Kurashiki Cotton Spinning, Co., Magozaburo Ohara, noticed the shortages in medical treatment in West Japan during the flu pandemic and built a large modern hospital with high-tech facilities, advanced medical treatments and doctors for factory workers and other local people (Kurashiki Cotton Spinning, Co, 1988, pp.136-137).

Furthermore, the Society for Engineering Education (1920, pp. 176-189), in a special volume of articles on working environments and industrial accidents, had a chapter on Influenza. This chapter included detailed proposals and suggestions to factory owners on how workers should be protected from infection in the factory; advice that was based on the above-mentioned government notification campaign.[14]

[14] It provided detail suggestions for female workers in factories. It suggested wearing pyjama for sleeping, appropriate meals, intermission during working, sterilizing tableware, cleanness and washing hand as passive measures for prevention. In addition, more aggressive measures it proposed include disposal of tissue papers after their blowing noses, making and wearing masks, and sunbathing.

Some prefectures mandated these preventive measures described in the notification policies for factories. Kochi prefecture is a good example (see Appendix for more detail). On January 25th, 1920, the notification, Prevention Measures for Safety First (*Anzen Daiichi Yobo Sho*), was made and sent to all 200 factories in the prefecture. On 28th January 1920, the Kochi City Parliament proposed the Regulations on Preventive Measures against Epidemics in Factories (*Kojo Densenbyo Yobo Kitei*). It specified how factory owners must report patients to prefectural office and sterilize their factories once workers are identified as infected.

4. Data Sources

4.1 Mortality Data

Direct data for the number of deaths attributed to the pandemic influenza are available from a special report, *Ryukousei Kanbo* (Influenza), published by the Ministry of Internal Affairs in 1922. As Hayami (2006) pointed out, however, two problems make this data impracticable for statistical analysis: First, as is usually the case for pandemics, it is difficult to clearly define a death that is attributable to the disease (see Viglione, 2020). As the Economist magazine points out "though official statistics may often be silent or misleading as to the cause of death, they are rarely wrong about a death actually having taken place."[15] In this regard Hayami (2006) concluded that, in Japan, the data under-estimated mortality from the pandemic. Second, this specific dataset includes many missing values. For example, some prefectures (e.g., Iwate, Miyagi, Chiba and Kyoto prefectures) did not report numbers for several months during the peak of the pandemic.

An alternative approach, if one were interested in quantifying both the direct and indirect changes in mortality rates associated with the pandemic, is to calculate excess deaths (e.g., Woolf et al., 2021). The aim with this method is to also capture deaths that are not directly related to the pandemic but are associated indirectly with it (for example, changes in rates of suicide; e.g., Mulligan, 2020). This is not our purpose, however, since we would like to identify the direct impact of the sickness and deaths caused by the pandemic on textile manufacturing.

[15] We note that this data registered a mortality at the prefecture in which it occurred, rather than in the prefecture in which the person is registered (these might be different for migrant workers).

We therefore pursue a hybrid approach. Instead of using influenza death records, we calculate excess deaths from the Japanese Empire Death Cause of Death Statistics (*Nihon Teikoku Shiin Toukei*), a dataset published annually by the Cabinet Office. The Cause of Death dataset includes the number of deaths by cause of death in each prefecture every month. To capture only those excess deaths that are directly related to the Influenza pandemic, and since Influenza is difficult to diagnose, we include all deaths that are associated with six respiratory-related causes and two classifications that are ambiguous. These were the categories suggested by Hayami (2010) and Shimao (2008): (1) influenza, (2) pulmonary tuberculosis, (3) acute bronchitis, (4) chronic bronchitis, (5) pneumonia and bronchitis, (6) other respiratory diseases, (7) diagnostically poorly defined illness, and (8) unknown causes. We note that the number of deaths due to the last two categories increased dramatically in 1918. At the time doctors often failed to recognize the Influenza pathogen, and thus many of these deaths were often treated as "poorly-defined illness" or "unknown causes."

In order to calculate mortality rates, we use annual prefecture level population data taken from the Population Census after 1920 and the Japanese Empire Static Population Census (*Nihon Teikoku Jinkou Seitai Toukei*) and Japanese Empire Statistical Yearbook (*Nihon Tokei Nenkan*) before 1920. Mortality rates are then expressed as deaths per '000s of the local population. To calculate the number of deaths associated with the pandemic, we calculate excess deaths using the methodology described in Richard et al. (2009), details of which are given in Section 5.

4.2 Non-Pharmaceutical Policy Interventions

The public notification policies can be categorized into two major types, and we coded them accordingly: a pamphlet/brochure distribution campaign, and a media campaign. The first one is the distribution and display of government notifications, i.e., the distribution of a pamphlet or notification made by government to all households and/or distribution of a pamphlet and the display of posters in many gathering places and public places, such as city halls, movie theatres, theatres, amusement places, bath places, barbers, schools, and bus and railway stations. The second type of campaign used was public media, and involved making portable cards with slogans, advertisements in newspapers, running of public notification clips at the beginning and end of movies, and the conduct of public lectures and meetings on the epidemic. The information about the public notification policies was taken from the *Ryukousei Kanbo* (Ministry of Internal Affairs, 1922) and are coded for each prefecture. Section 3 documented some examples obtained from this original document. In most specifications, however, we focus on investigating the presence of notification policies that aim to reach the majority of the population, without emphasising the different medium that is used for dissemination.

We also collected information from the *Ryukousei Kanbo* about other policies that were adopted by various prefectures. In particular, we noted: (1) when prefectures provided free vaccinations for poor people, thereby (presumably) increasing vaccination rates; (2) when prefectures ordered students to make masks for the population more broadly; and (3) policemen were instructed to tell people to wear masks (but with no penalties imposed). None of these measures were found to have had any impact on the textile sector so we do not report these estimations, but they are available upon request.

4.3 Textile Sector Data

As noted earlier, the textile sector was by far the largest manufacturing sector in Japan at the time, and as a very labour-intensive sector, was most vulnerable to the disruption associated with the pandemic. The textile sector data is available at an annual frequency at the prefectural level and comes from the Census of Agriculture and Commerce (*Nou Shomu Toukei*) (before 1919), the Census of Manufacturing (*Kougyou Toukei*) (after 1919), both published by Ministry of Agriculture and Commerce. In order to verify that these two sources, with their somewhat different definitions for inclusion, can indeed be linked, we examined the correlation between them for the two years in which both are available. Fortunately, from our perspective, it is high enough (0.93) to justify their linking. In our empirical specifications, we use the number of employees and the value of textile output, by prefecture-year.[16]

5. Excess Mortality at the Time of the Pandemic

We calculate excess mortality during the outbreak period, using the Japanese Empire Cause of Death Statistics (*Nihon Teikoku Shiin Toukei*). The data do not specify the new influenza as cause of death, but cover general common causes of death by month and by gender at the prefecture level.

[16] Data decomposing the sector into silk and cotton manufacturing is available, but there are too many missing observations to allow for reliable examination of potential disparate impacts on these two sub-sectors. Comprehensive data for other sectors is not available for this time period. Obviously, firm specific information on both productivity, revenue, and the infection rate, would have been very useful for our analysis. This, however, is not available for Japan (nor, as far as we know, for other countries).

We follow the common approach of modelling the seasonal component of mortality and identifying deviations from this as 'excess' mortality, as first proposed by Serfling (1963) as:

$$M_{it} = \alpha + \sum_{i=1}^{47} \beta_i \, sin\left(\frac{2\pi t}{12}\right) * \mu_i + \sum_{i=1}^{47} \delta_i \, cos\left(\frac{2\pi t}{12}\right) * \mu_i + \mu_i + t * \mu_i + \varepsilon_{it} \quad (1)$$

where *M* is the eight-causes mortality rate, measured in deaths per 1000 people, for month *t* in prefecture *i, μ* is a vector of prefecture time invariant indicators*, t* is a time trend, and *ε* is an i.i.d. error term. One should note that for (1) we pool data across prefectures and time but allow for prefecture specific differences in trends and the seasonal components by interacting these with the vector of prefecture-specific indicator variables.

To implement (1) we use monthly mortality data over the entire period 1916 to 1921, i.e., the two years before and the three years during which the pandemic occurred. In order to calculate per capita mortality rates, we take the annual population data and interpolated these linearly to monthly values. Estimated excess the mortality rate, M_{it}^{e}, in prefecture i in month t are then determined as:

$$M_{it}^{e} = M_{it} - \widehat{M}_{it} \quad (2)$$

where $\widehat{M}$ is the predicted value from Equation (1).

We estimate (1) and calculate (2) for total and female death rates separately, where the explanatory power of the model was 74 and 72 per cent, respectively. The mean monthly respiratory mortality rate, seasonal component, and implied excess mortality, as well as vertical lines indicating the beginning and end of the period during which the two outbreaks of the influenza occurred, are shown in Figures 1 and 2 for the total and female sample, respectively. As can be seen, for the total sample there were clearly two steep peaks of excess mortality during the time of the pandemic, where for the first excess rate of mortality was about 1.29 and for the second about 0.52 above the estimated seasonal component. A similar pattern is also apparent for the female respiratory deaths (1.27 and 0.53, respectively).

The two waves of the pandemic did not commence simultaneously in all regions. In order to take account of this in our measure of excess mortality due to the virus, we resort to information from *Ryukousei Kanbo* (Influenza) (Ministry of Internal Affairs, 1922) and identify the differences in windows of the flow across time and space. We then used these windows to isolate the relevant excess mortality months in each prefecture in the four relevant years (1918-1921) and summed these annually, providing us with annual excess mortality likely due to the influenza per prefecture. For all years in our analysis this variable was initially set equal to zero.

Summary statistics are provided in Table 1. Excess mortality per prefecture during the virus outbreak was about 0.88, but with a maximum of 4.04 (i.e., 0.404% of the population). The mean excess female mortality was slightly higher, at about 0.95 (and maximum of 4.11). Textile output varied considerably across prefectures and time, where on average 28 million yen worth of products were produced, but this ranged from as high as 310 million yen to a very low of 18,000 yen. The textile industry employed on average about 18,000 workers, per prefecture, in any year, but as with output this varied considerably, with one prefecture employing more than 166,000 people. In terms of the NPI policy, 83% of prefectures implemented a notification policy with a differing timing profile; we exploit this difference in our empirical analysis. Prefectures were more likely to have a media information campaign (67%) than a pamphlet distribution policy (50%).

Mortality rates are reported in Figures 1-2 for the whole country, and by prefecture in Appendix Figures 1-2. We note several observations. First, urban areas have two clear peaks of death rates. In particular, Osaka, Kyoto and Hyogo (Kobe) have very high peaks (i.e., high excess mortality). This is consistent with the anecdotal evidence from Hayami (2006), which showed the depth of the problem in these prefectures by citing many local newspapers. Second, the peak of the first wave is generally higher than that of the second wave in many prefectures (but not all). This was also observed by Hayami (2006), which observes that mortality rates (per population) were lower in the second wave but mortality rates (per patients) were higher. Many of the important prefectures, in terms of textile output as of 1917, such as Osaka, Aichi, Nagano, Tokyo, Hyogo, and Kyoto prefectures, have two peaks.

We also plot mortality rates for the first and second waves in Appendix Figures 3-4. In some prefectures we even see a contrast between the first and second waves. Akita prefecture (prefecture #5) and Fukui prefecture (18), for example, have the highest excess mortality rates in the second wave, and both had low excess mortality during the first wave. Appendix Figure 5 shows prefectural maps for the overall excess mortality rate (total and female) associated with the pandemic, and Appendix Figure 6 presents a map of the textile production for each prefecture (share of textile output). Textile production shares are high in central Japan—e.g., Nagano, Gunma, Osaka, Hyogo, Kyoto, Aichi, and Tokyo prefectures.

One potentially important drawback to our data is our inability to directly control for migration. Migration from rural hometowns to urban manufacturing centres, and back, was an important factor in the spatial spread of the influenza. However, as far as we know, data on inter-prefecture labour migration is only available from 1925 onward (Nishikawa, 1971). Our empirical spatial model aims to account for that lacuna.

6. Empirical Specification

Notwithstanding the absence of migration data, and in order to nevertheless account of the spatial spread of the disease and its impact and the potential spillovers across adjacent prefectures, we employ a Spatial Durbin Model (SDM). It allows for a spatially correlated lagged dependent variable, spatially correlated explanatory variables, and a spatially lagged error term:

$$log(Y_{it}) = y_{it} = \emptyset \sum_{j=1;j\neq i}^{47} w_{ij} y_{jt} + \beta \widehat{M_{it}^{e}} + \vartheta \sum_{j=1;j\neq i}^{47} w_{ij} y \widehat{M_{it}^{e}} + \mu_i + \gamma_t + \vartheta \sum_{j=1;j\neq i}^{47} w_{ij} \varepsilon_{jt} + \varepsilon_{it} \quad (3)$$

where Y is either textile output or employment for prefecture i in year t, $\widehat{M^{e}}$ is the predicted excess mortality due to the Influenza, μ is a vector of prefecture time invariant indicators, γ is a vector of year specific indicator variables, and ε is an i.i.d. error term. Importantly, w is the chosen spatial weight matrix which determines the nature of spatial correlation of the dependent variable, the independent variable, and the error term. Here we assume that spatial correlation is contiguous of the first order, i.e., that there is spatial correlation between prefectures that share common borders.[17]

We examine whether prefectural policies had an impact on textile output or employment with:

[17] Assuming an inverse-distance weighting matrix produced similar results.

$$y_{it} = \emptyset \sum_{j=1;j\neq i}^{47} w_{ij} y_{jt} + \beta \widehat{M_{it}^{e}} + \vartheta \sum_{j=1;j\neq i}^{47} w_{ij} y \widehat{M_{jt}^{e}} + \pi P_{it} + \delta \sum_{j=1;j\neq i}^{47} w_{ij} P_{jt} + \mu_i + \gamma_t + \vartheta \sum_{j=1;j\neq i}^{47} w_{ij} \varepsilon_{jt} + \varepsilon_{it} \quad (4)$$

where P is an indicator of whether a prefecture implemented a notification policy, as described above. The coefficient π measures the impact of the policy P on prefectural industry performance.

In order to examine whether prefectures that implemented notification policies experienced a different impact of excess mortality due to the Influenza on the performance of the textile industry we extended Equation (3) as follows:

$$y_{it} = \emptyset \sum_{j=1;j\neq i}^{47} w_{ij} y_{jt} + \beta \widehat{M_{it}^{e}} + \vartheta \sum_{j=1;j\neq i}^{47} w_{ij} y \widehat{M_{jt}^{e}} + \pi P_{it} + \delta \sum_{j=1;j\neq i}^{47} w_{ij} P_{jt} + \tau \widehat{M_{it}^{e}} P_{jt} + \varphi \sum_{j=1;j\neq i}^{47} w_{ij} y \widehat{M_{jt}^{e} P_{jt}} + \mu_i + \gamma_t + \vartheta \sum_{j=1;j\neq i}^{47} w_{ij} \varepsilon_{jt} + \varepsilon_{it} \quad (5)$$

where P is an indicator of whether a prefecture implemented a notification policy, as described above. The coefficients τ and φ will determine whether a prefecture with a notification policy and neighbouring prefectures with policies resulted in potentially different impacts of excess mortality on textile industry performance.

7. Results

We provide the estimated marginal impacts of excess mortality on our outcome variables from Equation (3) in Table 2, whereas the full set of estimated coefficients for Equation (3) is provided in Table A2 in the Appendix. We note that a Wald test supports our use of a spatial model in all specifications. As can be seen from column (1) in Table 2, total excess mortality, per prefecture, is associated with a statistically significant fall in the prefecture level output in the textile industry. Taking the marginal effect at face value, these results suggest that a prefecture with the mean of excess mortality would have experienced a 28% reduction in annual textile output.[18] Examining the decomposition of the impact arising from the direct impact within a prefecture and that coming from spillover effects from neighbouring prefectures shows that both of these channels played a

[18] This is calculated by multiplying the coefficient by the mean excess mortality (as provided in Table 1).

role in the fall of output. In these benchmark specifications, the indirect spatial spillovers are four times larger than the within (direct) prefecture effects.

In column (2) of Table 2 we observe that the impact of female excess mortality on textile output is marginally larger than the impact of total excess mortality. Since the textile industry employed proportionally more females, it is intuitively sensible that the impact of female mortality will be larger. We note, however, that the difference in impact between the results in columns (1) and (2) is not statistically significant, using a cross-regression z-test.

The impact of total excess mortality appears to be only marginally smaller when one looks at textile employment (the last two columns of Table 2), though the statistical significance is reduced. However, when decomposing this into the direct and indirect effects, the identified spatial spillovers on employment in textiles are no longer statistically significant, though the size of the coefficients is still similar. Taking the latter at face value indicates that (average) excess mortality during the Influenza pandemic is associated with an annual 7.1 percent fall in textile employment.

For comparison, we also estimated the specifications in Table 2 as a simple fixed effects non-spatial model with robust standard errors, and the results are shown in Table A1. Not taking account of spatial correlation suggested no effect of excess mortality on the textile industry, regardless of whether one looked at employment or output, or at total or female excess mortality. We proceed for the rest of the analysis by implementing our spatial model.

Again, examining female, instead of total, excess mortality in column (4) yields a very similar picture of the impact of total mortality through the direct and indirect impacts.[19] For female employment the total impact is statistically weaker, and this statistical significance disappears when the effect is decomposed into its direct and indirect components.

In Table 3 we show the marginal total impacts of both excess mortality and NPIs, and decompose these into the direct, and indirect marginal impacts, as specified in Equation (4) - the full set of estimated coefficients is given in Appendix Table A4. Several observations are noteworthy here, and largely align with the available qualitative evidence. Once we control for the policy (NPIs), the

[19] A z-test of equality of coefficients across specifications could not reject equality of the coefficients for the total, direct, and indirect impacts.

coefficient on excess mortality is larger, i.e., more negative by about 25-30% when compared to the estimates in Table 2. This suggests that the previous estimates, in Table 2, did not sufficiently distinguish between prefectures that implemented NPIs, and those that did not.

There is therefore a large difference in the impact of the pandemic on the textile sector between those prefectures that implemented NPI policies and those that did not. Prefectures that have not implemented any notification policies (P=0) will have had their textile industry affected more by the pandemic, when compared to those that did (P=1). This observation arises because the coefficient on the policy notification binary indicator is always positive (though statistically indistinguishable from zero). When considering, for example, column (2) in Table 3, we see that a non-NPI prefecture with the mean of excess female mortality would have experienced a 43% reduction in annual textile output due to this female mortality impact of the pandemic. In contrast, an NPI prefecture would only see a reduction of 18% (though this estimate is more variable).[20]

As was the case in Table 2, the decomposition of the effect into its direct and indirect aspects shows that it is still more the indirect spatial effect that is the main conduit of impact (this is true for both the coefficients on excess mortality and NPI). In fact, the ratio of direct to indirect effect is quite similar between Tables 2 and 3, but the coefficients on the NPI indicator are not statistically significant in those decompositions. To summarise, the overall message from Table 3 is that NPIs appeared to have been effective in preventing some but not all of the steep decline in economic activity (in the textile sector) that was associated with the pandemic.

Table 4 provides us even more nuance about the interaction between NPIs, the pandemic (as measured by excess mortality) and the textile sector, at the prefecture level in Japan, as specified in equation (5); with full results available in Appendix Table A5. When interacting the NPI measure with the excess mortality estimates, we find that the previous finding described in table 3 comes about because the introduction of NPIs changes the marginal impact of excess deaths on sectoral economic activity (in textiles). As we found in Table 3, non-NPI prefectures experienced a steeper decline in the textile sector for a given amount of excess mortality. But, more interestingly, at the

[20] A Chi-squared test of the equality of difference between the two coefficients rejected the null hypothesis that this difference was equal to zero.

margin, in non-NPI prefectures, any additional deaths would have been more costly to the textile sector than in prefectures that implemented NPI.

In terms of employment one finds, qualitatively, a very similar pattern to output (Table 4, columns 3-4). For employment, NPI-subjected prefectures have almost a net zero direct impact of excess mortality.[21] Using female instead of total excess mortality to capture the effect of the pandemic on textile employment does not suggest a particular difference, but with coefficient estimates that are less precise. As for the marginal impact, here we see that indeed the marginal impact of additional excess mortality is about zero for NPI prefectures, but large for non-NPI prefectures.

In Table A6-A9 in the Appendix, we present the marginal effects when decomposing the notification policies into those that relied on official distribution of information (through, for example, brochures), and those that relied on the public media. These specifications suggest that notification through the media was more effective in ameliorating the negative impact on output or on employment. But this ameliorating effect is never identified very robustly, with only a few specifications yielding statistically significant coefficients.

8. Conclusion

Recent research on COVID-19 and NPIs (e.g., Goolsbee and Syverson, 2020) is insightful, but is facing several threats to identification when focussing on the impact of NPIs (Goodman-Bacon and Marcus, 2020). First, during the current pandemic governments chose a whole suit of policy responses, so it is difficult to identify 'which intervention mattered'. For the 1918-1920 pandemic, however, the range of responses in Japan (and elsewhere) was much more limited, with almost no attempts to curtail cross-prefecture movements of people, and almost no attempt, globally, to impede international travel.

Second, for the recent pandemic there is some evidence that mandates have less of a direct impact on behaviour than expected, as people voluntarily changed their behaviour irrespective of what they were told to do. As such, the actual timing of the enactment of mandates is less important. Such pre-emptive self-imposed restrictions are less likely to be a confounding factor in the 1918-20 case. Given the lack of private information and scientific knowledge at the time about viruses

[21] Calculated as the sum of the first three coefficients.

in general, and influenza in particular, we consider it unlikely that this challenge to identification would have been very important for that time period.

Lastly, as Goodman-Bacon and Marcus (2020) point out, the imposition of NPIs is arguably dependent on the local mortality and morbidity rate from the epidemic. As such, this places a bigger barrier on the identification of the efficacy of NPIs in preventing infections, than it does for our interest in the role of NPIs in ameliorating the economic impact of the epidemic. More relevant for our work is to ask whether the state of the economy, and particularly the state of the textile sector, may have influenced the imposition of NPIs. We find no evidence for that, given the relatively light touch in which the government intervened in the textile sector, and the relative low importance of the textile sector mortality in the overall mortality impact of the pandemic (see Appendix Table 1).

The textile sector was an important part of manufacturing, but Japan was still very much an agrarian economy with a large retail sector, so it is less likely that the textile sector was perceived as important enough to drive policy. A different way to deal with this problem empirically would have been to find an instrumental variable for the imposition of NPIs. However, we could not identify any available candidate for an instrument for which the standard exclusion restrictions would plausibly hold.[22]

To summarise, we find that excess mortality is associated with a decline in output and value added in the textile sector when identifying these impacts across prefectures in Japan during the 1918-1920 pandemic. This finding is statistically very robust, and the decline in textile output and employment associated with the pandemic is very large. Thus, our findings add to a growing body of evidence that the 1918 pandemic was a deeper and economically more damaging event than has previously been considered, since the decline we find is very substantial.

We also investigated the efficacy of non-pharmaceutical interventions in ameliorating the impact of the pandemic and reducing the economic decline it is associated with. We find, indeed, that information-notification NPIs were effective, and prefectures that implemented them managed to reduce the adverse impact of the pandemic on the textile industry quite effectively. NPIs did not entail a trade-off between "money and life", but rather reduced the economic cost of the pandemic,

[22] We considered factors like population density, cultural factors like the degree of support for liberal/modern ideas (especially about public health; based on the prevalence of public health institutions in each prefecture), and differences in acquired human capital across prefectures (based on high-school test scores). However, none of these is temporally variable and sufficiently convincing as an IV.

while, as was found elsewhere, also reduced the mortality from this catastrophic and traumatic event.

Table 1: Summary Statistics

	Mean	St.Dev.	Min.	Max.
Excess mortality (total) [≠0]	0.88	1.02	0.00	4.04
Excess mortality (female) [≠0]	0.95	1.03	0.00	4.11
Output (mill. Yen)	28.22	46.17	0.018	310.31
Employment	18253	23531	36	166029
NPI (binary)	0.83	---	---	---
NPI (official - binary)	0.50	---	---	---
NPI (media - binary)	0.67	---	---	---

Table 2: Estimations (Equation 3)

Dependent Variable:	Output		Employment	
	(1)	(2)	(3)	(4)
TOTAL	-0.321***	-0.356***	-0.312*	-0.301*
	(0.107)	(0.108)	(0.164)	(0.167)
DIRECT	-0.062**	-0.077**	-0.086**	-0.064
	(0.028)	(0.030)	(0.036)	(0.040)
INDIRECT	-0.259**	-0.279***	-0.226	-0.237
	(0.101)	(0.101)	(0.158)	(0.161)
EXCESS MORTALITY:	*TOTAL*	*FEMALE*	*TOTAL*	*FEMALE*

Note: The full specification, including information about the sample size and goodness of fit is available in appendix table A3.

Table 3: Estimations (Equation 4)

Dependent Variable:		Output		Employment	
		(1)	(2)	(3)	(4)
TOTAL	Exc.Mort.	-0.401***	-0.460***	-0.337*	-0.329*
		(0.133)	(0.138)	(0.175)	(0.179)
	NPI	0.231	0.267	0.187	0.183
		(0.198)	(0.201)	(0.376)	(0.378)
DIRECT	Exc.Mort.	-0.067**	-0.085***	-0.088**	-0.065
		(0.028)	(0.031)	(0.036)	(0.040)
	NPI	0.044	0.031	0.070	0.054
		(0.100)	(0.100)	(0.144)	(0.144)
INDIRECT	Exc.Mort.	-0.334***	-0.375***	-0.249	-0.263
		(0.028)	(0.031)	(0.036)	(0.040)
	NPI	0.187	0.235	0.117	0.129
		(0.100)	(0.100)	(0.144)	(0.144)
EXCESS MORTALITY:		*TOTAL*	*FEMALE*	*TOTAL*	*FEMALE*

Note: The full specification, including information about the sample size and goodness of fit is available in appendix table A4.

Table 4: Estimations (Equation 5)

Dependent Variable:		Output		Employment	
		(1)	(2)	(3)	(4)
TOTAL	Exc.Mort.	-0.864***	-0.943***	-0.665***	-0.599***
		(0.205)	(0.216)	(0.241)	(0.233)
	NPI* Exc.Mort.	0.613**	0.711***	0.721**	0.710*
		(0.263)	(0.264)	(0.367)	(0.379)
	NPI	-0.056	0.014	-0.177	-0.217
		(0.215)	(0.212)	(0.410)	(0.423)
DIRECT	Exc.Mort.	-0.275***	-0.253***	-0.241***	-0.144**
		(0.050)	(0.048)	(0.064)	(0.059)
	NPI* Exc.Mort.	0.308***	0.288***	0.236***	0.149*
		(0.062)	(0.065)	(0.079)	(0.082)
	NPI	-0.063	-0.107	-0.033	-0.042
		(0.101)	(0.103)	(0.147)	(0.152)
INDIRECT	Exc.Mort.	-0.589***	-0.690***	-0.423*	-0.454**
		(0.050)	(0.048)	(0.064)	(0.059)
	NPI* Exc.Mort.	0.305	0.422*	0.485	0.561
		(0.062)	(0.065)	(0.079)	(0.082)
	NPI	0.119	0.121	-0.144	-0.175
		(0.180)	(0.177)	(0.374)	(0.384)
EXCESS MORTALITY:		*TOTAL*	*FEMALE*	*TOTAL*	*FEMALE*

Note: The full specification, including information about the sample size and goodness of fit is available in appendix table A5.

Figure 1: Total Actual, Seasonal and Excess Respiratory Mortality Rate

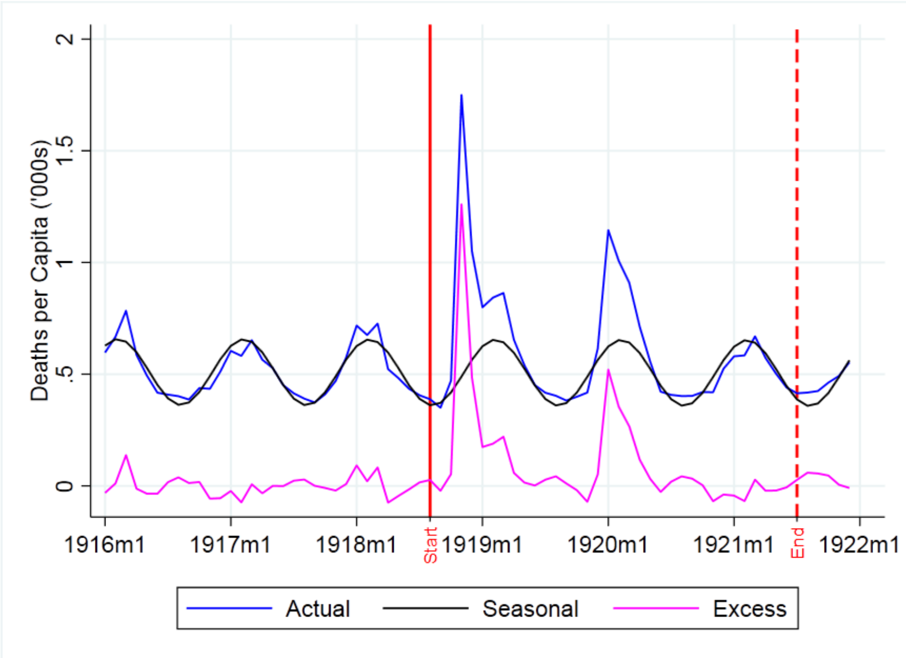
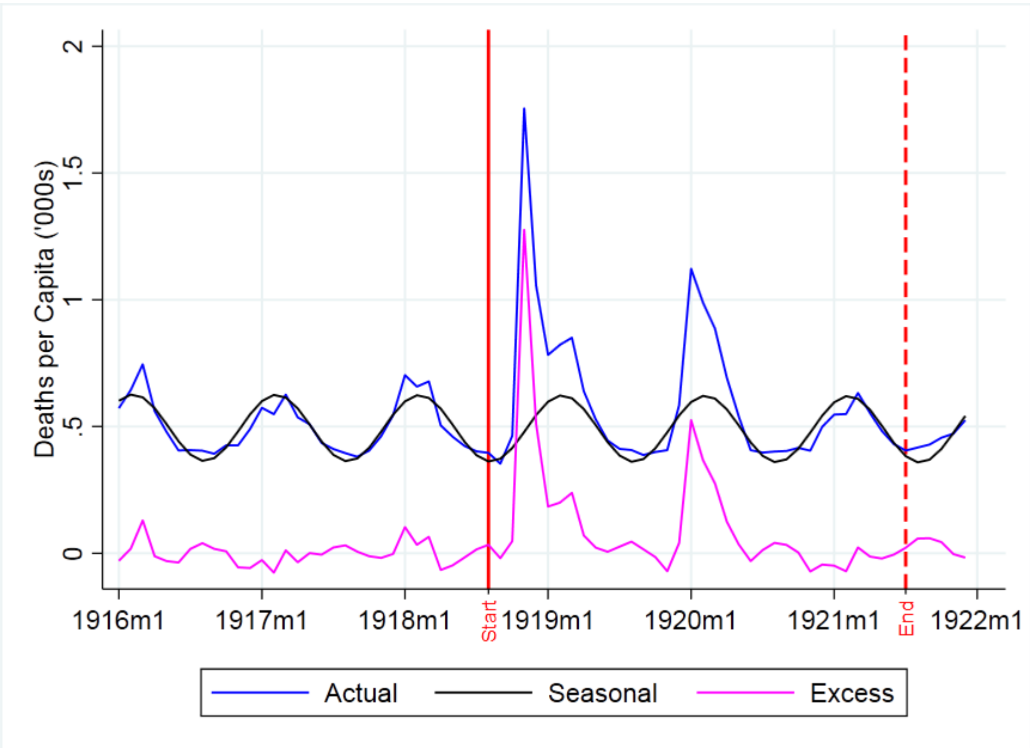


Figure 2: Female Actual, Seasonal and Excess Respiratory Mortality Rate



APPENDIX:

Appendix A: A case study from Kochi Prefecture

Source: Kochi Newspaper and Doyo Newspaper

There is a limited number of documents that survived in Japan on the pandemic flu; though local newspapers often reported on the flu in detail. At that time, each prefecture had a few local newspapers. However, many local newspaper archives were burnt by the US air raids of WWII, though some did survive. A few newspaper articles provided information on preventive measures, although many reported how the flu spread. Hayami (2006) did not collect much information about preventive measures; his focus was a chronological investigation on when, how and by whom the flu spread in each region.[23] Still, the local newspapers uncovered by Hayami (2006) in Kochi prefecture (Kochi Newspaper and Doyo Newspaper) preserved many articles about the pandemic preventive measures.[24] Uniquely, several extant articles in Kochi Newspaper and Doyo Newspaper reported preventive measures in detail.[25]

First wave—Passive NPIs

In the first wave, Kochi prefecture had a number of patients. Kochi Newspaper and Doyo Newspaper articles reported as following:

On October 20th, 1918 "some soldiers at an army base in Kochi city were infected. After this, the flu spread over prefecture." On October 29th, 1918: "many elementary and junior high schools in Kochi city had many patients and were closed down. The number of deaths also drastically increased" (October 31st, 1918, Doyo Newspaper).

In November 1918, Kochi newspaper reported the spread of infection to many neighbouring towns and villages of Kochi city. Many schools, city halls and factories around Kochi city were shut down. In Kochi city, office workers could not commute, and city offices, banks, shops, and transportation were close down. Hospitals were dealing with many patients, and many of them eventually started declining patients (November 5th, 1918, Kochi Newspaper).

On November 8th, 1918, an article that discussed the flu observed that "the current flu is not normal." The flu was much more dangerous than previously thought, and that as a preventive measure, sunny places with fresh air were best. It warned that gathering places and trains should be kept aired, and that a room without any breeze should be kept fresh with electric fans.

On November 11th, 1918, in Kochi Newspaper, Professor Shozo Toda (Professor of Public Health at Kyoto University) contributed an article on the flu. He suggested that people should observe social distance from patients and should not go to gathering/community places, because the flu was transmitted through the air. He observed that "sunshine with breeze can reduce contagious infection, and thus outdoor there is almost no risk of infection. Walking outside is the favourite way for keeping health". More optimistically, he argued

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[23] Hayami (2006) collected only one article from Kochi Newspaper (November 16th 1918) to demonstrate the seriousness of the situation in that prefecture.

[24] We thank Dr. Keita Kususe (Kochi Newspaper) and Kochi Newspaper Company for kindly providing all of the newspaper articles in this paper.

[25] In Kochi prefecture, there were two local major newspapers, Kochi Newspaper and Doyo Newspaper. Kochi Newspaper merged Doyo Newspaper in 1941 and even today it has more than 80% share of newspapers in Kochi prefecture.

that if people become infected, "sleeping soundly and preserving energy will lead patients to automatically recover without taking medicines."

On November 11th, 1918 in Doyo Newspaper (the same day as the article by Professor Toda), Mr. Hirokawa (a factory technician) was interviewed on "factory and hygiene." According to this article, many factories were shut down because of the pandemic in Kochi prefecture. Reducing profits seriously damaged capital and labour. The article further argued, puzzlingly, that the best way to fight the virus is by washing the mouth of each worker. He emphasized how important keeping health of workers is; and promised that factory workers would be immediately protected."

Second wave - aggressive NPIs

While NPIs were not very aggressive or stringent during the first wave period, they were pursued during the second wave. On January 16th, 1920, the government provided a much stronger statement on preventive measures. The government sent quarantine facilities to each prefecture. In response, on January 18th, Kochi prefecture proposed preventive measures.

On January 21st, 1920, the Police department of Kochi prefecture ordered theatre and movie theatre owners to prevent the entry of people if they are not wearing masks. On January 25th, 1920, the Police department in Kochi Prefecture sent the notification Prevention Measures for Safety First (*Anzen Daiichi Yobo Sho*) to all 200 factories in the prefecture. This was aimed at protecting workers from infection, particularly in textile and paper factories that employed a large number of workers. The prefectural office was concerned about the economic damage if flu spreads to these facilities. According to the notification: (1) Workers should wear masks anytime inside and outside of their factories. (2) Workers should gargle with salt water after eating and before bed. (3) Workers should keep distance from patients. (4) Workers should not go to gathering places. (5) Workers should immediately go to hospital if they catch the flu (Kochi Newspaper, 25th January 1920).

On 28th January 1920, the Kochi City Parliament proposed Regulations on Preventive Measures against Epidemics in Factories (Kojo Densenbyo Yobo Kitei). Later, this was passed by the Parliament. It specified how factory owners must report patients to prefectural office and sterilize factories, once workers are identified as infected. According to this newspaper article the regulations on factory owners were stringent and detailed. For example, the regulations provided guidelines on how to prevent further pandemic spread in factories and dormitories by, for example: Preventing the sharing of towels with patients; preventing the sharing of wash basins, and making sure workers keep faces and hands clean and cut figure nails. Factory owners were required to shut down their factories if the areas workers lived in become infected (Article 11). Once an infection occurred, factory owners were required to sterilize their facilities following instructions from the government quarantines (Article 10) (Doyo Newspaper, 28th January 1920).

On February 6th, 1920, clean up activity was started in Kochi city. All people joined cleaning in all districts over Kochi city. On March 1920, the pandemic came to the end (Doyo Newspaper, March 6th, 1920).

Appendix B: A case study of Asahi Glass, Co.

Source: Inagaki and Kikuchi (1920) "Report on Influenza in Tsurumi Factory of Asahi Glass, Co." Jikken Igaku Zasshi 4(1) 70-83.

Asahi Glass, Co. was founded in 1907 and became one of the major glass companies in Japan. In the first wave in 1918, in the Asahi Glass, Co. factory in Yokohama, workers had a significant number of infections (187) and 4 deaths. The death ratio (about 2% of those infected) was relatively low. In the second wave, the first patient in the company was identified in early January 3rd, 1919 and the numbers then substantially increased. In response to the increased number of patients, the company immediately held an emergency meeting and decided on several preventive policies:

(1) Bottles of saltwater were set in front of factory and dormitory. All workers were required to gargle with saltwater when entering and exiting these buildings.
(2) The employer was required to provide masks to all employees.
(3) Make temporary aid rooms in the dormitory and completely separate identified patients from other employees.
(4) Vaccination

The decision was to implement these policies immediately. Inagaki and Kikuchi (1920) concluded that the immediate treatment by Asahi Glass, Co. did successfully reduce infection rates.

Table A1

Occupation	% of total…. patients	% of total…. deaths	# of family members who are also….(per 100 employees) patients	# of family members who are also….(per 100 employees) deaths	Death rate (per 100 patient)	# of …. per 1000 employees patients	# of …. per 1000 employees deaths
Cottons and threads (reeling)	2.7	1.7	18.7	28.8	3.3	5.8	0.2
Fabric and knit	2.6	2.3	29.2	64.6	4.6	5.2	0.2
Clothes	0.9	0.9	55.8	72.1	5.4	2.8	0.2
Textiles total	6.2	5.0	28.5	53.5	4.1	4.8	0.2
Ag., Livestock, Sericulture	44.3	45.4	47.4	48.1	5.3	4.5	0.2
Forestry, Hunting	0.6	0.7	32.2	55.1	6.1	4.2	0.3
Fishery, Salt	5.8	5.2	40.5	43.0	4.6	14.6	0.7
Mining, Metallurgy	1.9	1.5	29.9	47.7	4.2	6.6	0.3
Mining/manufacturing earth	0.6	0.7	90.9	132.0	5.8	4.3	0.2
Manufacture of Metal	0.6	0.7	51.9	59.6	6.2	1.9	0.1
Industrial Machinery and Eq.	0.9	1.1	71.8	51.9	6.6	3.3	0.2
Chemical and Allied Products	0.1	0.1	43.3	57.1	3.9	1.3	0.1
Papermaking	0.4	0.7	53.2	56.9	8.3	5.1	0.4
Leather	0.2	0.3	30.7	33.3	6.5	7.5	0.5
Wood Products	1.8	2.2	48.9	48.4	6.1	3.9	0.2
Marine products (food)	0.2	0.2	76.5	47.1	5.8	34.6	2.0
Food and Beverage	1.3	1.5	84.2	70.9	5.9	3.5	0.2
Construction	1.6	1.9	64.7	76.9	5.9	3.1	0.2
Printing and Allied Industries	0.3	0.4	91.9	72.4	7.6	4.4	0.3
Misc. manufacturing	3.8	3.9	52.6	53.0	5.3	266.7	14.2
Retail	10.9	9.6	92.9	74.1	4.5	7.3	0.3
Wholesales	0.4	0.5	64.2	94.7	6.3	2.9	0.2
Banking Finance	0.4	0.4	85.2	116.7	4.9	4.7	0.2
Rental and leasing	0.8	0.8	77.2	62.1	5.4	62.7	3.4
Accommodation Hotel	4.1	3.2	51.7	53.6	4.1	8.0	0.3
Miscellaneous commerce	3.3	2.8	47.6	70.7	4.3	635.0	27.1
Transportation	2.3	2.6	84.7	93.0	5.8	3.1	0.2
Army and Navy	0.2	0.5	97.0	24.2	9.9	1.3	0.1
Public Officer	1.2	1.3	73.4	84.4	5.4	5.0	0.3
Self-employed	1.2	1.7	70.4	84.0	6.8	11.8	0.8
Arts and Entertainment	0.8	0.8	42.9	32.1	5.0	11.8	0.6
Miscellaneous employee	2.2	2.5	81.4	83.6	5.8	5.8	0.3
No occupation	1.5	1.9	319.8	202.2	6.6	2.7	0.2
Total	100.0	100.0	59.0	59.8	5.1	5.7	0.3

Table A2

	(1)	(2)	(3)	(4)
Exc.Mort.	-0.058	-0.022	-0.073	-0.012
	(0.039)	(0.051)	(0.043)	(0.063)
Y:	OUT	OUT	EMP	EMP
SAMPLE	ALL	FEMALE	ALL	FEMALE
Observations	1,175	1,175	1,175	1,175
F Test	57.19***	31.65***	59.34***	32.53***
R2	0.015	0.019	0.015	0.019

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A3

	(1)	(2)	(3)	(4)
Exc.Mort.	-0.0609**	-0.0909**	-0.0757**	-0.0694*
	(0.0277)	(0.0363)	(0.0304)	(0.0401)
W:log(Y)	0.139	-0.530***	0.136	-0.525***
	(0.124)	(0.166)	(0.124)	(0.166)
W:ME	-0.236**	-0.413*	-0.253***	-0.418*
	(0.0944)	(0.246)	(0.0934)	(0.250)
W:e	-0.260	0.892***	-0.275	0.892***
	(0.188)	(0.0184)	(0.190)	(0.0185)
Y:	OUT	OUT	EMP	EMP
SAMPLE	ALL	FEMALE	ALL	FEMALE
Observations	1,175	1,175	1,175	1,175
Wald Test	10.38**	2401.79***	11.91***	2374.71***
Pseudo R2	0.00831	0.0133	0.00768	0.0128

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A4

VARIABLES	(1)	(2)	(3)	(4)
Exc.Mort.	-0.0650**	-0.0823***	-0.0934**	-0.0714*
	(0.0279)	(0.0306)	(0.0365)	(0.0403)
P	0.0427	0.0297	0.0725	0.0572
	(0.100)	(0.0996)	(0.145)	(0.145)
W:log(Y)depvar	-0.288***	-0.318***	-0.449*	-0.459*
	(0.103)	(0.102)	(0.261)	(0.265)
W:ME	0.181	0.189	-0.524***	-0.518***
	(0.125)	(0.124)	(0.166)	(0.167)
W:P	-0.294	-0.319*	0.892***	0.891***
	(0.191)	(0.193)	(0.0187)	(0.0188)
W:e	0.160	0.204	0.226	0.236
	(0.137)	(0.137)	(0.558)	(0.559)
Y:	OUT	OUT	EMP	EMP
SAMPLE	ALL	FEMALE	ALL	FEMALE
Observations	1,175	1,175	1,175	1,175
(Pseudo) R2	0.0109	0.0108	0.0124	0.0121
Sp-pvalue	0.0160	0.00552	0	0

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A5

	(1)	(2)	(3)	(4)
Exc.Mort.	-0.272***	-0.251***	-0.249***	-0.154***
	(0.0501)	(0.0638)	(0.0471)	(0.0597)
ME*P	0.306***	0.247***	0.286***	0.161*
	(0.0621)	(0.0797)	(0.0645)	(0.0827)
P	-0.0634	-0.0364	-0.108	-0.0456
	(0.101)	(0.148)	(0.103)	(0.153)
Log(Y)	0.163	-0.498***	0.176	-0.489***
	(0.126)	(0.167)	(0.125)	(0.167)
W:ME	-0.496***	-0.794**	-0.579***	-0.790**
	(0.137)	(0.332)	(0.137)	(0.319)
W:ME*P	0.229	0.890*	0.331	0.961*
	(0.219)	(0.540)	(0.216)	(0.554)
W:Pl	0.119	-0.245	0.128	-0.297
	(0.162)	(0.605)	(0.159)	(0.618)
W:e	-0.253	0.888***	-0.322*	0.886***
	(0.188)	(0.0197)	(0.193)	(0.0201)
Y:	OUT	OUT	EMP	EMP
SAMPLE	ALL	FEMALE	ALL	FEMALE
Wald Test	20.22***	2173.85***	25.50***	2068.77***
Observations	1,175	1,175	1,175	1,175
(Pseudo) R2	0.0106	0.0136	0.0101	0.0132

*** p<0.01, ** p<0.05, * p<0.1

Table A6

Dependent Variable:		Output		Employment	
		(1)	(2)	(3)	(4)
TOTAL	Exc.Mort.	-0.422***	-0.457***	-0.385**	-0.383**
		(0.133)	(0.136)	(0.178)	(0.182)
	NPI[DISTR]	1.010**	0.897	0.499	0.441
		(0.402)	(0.393)	(0.452)	(0.451)
	NPI[MEDIA]	-0.786	-0.631	0.083	0.161
		(0.405)	(0.406)	(0.483)	(0.490)
DIRECT	Exc.Mort.	-0.071**	-0.085***	-0.095***	-0.072*
		(0.028)	(0.031)	(0.036)	(0.040)
	NPI[DISTR]	0.004	0.006**	-0.001	0.003
		(0.063)	(0.063)	(0.094)	(0.095)
	NPI[MEDIA]	-0.049	-0.046	0.113	0.106
		(0.068)	(0.068)	(0.099)	(0.099)
INDIRECT	Exc.Mort.	-0.352***	-0.372***	-0.290*	-0.310*
		(0.028)	(0.031)	(0.036)	(0.040)
	NPI[DISTR]	1.006**	0.891**	0.500	0.438
		(0.063)	(0.063)	(0.094)	(0.095)
	NPI[MEDIA]	-0.737*	-0.585	-0.029	0.055
		(0.068)	(0.068)	(0.099)	(0.099)
EXCESS MORTALITY:		*TOTAL*	*FEMALE*	*TOTAL*	*FEMALE*

Table: A7

	(1)	(2)	(3)	(4)
Exc.Mort.	-0.0685**	-0.0827***	-0.102***	-0.0794*
	(0.0280)	(0.0306)	(0.0368)	(0.0406)
P[DIST]	-0.00224	-0.000303	0.0105	0.0132
	(0.0633)	(0.0633)	(0.0954)	(0.0957)
P[MEDIA]	-0.0438	-0.0423	0.112	0.107
	(0.0676)	(0.0673)	(0.101)	(0.101)
W: Exc.Mort.	-0.306***	-0.320***	-0.519**	-0.537**
	(0.102)	(0.102)	(0.263)	(0.267)
W:P[DIST]	0.911***	0.802**	0.808	0.706
	(0.348)	(0.344)	(0.705)	(0.702)
W:P[MEDIA]	-0.659*	-0.519	0.0115	0.142
	(0.351)	(0.353)	(0.756)	(0.760)
W:log(Y)	0.174	0.179	-0.523***	-0.515***
	(0.124)	(0.124)	(0.166)	(0.166)
W:e	-0.322*	-0.335*	0.892***	0.891***
	(0.192)	(0.193)	(0.0188)	(0.0189)
Log(Y):	OUT	OUT	EMP	EMP
SAMPLE	ALL	FEMALE	ALL	FEMALE
Observations	1,175	1,175	1,175	1,175
Number of groups	47	47	47	47
Pseudo R2	0.0114	0.0113	0.0130	0.0123

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A8

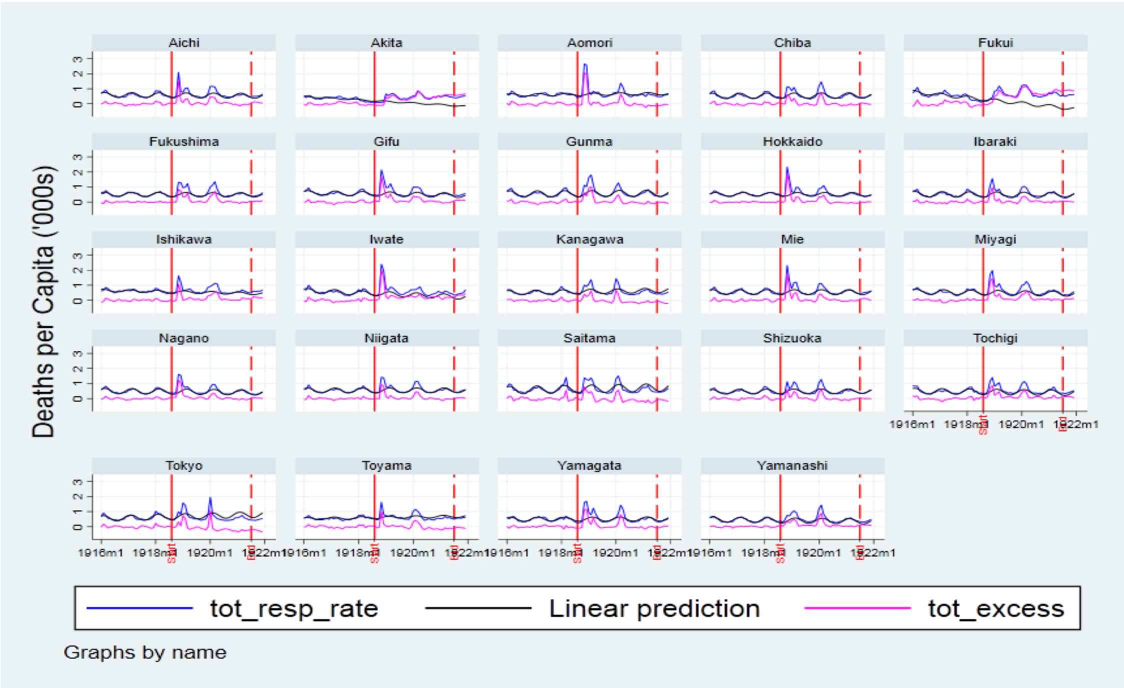
Dependent Variable:		Output		Employment	
		(1)	(2)	(3)	(4)
TOTAL	Exc.Mort.	-0.800***	-0.861***	-0.644***	-0.589**
		(0.197)	(0.206)	(0.237)	(0.230)
	NPI[DISTR]*E.M.	0.406	0.403	0.296	0.202
		(0.719)	(0.797)	(0.723)	(0.778)
	NPI[MEDIA]*E.M.	0.199	0.328	0.458	0.518
		(0.758)	(0.876)	(0.688)	(0.791)
	NPI[DISTR]	0.909	0.788*	0.294	0.284
		(0.439)	(0.463)	(0.583)	(0.601)
	NPI[MEDIA]	-0.846	-0.778	-0.136	-0.134
		(0.432)	(0.464)	(0.552)	(0.583)
DIRECT	Exc.Mort.	-0.245***	-0.225***	-0.207***	-0.121**
		(0.048)	(0.045)	(0.061)	(0.057)
	NPI[DISTR]*E.M.	-0.035	-0.030	0.015	-0.005
		(0.068)	(0.079)	(0.090)	(0.104)
	NPI[MEDIA]*E.M.	0.297*	0.285***	0.174*	0.111
		(0.074)	(0.082)	(0.093)	(0.103)
	NPI[DISTR]	0.020	-0.003	-0.021	-0.011
		(0.070)	(0.071)	(0.111)	(0.115)
	NPI[MEDIA]	-0.163	-0.172**	0.025	0.037
		(0.072)	(0.074)	(0.109)	(0.114)
INDIRECT	Exc.Mort.	-0.555*	-0.636***	-0.437*	-0.468**
		(0.048)	(0.045)	(0.061)	(0.057)
	NPI[DISTR]*E.M.	0.441	0.433	0.281	0.207
		(0.068)	(0.079)	(0.090)	(0.104)
	NPI[MEDIA]*E.M.	-0.098	0.043	0.283	0.407
		(0.074)	(0.082)	(0.093)	(0.103)
	NPI[DISTR]	0.890	0.791*	0.314	0.295
		(0.070)	(0.071)	(0.111)	(0.115)
	NPI[MEDIA]	-0.683	-0.605	-0.161	-0.171
		(0.072)	(0.074)	(0.109)	(0.114)
EXCESS MORTALITY:		*TOTAL*	*FEMALE*	*TOTAL*	*FEMALE*

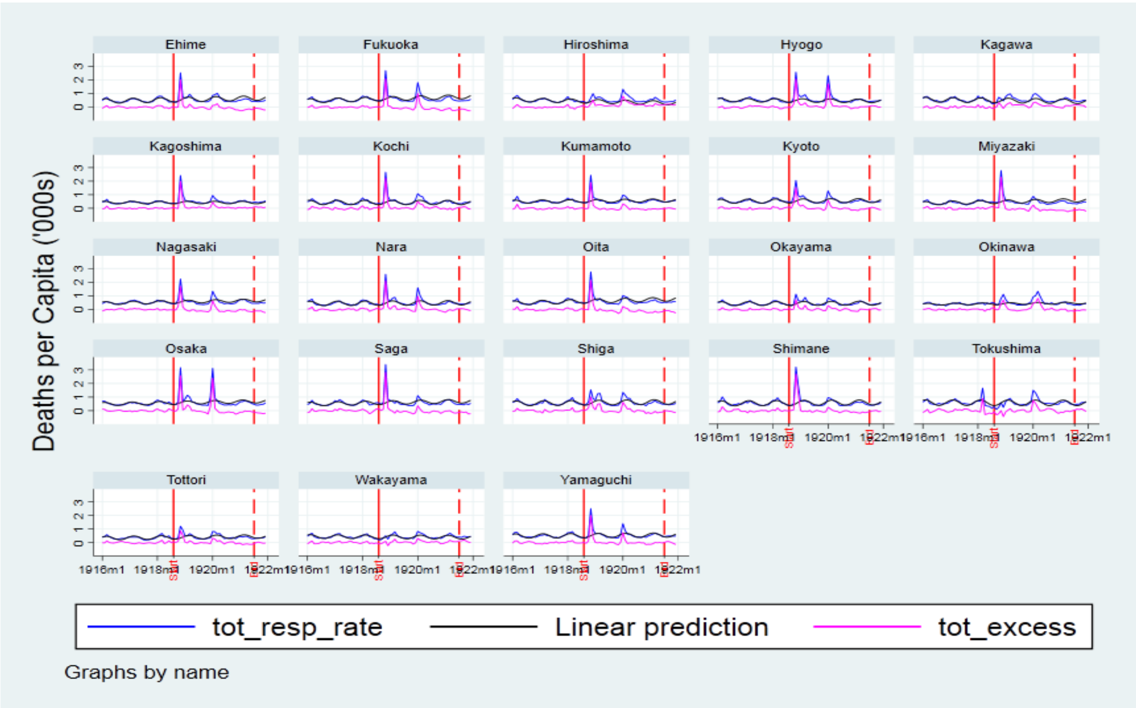
Table A9

	(1)	(2)	(3)	(4)
Exc.Mort.	-0.242***	-0.217***	-0.221***	-0.131**
	(0.0476)	(0.0610)	(0.0449)	(0.0575)
ME*P[DIST]	-0.0380	0.0216	-0.0325	-0.000315
	(0.0677)	(0.0951)	(0.0785)	(0.109)
ME*P[MEDIA]	0.298***	0.181*	0.284***	0.120
	(0.0727)	(0.0971)	(0.0798)	(0.109)
P[DIST]	0.0139	-0.0137	-0.00774	-0.00472
	(0.0698)	(0.114)	(0.0713)	(0.118)
P[MEDIA]	-0.159**	0.0213	-0.169**	0.0334
	(0.0718)	(0.110)	(0.0738)	(0.115)
W:log(Y)	0.169	-0.497***	0.173	-0.487***
	(0.124)	(0.167)	(0.124)	(0.167)
W: Exc.Mort.	-0.465***	-0.799**	-0.538***	-0.799**
	(0.134)	(0.327)	(0.136)	(0.315)
W:E.M.*P[DIST]	0.409	0.455	0.398	0.324
	(0.635)	(1.116)	(0.699)	(1.191)
W:E.M.*P[MEDIA]	-0.139	0.538	-0.0102	0.697
	(0.664)	(1.059)	(0.763)	(1.202)
W:P[DIST]	0.808**	0.490	0.718*	0.461
	(0.385)	(0.889)	(0.408)	(0.908)
W:P[MEDIA]	-0.595	-0.244	-0.519	-0.253
	(0.384)	(0.859)	(0.410)	(0.893)
W:e	-0.299	0.889***	-0.334*	0.887***
	(0.190)	(0.0198)	(0.193)	(0.0201)
Y:	OUTP	OUT	EMP	EMP
SAMPLE	ALL	FEMALE	ALL	FEMALE
Observations	1,175	1,175	1,175	1,175
Wald Test	24.70***	2188.43***	28.41***	2082.96***
Pseudo R2	0.0115	0.0143	0.0110	0.0131

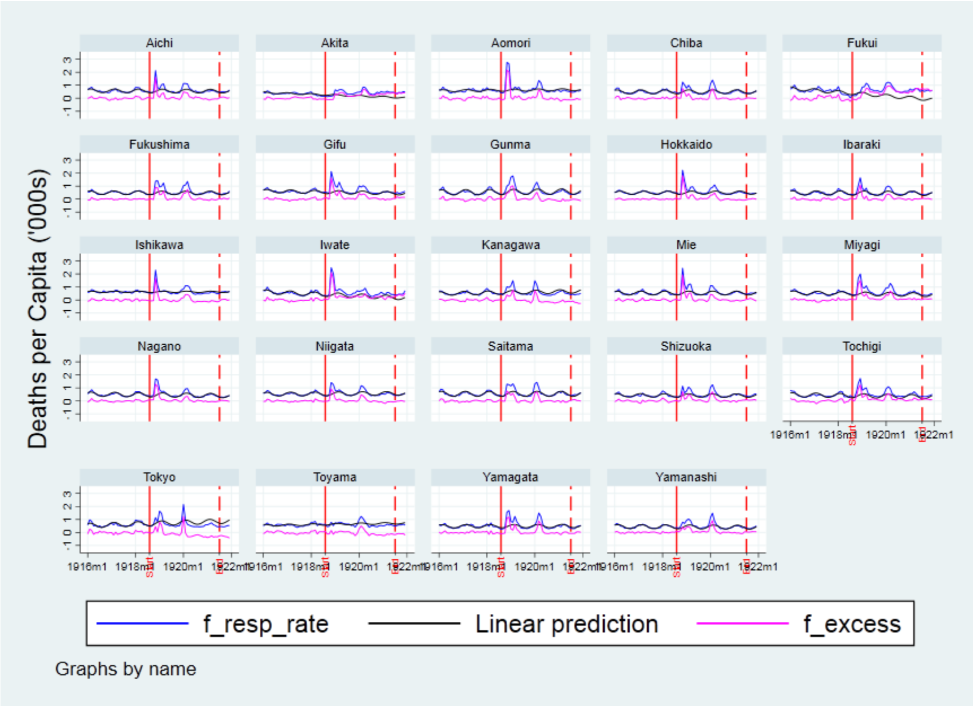
Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

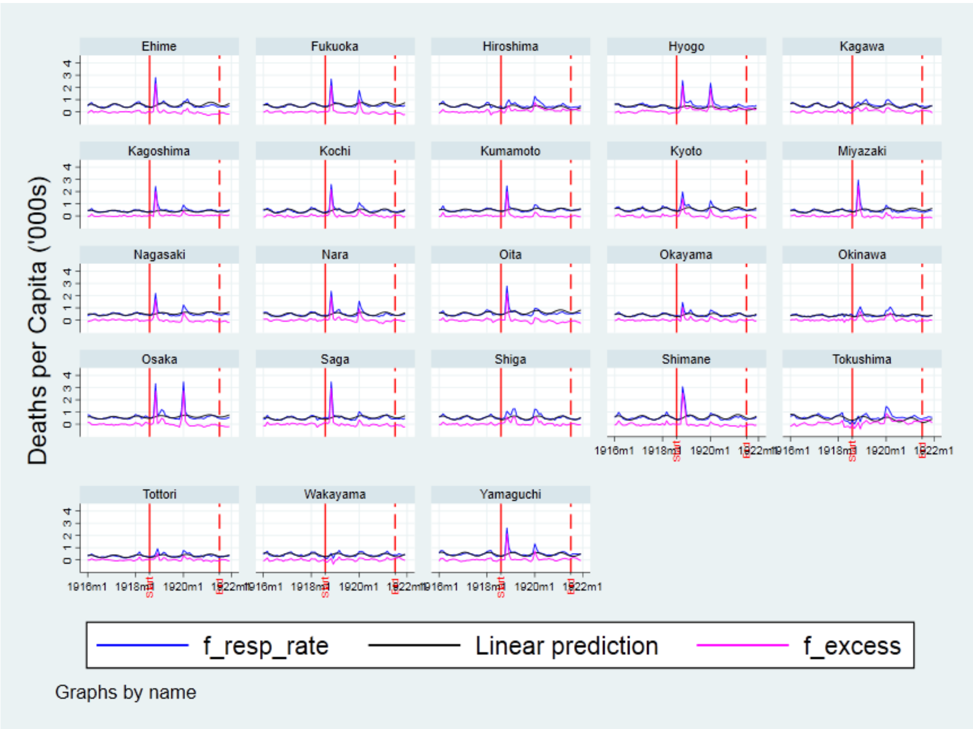
Appendix Figure A1 – Total Excess Mortality by Prefecture



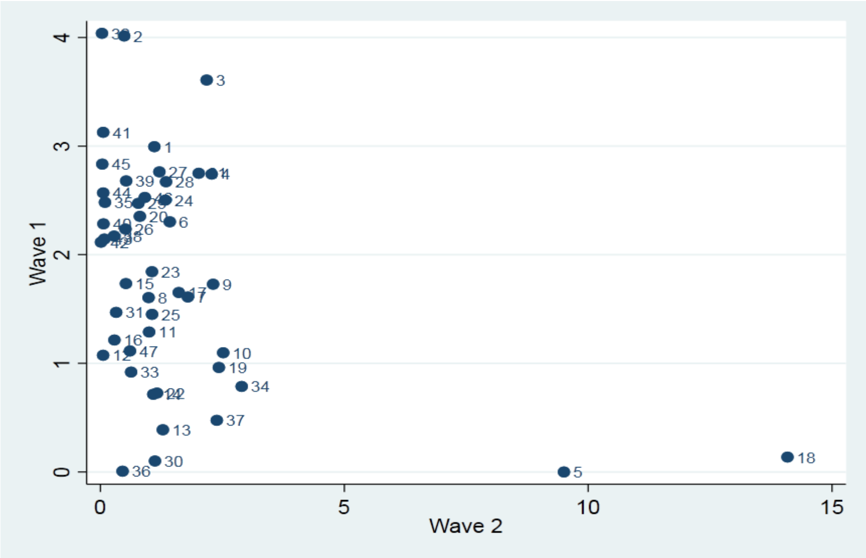


Appendix Figure A2 – Female Excess Mortality by Prefecture

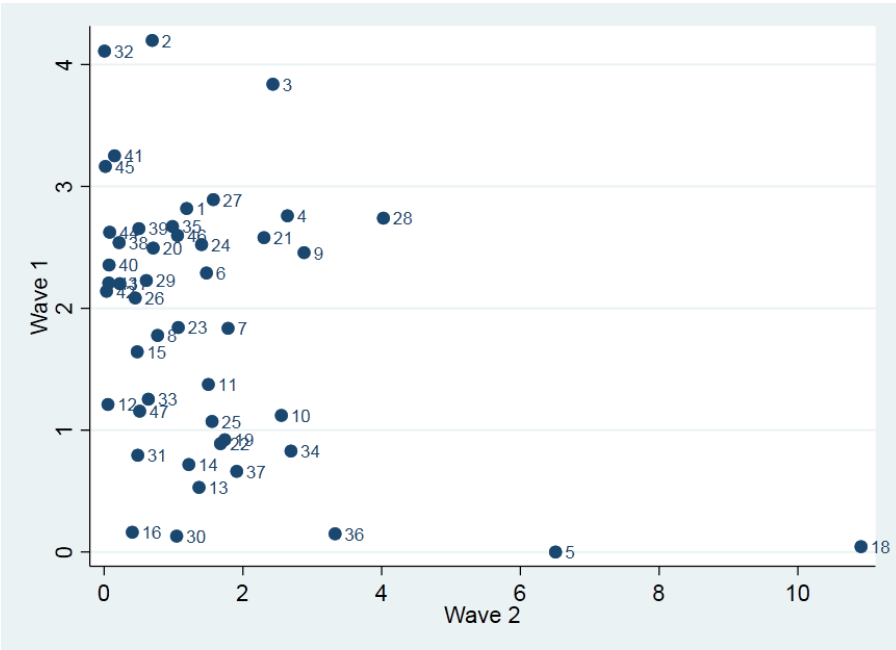




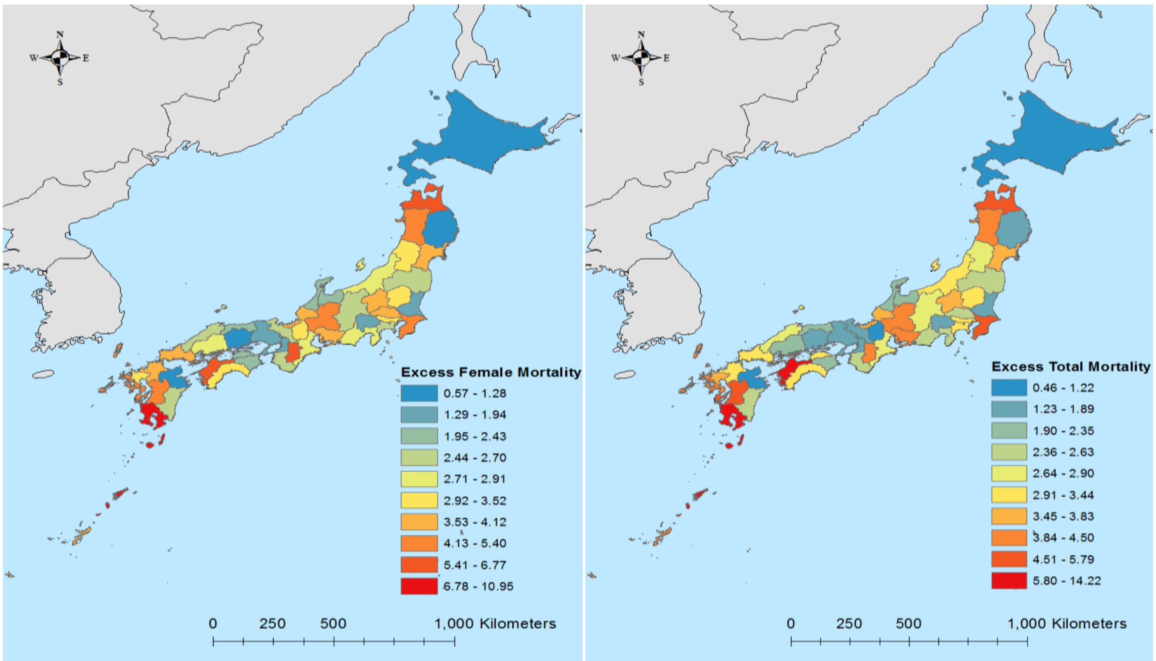
Appendix Figure A3 – Total Excess Mortality by Prefecture; by Wave



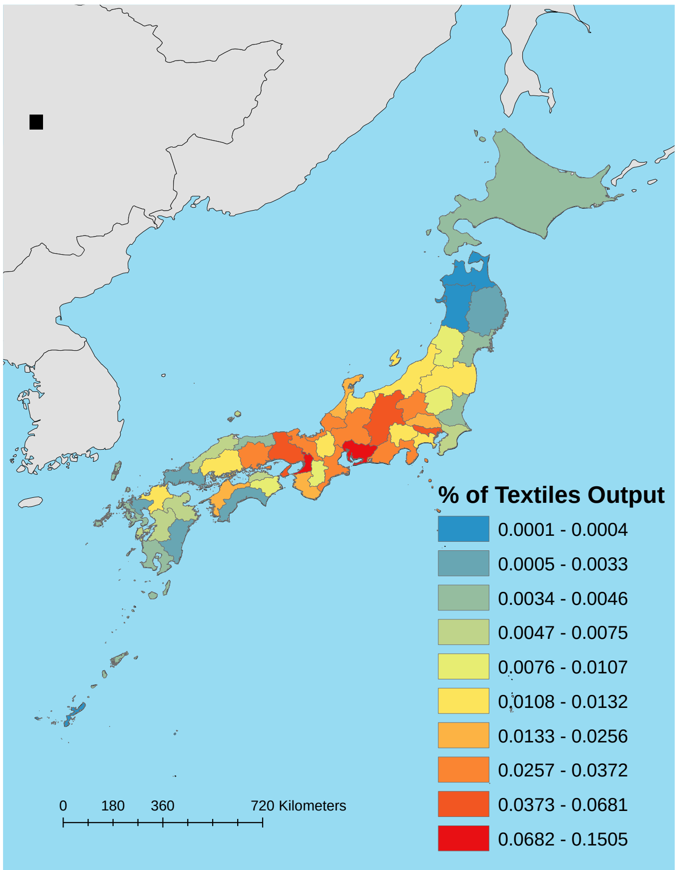
Appendix Figure A4 – Female Excess Mortality by Prefecture; by Wave



Appendix Figure A5: Excess Mortality Maps



Appendix Figure A6: Textile Output Map



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