How lasting are the economic consequences of pandemics? 220 years of Swedish experiences

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In this article I use the Riksbank's historical monetary statistics to analyse what effects pandemics have had on demographic and economic variables in Sweden since the start of the 19th century. The results show that pandemics have had negative effects on birth rates, death rates and family formation. Pandemics have also adversely affected the Swedish economy in the short term. The longer term effects are less clear. The effects on foreign trade and investment have, on the other hand, tended to be more long lasting. Going forward, this could imply that it will be important to be aware of potential protectionist tendencies, such as export restrictions and tariffs.

The COVID-19 crisis is in many respects unique, and therefore it is difficult to draw conclusions regarding the current situation on the basis of earlier pandemics. Furthermore, society has developed quite dramatically over the past 220 years with regard to knowledge, statistics, amount and spread of information, supply of media, technology and medical care. But even if one can discuss what conclusions can be drawn on the basis of earlier pandemics, the historical perspective is interesting in itself. Thanks to this, one can identify structures and mechanisms that can help today's decision-makers and authorities to better plan for and manage future threats.

1 Crises can have long-lasting effects

The COVID-19 pandemic is causing tremendous human and economic hardship around the world. The question that many people are now asking, is how long-lasting its effects might be.[1] In this article, I use long time series from the Riksbank's historical monetary statistics to study what effects earlier pandemics have had on variables such as gross domestic product (GDP) and inflation.[2] The Riksbank's statistics extend back to the early 17th century, and include information that, as far as I know, has not been studied in this particular context. Sweden's unique historical statistics also contain important demographic information such as the number of deaths, births, marriages and population. Based on pandemics in the period 1800–2020, I show that the long-term effects are uncertain. Pandemics have had effects in the shorter term and they have affected the entire fabric of society: from death rates to

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1 See, for instance, Blanchard and Pisani-Ferry (2021), Bodnár et al. (2020), Cerra et al. (2020a), Cerra et al. (2020b), Kozlowski et al. (2020), Martín Fuentes and Moder (2021), Moghadam et al. (2021), Sveriges Riksbank (2020).

2 With regard to the effects on inflation Bordo and Levy (2020), Goodhart (2020) and Goodhart and Pradhan (2020) contribute both theoretical and historical perspectives on how inflation can be lastingly affected by changes in the interplay between fiscal and monetary policy after wars, crises and demographic changes. Bordo and Levy (2020) discuss the connection between fiscal and monetary policy, while Goodhart (2020) and Goodhart and Pradhan (2020) argue that an ageing population and a decline in the rate of globalisation may entail higher inflation. They claim that a rising future dependency burden (total population compared with employed) will raise inflation. The impact of pandemics on demographics and sovereign debt could thus have lasting effects on inflation. Note that the analysis refers to lasting and not permanent effects on inflation. Blanchard (2020) discusses different potential scenarios for inflation after the pandemic.

family formation, from external markets to internal ones, from supply to demand. Overall, I find that there tends to be a more persistently negative effect on foreign trade, investment and real sovereign debt.

What repercussions a pandemic has depends on virulence, that is to say the ability of a microorganism to cause disease in the host. But it also depends on the economic, political and medical responses and on how much households and companies change their behaviour and for how long.[3] Pandemics can have long-lasting effects on the labour supply if, for instance, the working age population is affected. People who have been unemployed for a longer period risk losing competence and skills, increasing the risk that they will get caught in long-term unemployment. Even those who enter the labour market during a deep crisis can be affected through persistently lower wages. Pandemics can also have lasting effects on demand through increased precautionary savings and lower investment. Moreover, international trade may be affected by protectionism or changes in value chains and trade patterns.[4]

2 Effects of pandemics on Swedish demographic and economic conditions between 1800 and 2020

Pandemics have not only caused considerable human hardship, but also major economic strains. Figures 1 and 2 show the percentage change in the number of deaths and GDP per capita, respectively. The red dots show which year various epidemic diseases spread among the Swedish population. The pattern is relatively clear and unfortunately familiar from the coronavirus crisis. We can see in the figures that GDP fell by 7.8 per cent during the second cholera pandemic in 1834 and by 6.8 per cent during the 'Spanish flu' in 1918–1920. However, in the years when the 'Russian flu' (1889), the 'Asian flu' (1957) and the 'Hong Kong flu' (1968) affected Sweden and the world, growth was not negative. Figure 3 confirms the general picture that GDP growth was more clearly negatively affected in years when more serious epidemics, in terms of the number of deaths, affected Sweden.[5] In other periods, the correlation between mortality rate and GDP growth is not significant.

I study pandemics that have taken place since the start of the 19th century and limit my analysis to pandemics that have costed more than 100,000 lives in Europe.[6] Pandemics are per definition global, but I also control for epidemics that have at least partly only affected Sweden, as shown in Figures 1–3.[7] The reason for studying pandemics, and not just Swedish epidemics, is that their origins can be regarded as independent of Swedish economic and political conditions.[8] It is in this way possible to derive the effects from the pandemic and not

3 See, for instance, the article 'Long-term effects of the pandemic on the Swedish economy' in the Account of Monetary Policy 2020 (Sveriges Riksbank 2020).

4 Structural transformation and investment in new technology and new methods of working or organising companies and societies may on the other hand ultimately have positive effects on technological advances and growth rates of economies (Dieppe (ed.) 2020). With regard to pandemics' effects on protectionism, Boberg-Fazlic et al. (2020) find, for instance, that the Spanish flu 1918–1920 had a significant effect on trade policy and that tariffs increased as a consequence of the pandemic.

5 Barro et al. (2020) shows similar results for 43 countries affected by the Spanish flu during 1918–1920. They draw the conclusion that a higher influenza mortality rate led to lower GDP growth. The traditional perception that cyclical variations do not affect long-term growth has to some extent been questioned in academic research. For instance, the existence of hysteresis effects on the labour market (that is, a very lasting or permanent effect of shocks in unemployment) is a phenomenon that has been investigated and discussed to a large degree (see for example Blanchard and Summers 1986). Moreover, academic research, motivated by the slow recovery after the global financial crisis, has shown that economic recessions can cause lasting ('scarring') effects on the level of GDP, as more cyclical phenomena and events can affect the supply side of the economy (see, for example, Cerra et al. 2020a, Jordà et al. 2020 and Bluedorn and Leigh 2018).

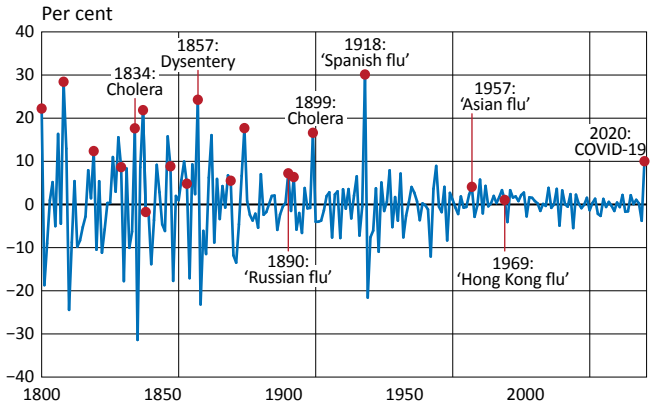
6 One alternative is to study more detailed statistics and information about a specific pandemic. See, for instance, Karlsson et al. (2014) for a regional analysis of the Spanish flu in Sweden.

7 See, for instance, Kelly (2011) for a discussion of how a pandemic is defined.

8 Historians and various social commentators have discussed the causes of these crises. Suggestions include food shortages, lack of hygiene, war or overpopulation, but the results are often contradictory. Here I therefore take a more global perspective and study the larger European pandemics that have not originated in Sweden.

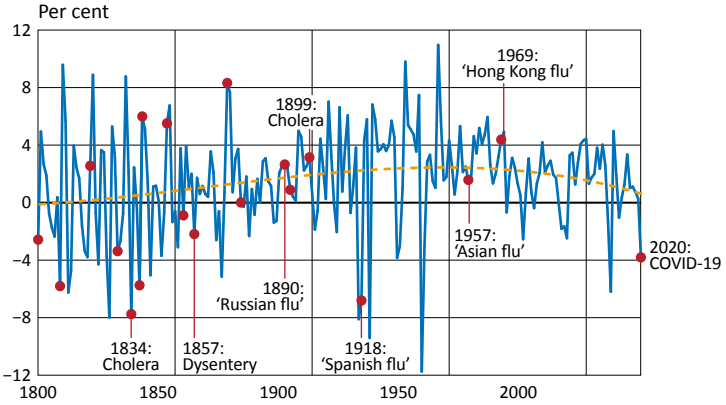
from other conditions. The pandemics I study are the same as those studied by Jordà et al. (2020) and my analysis follows their approach to a large degree. My focus is however on Sweden, where we have access to more detailed macroeconomic and demographic statistics. Although I have statistics for several variables from the start of the 17th century, I limit the sample to 1800–2020. The reason is that I can control for and analyse more variables after 1800. I thus obtain a better picture of how pandemics have affected the economy.[9]

Figure 1. Change in number of deaths and different epidemics in Sweden



Note. See Table A2 in Appendix A for a compilation of epidemics.
Source: Statistics Sweden

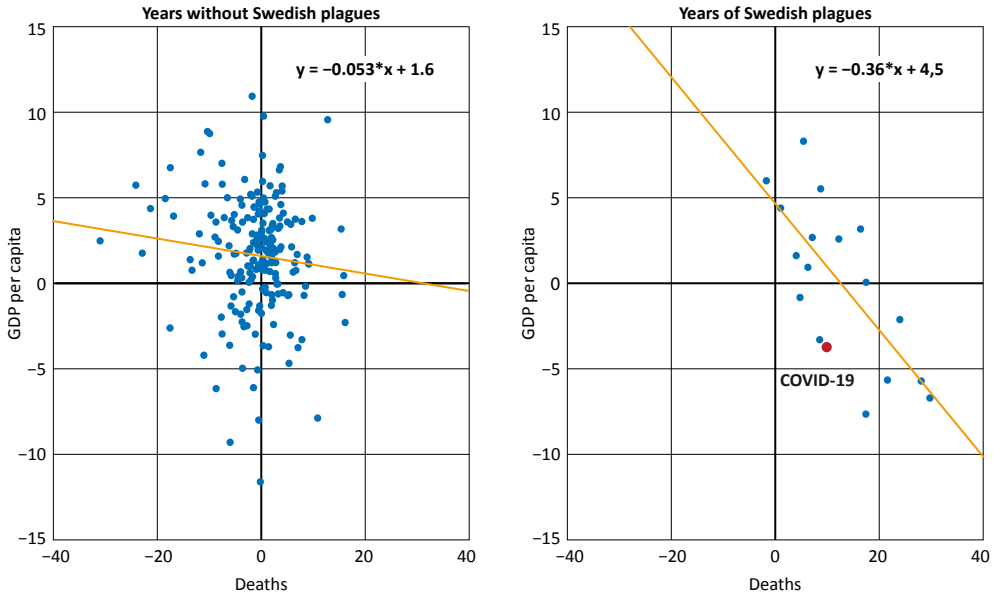
Figure 2. GDP growth per capita and different epidemics in Sweden



Note. See Table A2 in Appendix A for a compilation of epidemics. The broken line shows a trend estimated using a third degree polynomial.
Source: Statistics Sweden

9 However, the choice of sample period implies that plague pandemics are not studied, as the final plague occurred between 1720 and 1722.

Figure 3. Correlation between GDP growth per capita and change in number of deaths
Per cent



Note. See Table A2 in Appendix A for a compilation of epidemics. The solid line represents the best linear fit.
Source: Statistics Sweden

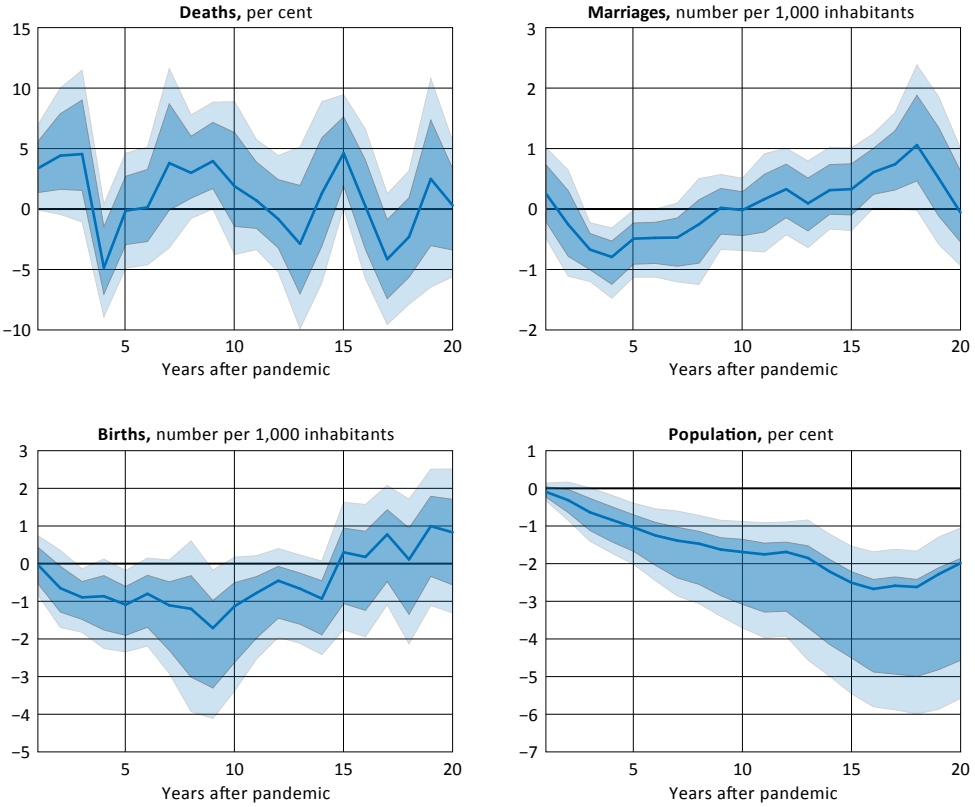
To study the effects of pandemics, I use a time series regression model that in the academic literature is termed a local projection model.[10] Under certain conditions one can use such a model to estimate the causal effects of, for instance, pandemics on different demographic or economic variables. In the regressions I control for a number of demographic and economic variables for up to eight years prior to the pandemics. (See Appendix B for a more detailed description.) Figures 4, 5 and 6 show the estimated average effects during a period of up to 20 years after pandemics between 1800 and 2020.[11] In Figure 4 we can see that the number of deaths has risen on average by several per cent in the years following a pandemic. In the longer run, the number tends to fall. The number of deaths has not only risen directly, but also again after four to five years. Some of the pandemics, such as the second cholera pandemic, took several years to reach Sweden, which was affected in 1834.[12] The most obvious effect on the demographic variables I study is that the population has declined by on average around 2 per cent in the longer run after a pandemic. The number of marriages and the number of births have on average declined in the short and medium term by 1 and 2 per 1,000 inhabitants. To summarise, the number of births, deaths and marriages have all been adversely affected by the pandemics.[13]

In Figure 5 we can see that the average effect on GDP per capita is relatively uncertain. In the short term, GDP has fallen after a pandemic, but the results are not significantly different from zero. This is in line with Figure 3, which also shows that Swedish epidemics are not always correlated with a negative GDP growth. However, concealed behind the effects on GDP are relatively noticeable changes in the components of GDP. Consumption as a percentage of GDP, both private and public sector, has tended to rise while investments, exports and imports have declined as a percentage of GDP in the shorter term (up to almost 10 years). Investments and exports have declined and are the components that

10 See, for example, Jordà (2005) and Montiel Olea and Plagborg-Møller (under publication).
11 If the assumption that the pandemics are exogenous and random, and that the residuals in equation 2 in Appendix B are independent of information going forwards and backwards in time (assumption 1 in Montiel Olea and Plagborg-Møller) then the effects can be interpreted as causal relationships.
12 See, for instance, the descriptions on pages 182–183 in Lundin and Strindberg (1882).
13 See Boberg-Fazlic et al. (2017) and Bloom-Feshbach et al. (2011) for similar results, and Ullah et al. (2020) for a discussion of potential effects of COVID-19 on future birth rates.

have primarily contributed to GDP falling. Gross national saving (investments and net exports) in the economy has thus fallen over a period, which one would not expect if it was precautionary saving that was primarily affected, as savings would in this case have increased.

Figure 4. Demographic effects of pandemics between 1800 and 2020
Per cent and number per 1,000 inhabitants



Note. The different figures show the average historical effects on demographic variables up to 20 years after the pandemics that are compiled in Table A2 in Appendix A. The shaded areas show 1 and 2 standard deviation confidence intervals. If the responses (including the shaded areas) are different from zero (they do not include the x-axis), one can conclude that the pandemics on average have had a statistically significant effect on the variable in question.

The fact that the population declines after a pandemic means, all else being equal, a lower supply of labour (see Figure 6). This is compatible with higher real wages, for which there have been tendencies. However, in the long term, real wages have fallen back. The effects on inflation are uncertain and not significant. This may be because pandemics have negative effects on both supply, which increases costs and prices, and demand, which reduced prices. Economic policy has been relatively passive or even tighter in the short/medium term, interpreted in terms of the effects on the money supply and sovereign debt. The effect on the money supply is negative and there are no significant effects on sovereign debt for up to ten years. In the longer run, monetary and fiscal policy have been more expansionary, with both rising sovereign debt and money supply.

All in all, the average effects in the short and medium term are relatively clear. They are also by and large in line with what one can expect according to models that integrate spread of infection and the macro economy, which show negative effects on both demand for and supply of labour.[14] This has contradictory effects on prices, which are in line with the relatively moderate, but primarily uncertain effects that pandemics have on inflation. In the

14 See, for example, Eichenbaum et al. (2021).

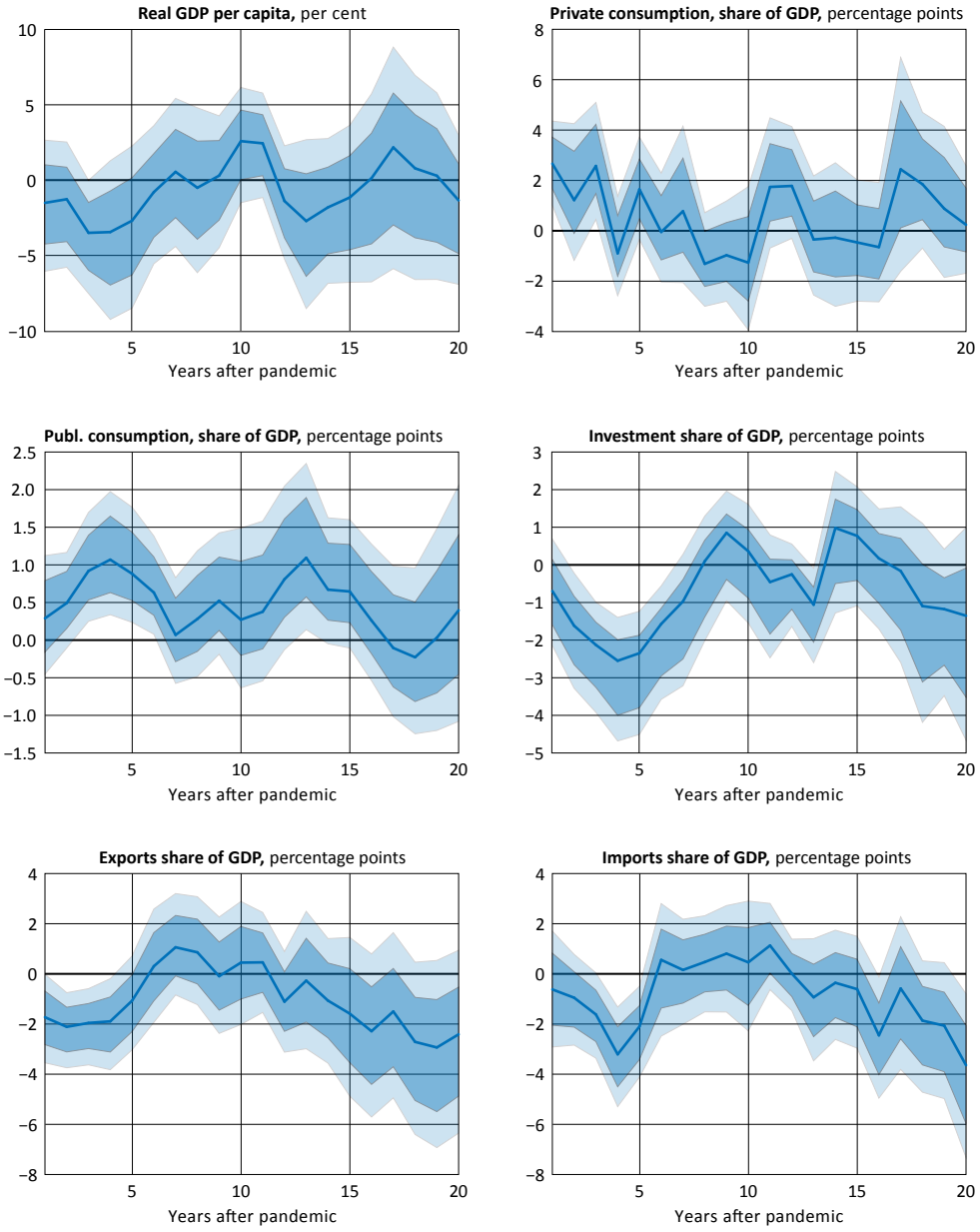
longer term, the effects are uncertain and mostly not significant. Foreign trade, investment and real sovereign debt are exceptions, however. They have on average tended to be more persistently affected by pandemics.

Other research articles show both similar and different effects of pandemics. Jordà et al. (2020) study what effects pandemics have on, for instance, real interest rates and find that interest rates fall persistently. Their historical perspective and method are similar to my own approach, but they lack detailed information on demographics, GDP and inflation. For the United Kingdom, they show that GDP per capita and real wages have on average risen after pandemics between 1311 and 2016.

Ma et al. (2020) analyse the effects on the basis of a much smaller sample of pandemics between 1968 and 2018, but for a larger number of countries.[15] Their results indicate significant effects of pandemics in the countries affected. Real GDP falls by around three per cent and unemployment rises by around one percentage point. Moreover, the effects last for up to five years. The growth rate bounces back relatively quickly, but the level of GDP remains low even after five years. Public consumption rises, however, and counteracts to some extent the effects of the health crisis. They also show a negative impact on trade. The epidemics included in the analysis were mostly local events that are not comparable with a global pandemic. But on the whole, the results are concordant with those I find for Sweden.

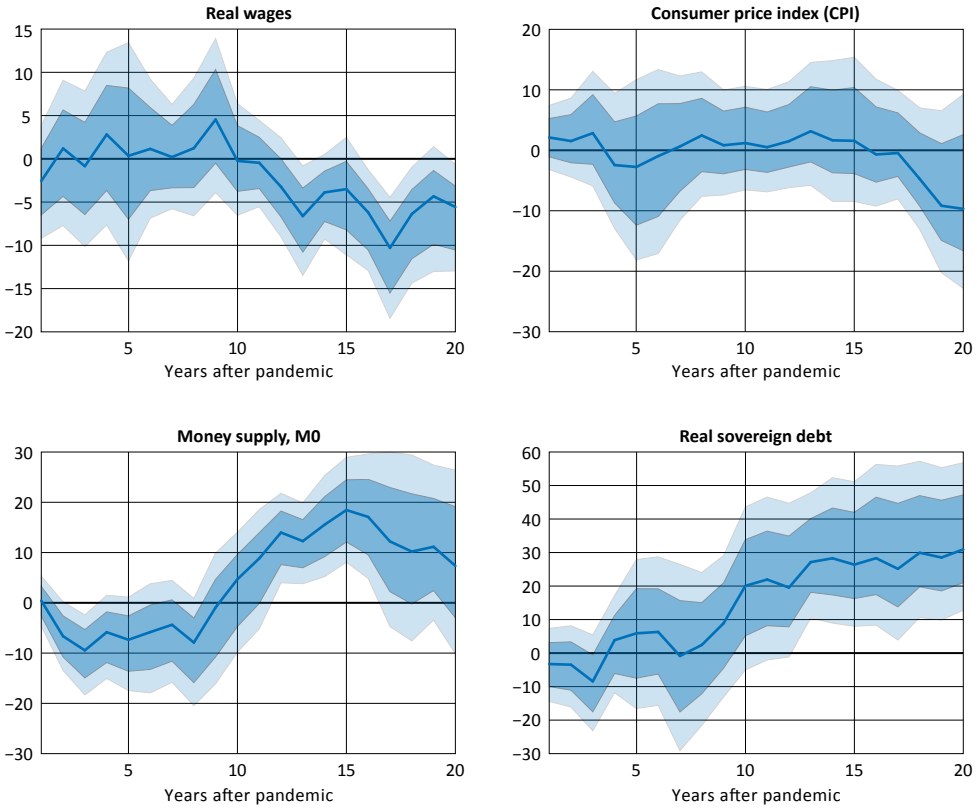
15 An article that is very similar in many ways to that of Ma et al. (2020) is Martín Fuentes and Moder (2020). They analyse what effects pandemic have on potential growth, as well as the effects of other crisis-like events such as wars, oil embargos and financial crises, since 1970. The results imply that the initial effect on the level of potential production is relatively short-lived and tends to disappear two years after the end of the epidemic. Financial crises, on the other hand, are linked to very lasting negative effects on potential production levels.

Figure 5. Economic effects of pandemics between 1800 and 2020
Per cent and percentage points



Note. See note under Figure 4.

Figure 6. Economic effects of pandemics between 1800 and 2020
Per cent



Note. See note under Figure 4.

3 Closing comments

The results show that pandemics have had negative effects on birth rates, death rates and family formation. They have also had a negative impact on the Swedish economy in the short term. The longer term effects are however less clear. Foreign trade, investment and real sovereign debt have tended to be negatively impacted more persistently. This could possibly imply that it will be important to be watchful of potential protectionist tendencies, such as export restrictions and tariffs which can in turn negatively affect foreign trade going forward.

What conclusions can we actually draw from earlier experiences of pandemics?[16] It is difficult to respond to this for several reasons. Society has developed dramatically over the past 220 years, and the situation with regard to overall knowledge, public access to media, technological progress and medical care is very different today. At the same time, diseases can now spread rapidly, both within and between countries, which means that one must act quickly in response to the initial outbreak. Climate change can also play a role.[17] All of this means that the consequences of the coronavirus pandemic may differ from previous pandemics. Another aspect is that the national lockdowns have no counterpart in history, even if regional travel bans have been used in earlier pandemics.[18] In addition, the effects may depend on which part of the population is mostly affected. Almost all deaths related to COVID-19 were among the elderly. During the pandemic 1918–1919, deaths occurred

16 See Conley and Johnson (2021) for a discussion.
17 Apart from being exacerbated by globalisation, epidemic potential is elevated by climate change and urbanisation (Bloom et al. 2018). Climate change extends life environments for various common disease vectors, such as the Aedes aegypti mosquito, which can spread dengue, chikungunya, Zika and yellow fever. Urbanisation means that more people live close together, which amplify transmission of contagious diseases.
18 See Mateus et al. (2014).

instead mainly among younger people.[19] Gagnon et al. (2020) show in a theoretical model that if COVID-19 would have affected the population according to the same age pattern as the Spanish flue, the effects on the supply side of the economy would be stronger and more lasting.

Even if one can discuss what conclusions can be drawn on the basis of earlier pandemics, the historical perspective is interesting in itself. Thanks to this, one can identify structures and mechanisms that can help today's decision-makers and authorities to better plan for and manage future threats.[20]

19 See, for example, Simonsen et al. (1998)

20 See, for example Elgh (2007) for a discussion.

References

Barro, Robert, José Ursúa, and Joanna Weng (2020), 'The Coronavirus and the great influenza pandemic: lessons from the "Spanish Flu" for the Coronavirus's potential effects on mortality and economic activity', Working Paper Series 26866, NBER working paper.

Blanchard, Olivier (2020), 'Is there deflation or inflation in our future?', VoxEU.org, 24 April.

Blanchard, Olivier and Jean Pisani-Ferry (2021), 'Persistent COVID-19: Exploring potential economic implications', PIIE series on Economic Policy for a Pandemic Age: How the World Must Prepare.

Bloom-Feshbach, Kimberley, Lone Simonsen, Cécile Viboud, Kåre Mølbak, Mark Miller, Magnus Gottfredsson and Viggo Andreasen (2011), 'Natality decline and miscarriages associated with the 1918 influenza pandemic: the Scandinavian and United States experiences', *The Journal of Infectious Diseases*, vol. 204, no. 8, pp. 1157–1164.

Bloom, David, Daniel Cadarette and JP Sevilla (2018), 'The economic risks and impacts of epidemics', *International Monetary Fund, F&D Magazine*, June 2018.

Bluedorn, John and Daniel Leigh (2018), 'Is the cycle the trend? Evidence from the views of international forecasters', IMF Working Papers, No. 18/163.

Boberg-Fazlic, Nina, Maryna Ivets, Martin Karlsson and Therese Nilsson (2017), 'Disease and fertility: evidence from the 1918 influenza pandemic in Sweden', Research Institute of Industrial Economics Working Paper Series, No. 1179.

Boberg-Fazlic, Nina, Markus Lampe, Maja Uhre Pedersen and Paul Sharp (2020), 'Pandemics and protectionism: evidence from the "Spanish flu"', CAGE Online Working Paper Series 479, Competitive Advantage in the Global Economy (CAGE).

Bodnár, Katalin, Julien Le Roux, Paloma Lopez-Garcia and Béla Szörfi (2020), 'The impact of COVID-19 on potential output in the euro area', *Economic Bulletin*, No. 7, ECB.

Cerra, Valerie, Antonio Fatás, and Sweta Saxena (2020a), 'The persistence of a COVID-induced global recession', VoxEU.org, 14 May.

Cerra, Valerie, Antonio Fatás, and Sweta Saxena (2020b), 'Hysteresis and business cycles,' CEPR Discussion Papers 14531, C.E.P.R. Discussion Papers.

Conley, Dalton and Tim Johnson (2021), 'Opinion: Past is future for the era of COVID-19 research in the social sciences', *Proceedings of the National Academy of Sciences* Mar 2021, vol. 118, no. 13.

Dieppe, Alistair (ed.), (2020), *Global productivity: trends, drivers, and policies*, World Bank.

Edvinsson, Rodney, Tor Jacobson and Daniel Waldenström (ed.), *Historical Monetary and Financial Statistics for Sweden*, Vol. 1 and 2 , Stockholm: Sveriges Riksbank and Ekerlids förlag, 2014.

Eichenbaum, Martin, Sergio Rebelo and Mathias Trabandt (2021), 'The macroeconomics of epidemics', *The Review of Financial Studies*, 2021.

Elgh, Fredrik, (2007), 'Pandemiers påverkan på samhället historisk erfarenhet nödvändig för dagens beredskapsåtgärder', *(The effects of pandemics on society, historical experience necessary for today's emergency preparedness)*, *Läkartidningen*, vol. 104, No. 8, pp. 615–619.

Goodhart, Charles (2020), 'Inflation after the pandemic: theory and practice', voxEU.org, 13 June.

Goodhart, Charles and Manoj Pradhan (2020), *The great demographic reversal: ageing societies, waning inequality, and the inflation revival*, Palgrave Macmillan.

Herbst, Edward and Benjamin Johannsen (2021), 'Bias in local projections,' Finance and Economics Discussion Series 2020-010r1. Washington: Board of Governors of the Federal Reserve System.

Jordà, Òscar (2005), 'Estimation and inference of impulse responses by local projections', *American Economic Review*, vol. 95, no. 1, pp. 161–182.

Jordà, Òscar, Sanjay Singh and Alan Taylor (2020), 'Longer-run economic consequences of pandemics', Federal Reserve Bank of San Francisco Working Papers No 2020-09.

Karlsson, Martin, Therese Nilsson and Stefan Pichler (2014), 'The impact of the 1918 Spanish flu epidemic on economic performance in Sweden: an investigation into the consequences of an extraordinary mortality shock,' *Journal of Health Economics*, vol. 36, pp. 1–19.

Kelly, Heath (2011), 'The classical definition of a pandemic is not elusive', *Bulletin of the World Health Organization*, vol. 89, pp. 540–541.

Kozlowski, Julian, Laura Veldkamp and Venky Venkateswaran (2020), 'Scarring body and mind: The long-term belief-scarring effects of COVID-19', NBER Working Paper No. 27439.

Lundin, Claes and August Strindberg (1882), *Gamla Stockholm: anteckningar ur tryckta och otryckta källor*,(Old Stockholm: notes from printed and unprinted sources) Jos Seligmann & Co förlag.

Ma, Chang, John Rogers and Sili Zhou (2020), 'Modern pandemics: Recession and recovery,' International Finance Discussion Papers 1295, Washington: Board of Governors of the Federal Reserve System.

Martín Fuentes, Natalia and Isabella Moder (2020), 'The scarring effects of past crises on the global economy', *Economic Bulletin*, No. 8, ECB.

Mateus, Ana, Harmony Otete, Charles Beck, Gayle Dolan, and Jonathan Nguyen-Van-Tam (2014), 'Effectiveness of travel restrictions in the rapid containment of human influenza: a systematic review', *Bulletin of the World Health Organization*, vol. 92, no. 12, pp. 868–880D.

Moghadam, Reza, Markus Guetschow and Camille White (2021), 'Scarring in Europe', SUERF Policy Note, no. 227.

Montiel Olea, José Luis and Mikkel Plagborg-Møller (under publication), 'Local projection inference is simpler and more robust than you think' *Econometrica*.

Statistics Sweden (2020), 'Kohortdödligheten i Sverige' (Cohort mortality in Sweden), Mortality developments up to 2019, Demographic reports 2020:3.

Schmelzing, Paul (2020), 'Eight centuries of global real interest rates, R–G, and the "suprasecular" decline, 1311–2018', Bank of England Staff Working Paper 845.

Simonsen, Lone, Matthew Clarke, Lawrence Schonberger, Nancy Arden, Nancy Cox, and Keiji Fukuda (1998), 'Pandemic versus epidemic influenza mortality: a pattern of changing age distribution', *The Journal of Infectious Diseases*, vol. 178, no. 1, pp. 53–60.

Sveriges Riksbank (2020), 'The long-term economic effects of the pandemic are uncertain' Article in Monetary Policy Report, November 2020.

Ullah, Asad, Abu Tayab Moin, Yusha Araf, Atiqur Rahman Bhuiyan, Mark Griffiths, David Gozal (2020), 'Potential effects of the COVID-19 pandemic on future birth rate', *Frontiers in Public Health*, vol. 8.

Appendix A

Data

Table A1. Compilation of pandemics with more than 100,000 deaths in Europe
Year and illness.

Year	Pandemic	Year	Pandemic
1596–1602	Plague in Spain	1915–1926	European sleeping sickness
1629–1631	Plague in Italy	1918–1920	'Spanish flu'
1647–1652	Plague in Seville	1957–1958	'Asian flu'
1656–1658	Plague in Naples	1968–1969	'Hong Kong flu'
1665–1666	Plague in London	2009	Swine flu
1700–1721	Plague in Nordic countries	2020–	COVID-19
1720–1722	Plague in Marseilles		
1816–1824	First cholera pandemic		
1826–1851	Second cholera pandemic		
1852–1860	Third cholera pandemic		
1863–1875	Fourth cholera pandemic		
1889–1890	'Russian flu'		
1899–1923	Sixth cholera pandemic		

Source: Jordà et al. (2020)

Table A2. Compilation of epidemics and pandemics in Sweden
Year and illness.

Year	Epidemic / Pandemic	Year	Epidemic / Pandemic
1757	Smallpox	1838–1839	Smallpox
1763	Smallpox	1847	Cholera
1772–1773	Dysentery	1853	Cholera
1779	Smallpox	1857	Dysentery
1783	Dysentery	1869	Smallpox
1784	Smallpox	1874–1876	Smallpox
1795	Typhus; smallpox	1889 (December)	'Russian flu'
1800	Smallpox	1892	Diphtheria
1808–1809	Dysentery	1899	Sixth cholera pandemic
1819	Dysentery	1918–1919	'Spanish flu'
1829	Measles	1957	'Asian flu'
1834	Cholera; smallpox	1969	'Hong Kong flu'
1837	Smallpox		

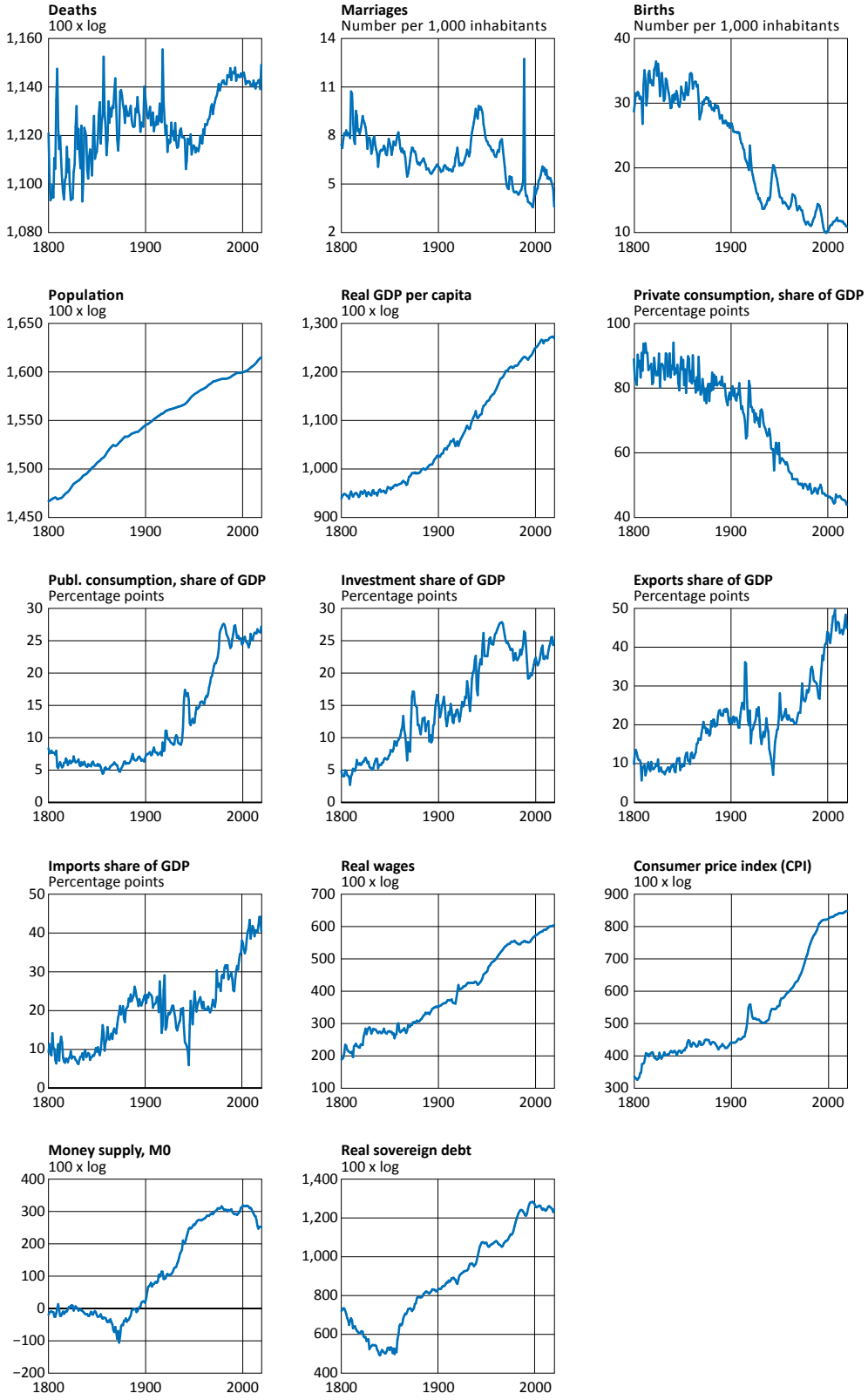
Source: Statistics Sweden (2020)

Table A3. Compilation of statistics, transformations and sources.

Variable	Unit	Years available	Transformation	Source
Pandemic	Dummy	1600–2020	None	Jordà et al. (2020)
Epidemics	Dummy	1757–2020	None	Statistics Sweden (2020)
Deaths	Number	1749–2020	100 x log	Statistics Sweden
Marriages	Number	1749–2020	1000 x (marriages / population)	Statistics Sweden
Births	Number	1749–2020	1000 x (births / population)	Statistics Sweden
Population	Number	1749–2020	100 x log	Statistics Sweden
Real GDP per capita	SEK, year 2000 prices	1620–2020	100 x log	Sveriges Riksbank and Statistics Sweden
Private consumption, share of GDP	Percentage	1800–2020	100 x (nom C / nom GDP)	Sveriges Riksbank and Statistics Sweden
Publ. consumption, share of GDP	Percentage	1800–2020	100 x (nom G / nom GDP)	Sveriges Riksbank and Statistics Sweden
Investment share of GDP	Percentage	1800–2020	100 x (nom I / nom GDP)	Sveriges Riksbank and Statistics Sweden
Exports share of GDP	Percentage	1800–2020	100 x (nom Exp / nom GDP)	Sveriges Riksbank and Statistics Sweden
Imports share of GDP	Percentage	1800–2020	100 x (nom Imp / nom GDP)	Sveriges Riksbank and Statistics Sweden
Real wages	SEK	1600–2020	100 x log (wages / CPI)	Sveriges Riksbank, Statistics Sweden and National Mediation Office
Consumer price index (CPI)	1914 = 100	1600–2020	100 x log	Sveriges Riksbank and Statistics Sweden
Money supply, M0	SEK	1620–2020	100 x log (M0 / CPI)	Sveriges Riksbank and Statistics Sweden
Real sovereign debt	SEK	1670–2020	100 x log (debt / CPI)	Sveriges Riksbank and Statistics Sweden

Note. The source Sveriges Riksbank refers to historical monetary statistics for Sweden. A description can be found in Edvinsson et al. (2014).

Figure A1. Compilation of statistics described in Table A3



Source: See Table A3 for transformations and sources.

Appendix B

Econometric method

One can compare a pandemic to a randomised controlled study, but on a larger scale, where the spread of infection determines when a population is affected.[21] If one treats a pandemic as this type of controlled randomised experiment, it is statistically possible to construct a counterfactual expected economic development, given what has been observed and the historical statistical sample. Similarly, one can calculate the expected development if a pandemic occurs. This is the background to the statistical method I use (Jordà 2005). The effect of a pandemic that occurs in the period t on, for example, GDP in period $t + h$ can more formally be expressed as follows:

$$(1) \qquad \tau(h) = E(y_{t+h} \mid P_t = 1; \Omega_t) - E(y_{t+h} \mid P_t = 0; \Omega_t), \qquad h = 0{:}H,$$

where y_{t+h} refers the logarithm of the dependent variables studied for year t+h, for instance, Swedish GDP. P_t is a dummy variable[22] that assumes the value 1 in the last year of a pandemic (see Table A1) and the value 0 if there is no pandemic in a particular year, and the operator $E(.|.)$ states the best forecast in terms of lowest mean square value of the forecast errors. The information set in year t that I control for, that is, the variables included as independent variables in the regression below (X_t), is given by Ω_t. I estimate $\tau(h)$ in the same way as Jordà et al. (2020), namely with a so-called local projection which means that H regressions are estimated where $h = 20$:

$$(2) \qquad y_{t+h} = \alpha^h + \beta^h P_t + \sum_{l=1}^{L} \gamma_l^h X_{t-l} + \varepsilon_{t+h}^h; \qquad h = 0,\ldots,H,$$

where $\beta^h = \tau(h)$. I choose 8 lags and thereby set $L = 8$.[23] In X_t the basic specification includes the following variables: lagged dependent variable, epidemics that spread among the Swedish population different years, number of deaths during a year, marriages, births, population number, real GDP per capita, real money supply, real sovereign debt, inflation index (consumer price index), private consumption as a percentage of GDP, public consumption as a percentage of GDP, fixed gross investment as a percentage of GDP, exports as a percentage of GDP, imports as a percentage of GDP and real wages.[24] All variables are multiplied by 100. The variables that are not measured as a percentage of GDP are expressed in logarithms, which means that the effects are expressed in per cent or percentage points (the exception is marriages and births, which are expressed in numbers per 1,000 individuals in the population). The pandemics are a dummy variable that is not transformed. See Table A3 above for a description of sources and transformations.

21 A randomised controlled study is a study where the participants are randomly selected either to the group that has the intervention or treatment to be studied, or to a control group. This in theory creates groups that are similar to one another on average. The only thing that separates the groups systematically is what intervention they receive.

22 A dummy variable is a variable that indicates the absence or presence of a particular property. A dummy variable assumes the values 0 and 1, where 0 indicates the absence of properties and 1 indicates the presence of the properties.

23 The results are robust for L=4. See Montiel Olea and Plagborg-Møller (under publication) for the importance of including the lagged dependent variable (y_{t-1}) as control variable in local projections where the variables are persistent. See also Herbst and Johannsen (2021) for a discussion of the bias (systematic errors) in β^h which can arise in short samples (they focus on 50 and 100 periods). The results are almost the same if I instead estimate (2) with $y_{t+h} - y_{t-1}$ as dependent variable and where the control variables are $X_t - X_{t-1}$.

24 In my application, I thus follow Montiel Olea and Plagborg-Møller (under publication) in two different ways. I check both for lagged variables of the dependent variable and for a large number of control variables. This is important for consistent inference of long-term impulse responses when data are persistent and to ensure that the standard deviation of the regression is conditionally average independent (their first assumption).