Jurnal Ekonomi Malaysia 56(3) 2022 103 - 117
http://dx.doi.org/10.17576/JEM-2022-5603-06

The Spanish Flu Pandemic and Income Distribution in Java: Lessons from the 1920s

(Pandemik Selesema Sepanyol dan Pengagihan Pendapatan di Jawa: Pengajaran dari tahun 1920-an)

Aloysius Gunadi Brata
Atma Jaya Yogyakarta University

Sigit Triandaru
Atma Jaya Yogyakarta University

Yenny Patnasari
Atma Jaya Yogyakarta University

Rini Setyastuti
Atma Jaya Yogyakarta University

Agustinus Edi Sutarta
Atma Jaya Yogyakarta University

Andreas Sukamto
Atma Jaya Yogyakarta University

ABSTRACT

COVID-19 pandemic has renewed the debate over economic inequality as well as the relative importance of policies for saving lives vs. protecting livelihoods during times of crisis. This paper therefore offers some insights from economic history through investigating the relationship between the Spanish Flu pandemic and income distribution at the residency level in late colonial Java, Indonesia's most populous province. In addition, we examine recent inequality trends in Java during COVID-19. Our econometric analysis shows that population fatality during pandemic is negatively associated with economic inequality across 14 residencies. This in turn improved income distribution across residencies in the post-pandemic period in late colonial Java. We also find some evidence that estate land for commercial plantation moderated the re-distributive role of the pandemic. Based on the results, we further discuss the key lessons learned from the Spanish flu for contemporary times, proposing possible causes of increasing inequality due to the COVID-19 pandemic and the importance of protecting citizens in productive age groups, especially those on low incomes. Referring to more recent spatial and temporal trends, we conjecture on the existence of an inequality trap in Java. Although this did not follow the historical pattern evident in late colonial Java, COVID-19 may have at least a scarring effect on residency-level inequality in Java.

Keywords: Pandemic; Spanish flu; income distribution; Java
JEL: D31, I14, I30, J11, J31

Received 23 June 2022; Revised 15 October 2022; Accepted 27 October 2022; Available online 30 October 2022

ABSTRAK

Pandemik COVID-19 telah memperbaharui perdebatan mengenai ketidaksamaan ekonomi serta kepentingan relatif polisi untuk menyelamatkan nyawa berbanding melindungi mata pencarian semasa krisis. Oleh itu makalah ini menawarkan beberapa pandangan daripada sejarah ekonomi melalui penyiasatan hubungan antara wabak Selesema Sepanyol dan pengagihan pendapatan di peringkat pemastautin di zaman kolonial Jawa, wilayah paling ramai penduduk di Indonesia. Selain itu, kami mengkaji tren ketidaksamaan terbaharu di Jawa semasa COVID-19. Analisis ekonometrik kami menunjukkan bahawa kematian penduduk semasa wabak dikaitkan secara negatif dengan ketidaksamaan ekonomi di 14 residensi. Ini seterusnya meningkatkan pengagihan pendapatan merentas residensi dalam tempoh pasca-pandemi di Jawa kolonial. Kami juga mendapati beberapa bukti bahawa tanah estet untuk perladangan komersial menyederhanakan peranan pengagihan semula wabak itu. Berdasarkan keputusan itu, kami membincangkan lebih lanjut pelajaran penting yang dipelajari daripada Selesema Sepanyol untuk zaman kontemporari, mencadangkan kemungkinan punca peningkatan ketidaksamaan akibat pandemik COVID-19 dan

kepentingan melindungi rakyat dalam kumpulan umur yang produktif, terutamanya mereka yang berpendapatan rendah. Merujuk kepada tren spatial dan yang lebih terkini, kami menjangkakan wujudnya perangkap ketidaksamaan di Jawa. Walaupun ini tidak mengikut corak sejarah yang terbukti pada zaman kolonial Jawa, COVID-19 mungkin mempunyai sekurang-kurangnya kesan parut pada ketidaksamaan peringkat pemastautin di Jawa.

Kata kunci: Pandemik; Selesema Sepanyol; pembahagian pendapatan; Jawa

INTRODUCTION

The COVID-19 pandemic has revived interest in past experiences of major disease outbreaks and their distributive implications (Alfani 2022). The loss of lives during the recent pandemic and differential mortality rate is acknowledged as a major source of between-country changes in income distribution (Ferreira et al. 2021). But relatively less is known about the inequality consequences of within-country variation in population loss. However, some insights are available from economic history. One of the deadliest pandemics in history is the Spanish Flu which occurred a century ago causing a sharp increase in mortality (Taubenberger & Morens 2019, Sayed & Peng 2021). According to Svenn-Erik Mamelund (1998), coastal locations, urban centres, and areas with higher levels of connection via communication and transport networks experienced higher mortality rates than remote, rural, and isolated areas (see Johnson & Mueller 2002).

At the same time, it is argued that the statistics related to pandemic deaths are underreported due to several reasons such as non-registration and the inconsistent coverage of the population which often overlooks rural and/or native populations especially in the colonies (Johnson & Mueller 2002). An updated account shows that the flu infected about 500 million people or one-third of the world's population. It is estimated that this pandemic killed 50–100 million people and most of them are young people. The mortality rate of the influenza pandemic in Asia was 26-36 million and the published death toll for Indonesia was 1.5 million (Johnson & Mueller 2002).

The above historical lessons have welfare implications for regions with large and dense human settlements such as Indonesia's Java province, which are more vulnerable to large scale deaths during major disease outbreaks. This paper therefore revisits the relationship between the Spanish Flu and the income distribution at the residency level in the late colonial Java. This exercise has policy relevance for several reasons. First, the estimated population loss caused by the past pandemic for Java alone is in the range of 4.26–4.37 million (Chandra 2013, van der Eng 2020). At the residency level, the rates of population loss range from 1.10% to 23.71%. This death toll is significantly higher than the official statistics of the pandemic. Second, although the Spanish influenza did not affect gross domestic product (GDP) or the production of rice and food crops in general, it negatively affected the production of the sugar industry, especially after 1919, through the reallocation of labour and land from non-essential crops to food production during the pandemic (Gallardo-Albarrán & de Zwart 2021). Third, inequality from 1920 to 1928 decreased in some residencies; namely Kediri, Surabaya, Pekalongan, Batavia, Priangan, Besuki (de Zwart 2022). Therefore, an analysis of the overall relationship between inequality and the number of deaths can also shed light on post covid-19 inequality in Java.

This study makes several contributions to the literature. First it provides evidence on the distributive role of the 1918 pandemic in a developing country, as well as on the influence of other factors, in particular the reallocation of resources in the agricultural sector in moderating the distributive impact of the pandemic. de Zwart (2022) investigated the influence of exports and area of plantations on the income inequality across residencies in late colonial Indonesia. He however, did not formally include the flu pandemic as another possible determinant of the spatial variation of income inequality. We included this in this study through employing a unique dataset compiled from Chandra (2013) and de Zwart (2022). Given the small number of observations, however, we limit our analysis to simple correlations and use the results for illustrative purposes only.

Second, prior to the COVID-19 pandemic, inequalities between rich and poor, including spatial inequalities, had been identified as a serious issue in Indonesia (Leigh & van der Eng 2010, World Bank 2015, Akita & Miyata 2018). Furthermore, some important aspects such as education and democracy have not improved equality (Wicaksono et al. 2017, Kawamura 2019). Although living standards in Indonesia have risen and poverty has fallen rapidly especially during periods of faster economic growth, poverty decline since the 1999 growth has been slower while inequality has risen (Hill 2021). Persistent high or rising inequality can contribute to political instability and undermine the social cohesion required for economic development. It is thus critical for Indonesia and other countries in Asia to design a proper policy to address inequality (Asadullah & Maliki 2017). It is not surprising that there is a strong correlation between the possible number of people at risk of being infected and the number experiencing multidimensional poverty in Indonesia (Thaariq et al. 2020). The authors also noted that people classified

as at risk of being infected mostly live in urban areas, although around 80% of the total multidimensional poor population in Indonesia are villagers. Therefore, COVID-19 has the possibility to affect inequality in Indonesia and on this we can learn from the past, especially from the 1918 flu pandemic.

Recent data also show that income inequality as measured by the Gini Index is rising, especially in the provinces in Java (Brata et al. 2021a, Brata et al. 2022). Therefore, besides the availability of data from the 1918 pandemic, the trend of increasing inequality in Java is also our reason to focus on the island. We may derive lessons learned from this historic pandemic to design current modern policies on how to recover from the pandemic and rebuild a more just society in Indonesia, as well as elsewhere in contemporary colonial Asia, especially on the role of public policy in dealing with inequality.

The rest of the paper is organized as follows. Section 2 offers a brief description of the relevant literature and conceptual framework, while section 3 explains the study context. The following section 4 explains data and research method while section 5 provides results and discussion. Section 6 describes lessons from the past pandemic for the post-COVID-19, and section 7 is the conclusion.

LITERATURE REVIEW & CONCEPTUAL FRAMEWORK

There is a long tradition of research in the field of development economics and demography on the link between population growth and the distribution of income. The main conclusion is that higher population growth rates increase inequality (see Ram 1984; Lam 1986, 1997). Therefore, reduction of the population growth is one of the targeted policies to reach a more equal income distribution. Alternatively, unpredictable shocks, such as pandemics, that affect population growth, may also influence income distribution, primarily through labour market.

A pandemic can have a distributive effect through the changes in labour supply that affect wages (Sayed & Peng 2021). If productivity remains constant, the shock to the labour supply caused by the deadly pandemic leads to an increase in the wages of those workers who survive the pandemic. To illustrate this process, we can imagine two villages that had the same wage level before the contagion. The first village (A) was affected by the pandemic, while the second village was not affected. Labour supply in village A decreased due to the deaths of some workers and the depletion of seasonal migrants. The contraction of labour supply then increased the wages in this village. Therefore, workers who survived the pandemic received better wages than before. In contrast, wage levels remained unaffected in village B since there was no change in the labour supply. As a result, income distribution in village A become more equal, assuming that most workers who died due to the pandemic were low paid workers; otherwise the pandemic would have increased income inequality. In addition, if the wages in village B before the pandemic were higher than in village A, then the pandemic reduced the wage difference between them. In other words, if the most affected regions or workers had relatively lower income, the pandemic would increase equality. Thus, how income was distributed among regions and workers, vis avis how population loss was dispersed, would determine how the pandemic affected inequality. Therefore, the difference in the level of equality in income distribution between the villages was also reduced.

When the assumption of constant productivity does not hold, since pandemics can also lead to a decline in productivity, a pandemic may have a different impact on wages (Sayed & Peng 2021). The shock in productivity reduces demand for labour, leading to a fall, stability, or a rise in wages. If the shift of labour supply is greater than the shift of labour demand, we should expect the pandemic to result in higher wages, otherwise, the result is a decrease in wages. Therefore, the ultimate impact of the pandemic also depends on the magnitude of the labour supply shock relative to the productivity shock caused by the pandemic.

Empirical studies also found different results indicating that different pandemic has different characteristics. Alfani (2020, 2022) discovered that the Black Death, the worst epidemics of preindustrial era in the 14th century, improved equality. This pandemic improved equality since the richest 10% of the population lost their grip on 15%–20% of overall wealth in the aftermath of this contagion. The plague also sharply reduced labour supply which led to an increase in real wages and gave the poorest more bargaining power to negotiate better working conditions that subsequently improved equality. The decline in inequality was long-lasting, as the wealth concentration did not reach pre-Black Death levels again before the second half of the 17th century. Sayed and Peng (2020) investigated the impacts of four pandemics on inequality in France, Germany, the United Kingdom, and the United States. They found that pandemics with more than 100,000 deaths contributed to a decline in income inequality in the years following the pandemics.

In contrast, Galletta and Giommoni (2020) established that the 1918 ‘Spanish flu’ pandemic increased income inequality in the short to medium term in Italy. The main cause for the increase was a reduction in the share of income generated by the poorer group of the population. The general effect of the 1918 pandemic tended to have long-lasting consequences since municipalities that experienced the most damage from the flu reported a less equal distribution of income

even after 100 years. These contrasting findings confirmed Alfani (2022) that the distributive role of mortality rates was also mediated by a range of factors, especially the institutional framework in place at the onset of each crisis. Alfani also noted that the past epidemics could also reduce poverty through two deeply different mechanisms; redistribution towards the poor or extermination of the poor.

Based on past studies, the population impact of the Spanish flu in 1920s will be represented by population loss at the residencies level in Java. This population loss variable is expected to reduce income inequality which is measured by several indexes since it is argued that the contraction of labour will increase the wages. However, the ultimate impact of this pandemic will be weakened if the shift in labour supply is smaller than the shift in labour demand. To identify this issue, the variable of commercial estates will also be used.

STUDY CONTEXT

During the late Dutch colonial era, the island of Java comprised 17 residencies in which two were principalities of Yogyakarta and Surakarta (Figure 1). In the modern era, there are six provinces in Java due to the reorganization of the residencies (Figure 2); namely Banten province comprising Banten residency and part of Batavia residency; West Java province comprising Priangan, Cirebon, and part of Batavia; the central area of Batavia became Jakarta; Residencies of Semarang, Pati, Pekalongan, Banyumas, Kedu, Surakarta, and Rembang; the principalities of Jogjakarta became Yogyakarta Special Province; while East Java province comprising Surabaya, Malang, Kediri, Pasuruan, Malang, and Besuki. The residencies later became districts and cities in their respective provinces based on reorganization of their administrative boundaries under the post-colonial Government of Indonesia.

Java in the late colonial era was a low-income agricultural society, being dependent on agriculture as the main source of income. It was however insufficient to improve living standard. Until the late 1920s, the share of agriculture remained at about 55-60% of GDP of Java (van Zanden 2012). Until recently, Java still dominates the national economy at more than 50%. When the Spanish flu began to spread in Indonesia, the colonial government rejected the adoption of the lockdown policy based on the argument this policy will generate chaos and upset economic stability (Ravando 2020). Additionally, the availability of medicine to treat the flu was very limited. In modern times, the health system still face many limitations such as the low ratios of hospital beds and physicians (Olivia et al. 2020).

In the context of late colonial Java (Figure 1), resource diversion may also influence the distributive role of the pandemic. The resource diversion is a result of a competition between sugar production for the global market and food or rice production for the domestic market (Gallardo-Albarrán & de Zwart 2021, de Zwart 2022). Land and labour shifted to rice at the expense of sugar production. The diversion can have a moderating role on the impact of the flu pandemic on income inequality.

In his study on the inequality in 32 residencies in late colonial Indonesia, de Zwart (2022) used the total value of export per capita and the coverage of planted estate lands as a share of the total land surface in a residency to assess the influence of global trade. He found that the total share of land area used for plantation agriculture in a residency was related to various measures of inequality. The coefficients were positive indicating that the plantation area related to export tended to increase inequality.

Another important characteristic of the pandemic in Java was in the aggregate food production that did not decline, although total sugar output, as well as sugar output per hectare, declined in 1919 (Gallardo-Albarrán & de Zwart 2021). However, sugar production was not correlated with variation in mortality across residencies caused by the pandemic. The authors argued that labour and land were redirected from non-essential crops to food production during the influenza epidemic due to several partially interrelated developments (see also Knight 2000, van Dijk 2007, Wibowo et al. 2009, Ravando 2020). First, sugar prices were down due to the advent of WWI which disrupted the global market and affected shipping capacity which in turn caused stockpiling of sugar across Java. Second, there was a shortage of rice caused by market disruptions and drought across Southeast Asia which drove up prices throughout Java. There were thus incentives to divert labour from sugar to rice production when the impact of influenza caused labour shortage across the island.

Gallardo-Albarrán and de Zwart (2021) further found that labour markets clearly responded to labour shortage caused by the epidemic. Wages of agricultural workers or coolies increased higher than wages of plantation workers (mainly in sugar production) confirming the importance of food or rice production and the decline in sugar production. Since the average production of sugar finally rebounded, we can expect that the share of planted estate land for export also increased. Data show that the average of this planted land increased from 3.90 in 1920 to 4.01 and 4.40 in 1924 and 1928, respectively.

Combining the conceptual framework and the historical context of late colonial Java, we may expect that the pandemic may have a distributive role and probably has a relatively long-term impact on the inequality measures. However global trade can moderate the distributive role of the pandemic by causing an increase in income inequality. In consequence some pertinent lessons can be drawn for the control and management of the current COVID-19 and future pandemics.

FIGURE 1. Map of the residencies of Java in 1920
Source: Chandra (2013).

FIGURE 2. Map of the provinces of Java in the current years
Source: https://asiapacific.anu.edu.au/mapsonline/base-maps/java-provinces. (Accessed 30 September 2022)

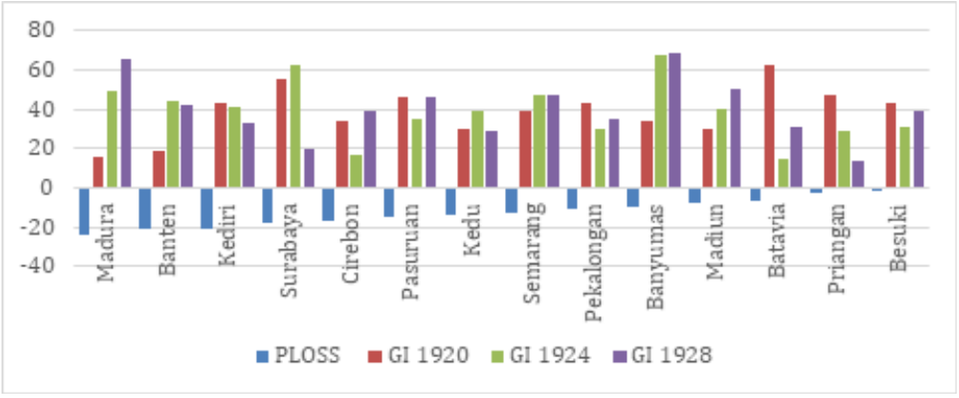

FIGURE 3. Population loss (PLOSS) and Gini Index (GI) at the residency level in Java
Source: based on Chandra (2013) and de Zwart (2022)

DATA AND RESEARCH METHOD

This study utilizes unique historical data covering residencies in late colonial Java. The estimated population loss caused by the 1918-19 Spanish Flu was sourced from Chandra (2013). Population loss is defined as the difference between the expected population given the pre-pandemic trajectory and the observed population in the immediate aftermath of the pandemic. The estimated data reflect a combination of excess mortality and depressed fertility since migration both within and to or from Java was a minor phenomenon when compared to the size of the populations of the various residencies of Java. The second source of data was de Zwart (2022) who provided the inequality data across 32 residencies in late colonial Indonesia for 1920, 1924, and 1928. The main inequality data included Gini Index, Theil Index, Inequality Extraction Rate and Top Income Rate. De Zwart reconstructed this inequality data based on the tabulations of the colonial income tax from the years 1920 to 1928 in the Colonial Reports (*Koloniale Verslagen*).

There were 17 regions on the map (Figure 1), including the principalities of Jogjakarta and Surakarta which were excluded from the dataset since these two principalities were governed by different administrative systems. As principalities, they were not classified as government land (Brata et al. 2013) and as such different mechanisms were adopted in the data collection (Chandra 2013). Since the inequality data for the residency of Rembang was also unavailable for 1928, we then extracted data for only 14 residencies in Java. The number of observations used in the estimations was very small, being consistent with the number of regions in Java in that era. In dealing with this issue, our estimation strategy was to limit the number of independent variables to avoid a substantial loss in the degree of freedom. In lieu of the small number of observations, the estimation results in this study should thus be interpreted with caution, and the analysis brought down to the district/city level that may improve the results. To do so, one should compile historical statistics from the colonial archives, but this is beyond the scope of the current study.

With regard to the population loss data, we have data for 1918-1919 only while inequality measures are available for 1920, 1924, and 1928. Therefore, we regressed population loss during the pandemic on inequality after the pandemic to estimate the relationship between the population loss on the various income inequality indices for 1920, 1924, and 1928. This estimation strategy was adopted since data for the main explanatory variable was only available for 1918-1919. This reflected a lag in identification strategy that may also minimize endogeneity problem. Therefore, the correlations between the population loss and income inequality reflect the influence of the pandemic on the post pandemic inequality. These are the lagged effects of the pandemic on income inequality in 1920, 1924, and 1928.

The population loss data were transformed from negative to positive values. Thus the greater the positive value the greater was the population loss. The effect of population loss was expected to decrease over the years. We also used other indices of the Gini Index, as provided in de Zwart (2022) in our sensitivity tests. These include Theil Index, Inequality Extraction Rate and Top Income Rate (see Appendix for their summary statistics).

Data on the area of estate land relative to the total size of a residency were sourced from de Zwart (2022) and this constitute another explanatory variable. As previously explained, the statistics on estates are different from the information on the distribution of land. While the statistics only concern data on commercial estates, information on land distribution shows indigenous landholding, especially for subsistence production. Since estate land was used for commercial production of export commodities, it affected the distribution of the gains from trades in which the destructive impact of smallholders' production on equality is less than that of plantation agriculture in commercial estates. This argument is also in line with the general framework of the influence of global trade on inequality in which changes in product prices in the global market will be transmitted to the demand for production factors, especially labour and land (Roser & Cuaresma 2016). In the context of Java in the 1920s, the decline of sugar price affected the area of estate land used in sugar production which in turn influenced the demand for labour in this sector that was already affected by the pandemic (see also Gallardo-Albarrán & de Zwart 2021). To cover this issue, we also include the interaction with population loss to examine the moderating role of the reallocation of resources related to the development in the global market, especially in the agricultural sector. This interaction variable is expected to have a positive coefficient reflecting the global market to reduce the distributive influence of the pandemic on income distribution. The main data is visualized in Figure 3, in which PLOS and GI represent population loss and Gini Index, respectively.

RESULTS AND DISCUSSION

We first estimated the relationship between population loss and the main indicators of income inequality. The OLS regression estimates of our basic model are presented in Table 1. For all inequality measures, population loss has a negative coefficient for all years. This result supports our expectation indicating that the pandemic improves income equality. However, the result is only statistically significant for Gini Index (1920) and Inequality Extraction Rate (1920 and 1928). Since

TABLE 1. OLS estimates of the association between inequality and population loss (Baseline model)

Inequality	Year	Poploss	_cons	R-sqr
Gini	1920	-.89*	50***	.23
		(.48)	(6.11)	
	1924	-.93	51.06***	.18
		(.56)	(7.47)	
	1928	-.98	52.42***	.20
		(.57)	(7.39)	
Theil	1920	-.56	32.95***	.05
		(.67)	(9.69)	
	1924	-.66	36.89***	.06
		(.69)	(9.8)	
	1928	-.82	40.64***	.09
		(.67)	(9.24)	
Inequality Extraction Rate	1920	-1.37*	99.48***	.25
		(.74)	(8.15)	
	1924	-1.13	76.57***	.22
		(.66)	(8)	
	1928	-1.25*	73.89***	.25
		(.67)	(8.08)	
Top Income Rate	1920	-.47	46.02***	.02
		(.93)	(12.88)	
	1924	-.75	58.17***	.03
		(1.18)	(15.2)	
	1928	-.96	63.84***	.04
		(1.22)	(14.48)	

Notes: Robust standard errors are in parentheses. *** p<.01, ** p<.05, * p<.1. Number of observations is 14.

TABLE 2. OLS estimates of the association between inequality and population loss (Model with added interaction term: plant_sh)

Inequality	Year	poploss	plant_sh	poploss_plant_sh	_cons	R-sqr
Gini	1920	-1.43**	-.07	.19*	48.32***	.68
		(.54)	(1.7)	(.09)	(10.85)	
	1924	-1.47*	-.15	.20	49.39**	.49
		(.79)	(2.48)	(.13)	(15.83)	
	1928	-1.46	-.74	.15	54.95***	.30
		(.97)	(2.13)	(.12)	(17.12)	
Theil	1920	-1.21	-.13	.24*	31.16*	.41
		(.78)	(2.31)	(.12)	(15.96)	
	1924	-1.26	-.33	.21	36.06	.27
		(.99)	(2.96)	(.16)	(20.35)	
	1928	-1.38	-1.12	.14	45.93**	.14
		(1.12)	(2.45)	(.13)	(20.24)	
Inequality Extraction Rate	1920	-2.53***	-1.86	.35***	105.63***	.62
		(.64)	(2.02)	(.08)	(13.49)	
	1924	-1.9**	-.72	.26*	77.29***	.58
		(.84)	(2.56)	(.13)	(16.78)	
	1928	-1.97*	-1.13	.22	77.93***	.42
		(1.06)	(2.28)	(.13)	(18.47)	
Top Income Rate	1920	-1.34	-.19	.32	43.67*	.33
		(1.07)	(3.53)	(.23)	(21.88)	
	1924	-1.93	-1.69	.37	62.8*	.19
		(1.61)	(5.45)	(.34)	(32.68)	
	1928	-2.04	-2.97	.2	81.27*	.06
		(2.17)	(4.8)	(.27)	(37)	

Notes: Robust standard errors are in parentheses. *** p<.01, ** p<.05, * p<.1. Number of observations is 14.

TABLE 3. OLS estimates of the association between inequality and population loss (Baseline model with alternative dependent variables (inequality measures))

Inequality	Year	Poploss	_cons	R-sqr
Gini_90	1920	-1.06*	56.09***	.27
		(.54)	(6.32)	
	1924	-1.08*	56.53***	.22
		(.6)	(7.38)	
	1928	-1.13*	58.01***	.24
		(.6)	(7.31)	
Gini_119	1920	-.86*	49.09***	.22
		(.48)	(6.08)	
	1924	-.91	50.25***	*.17*
		(.56)	(7.49)	
	1928	-.96	51.58***	.19
		(.56)	(7.41)	
Gini Change	1920	-.86*	49.09***	.22
		(.48)	(6.08)	
	1924	-.99	53.17***	.20
		(.57)	(7.42)	
	1928	-.98	52.42***	.20
		(.57)	(7.39)	
Taxpayer Gini	1920	-.47	67.1***	.14
		(.42)	(4.44)	
	1924	-.45	66.13***	.12
		(.4)	(4.46)	
	1928	-.56	68.92***	.21
		(.38)	(4.12)	

Notes: Robust standard errors are in parentheses. *** p<.01, ** p<.05, * p<.1. Number of observations is 14.

TABLE 4. OLS estimates of the association between inequality and population loss (Extended model with added interaction term (plant_sh) and alternative dependent variables (inequality measures))

Inequality	Year	poploss	plant_sh	poploss_plant_sh	_cons	R-sqr
Gini_90	1920	-1.80***	-.62	.25***	56.74***	.75
		(.50)	(1.47)	(.08)	(9.94)	
	1924	-1.85**	-.83	.25*	57.89***	.58
		(.73)	(2.13)	(.11)	(14.36)	
	1928	-1.83*	-1.23	.20*	63.11***	.38
		(.91)	(1.87)	(.10)	(15.60)	
Gini_119	1920	-1.37**	.01	.19*	47.08***	.67
		(.55)	(1.73)	(.09)	(10.96)	
	1924	-1.41	-.05	.19	48.15**	.48
		(.8)	(2.53)	(.14)	(16.03)	
	1928	-1.41	-.67	.14	53.75**	.29
		(.98)	(2.17)	(.12)	(17.32)	
Gini Change	1920	-1.37**	.01	.19*	47.08***	.67
		(.55)	(1.73)	(.09)	(10.96)	
	1924	-1.61*	-.40	.22	52.62***	.53
		(.77)	(2.35)	(.13)	(15.29)	
	1928	-1.46	-.74	.15	54.95***	.30
		(.97)	(2.13)	(.12)	(17.12)	
Taxpayer Gini	1920	-1.24***	-1.48*	.23***	72.57***	.77
		(.34)	(.73)	(.05)	(5.45)	
	1924	-1.20*	-1.71	.20**	73.05***	.47
		(.54)	(1.49)	(.09)	(9.69)	
	1928	-1.42**	-2.12*	.18**	80.58***	.46
		(.53)	(1.03)	(.07)	(8.47)	

Notes: Robust standard errors are in parentheses. *** p<.01, ** p<.05, * p<.1. Number of observations is 14.

the population shock occurred a few years before the year of the inequality measures, it indicates that the flu pandemic has a relatively long-term impact on income inequality, especially on the Inequality Extraction Rate.

The findings are in line with those of Alfani (2020, 2022) for the Black Death pandemic but in contrast to Galletta and Giommoni (2020) for the 1918 'Spanish flu'. The results also confirm that the pandemic can have different impacts in different contexts. Java in the late colonial time was still an agricultural society, while Italy during the Spanish flu was more industrialized. Therefore, it can be surmised that a pandemic provides a 'benefit' of equality for agricultural or traditional societies, while the reverse is true for the more industrialized ones.

In subsequence we add the estate land share and its interaction with population loss, to the basic model. Table 2 presents the OLS regression estimates of the interaction model. As in the previous model, the coefficients of population loss consistently have a negative sign but with greater magnitudes. The coefficient of population loss becomes statistically significant not only in Gini (1920) and Inequality Extraction Rate (1920, 1928) but also in Gini (1924) and Inequality Extraction Rate (1924). The results confirm that the pandemic reduces inequality in income distribution across residencies in Java.

The planted area of estate land (*plant_sh*) variable has no statistically significant correlation with income distribution, but its interaction variable (*poploss_plant_sh*) shows a positive coefficient and is statistically significant in Gini (1920), Theil (1920), and Inequality Extraction Rate (1920, 1924). Their positive coefficients allow us to interpret that the share of estate land weakens the distributive role of the pandemic. Since most of the estate land represents sugar production, the results support the expectation that global trade plays a role in moderating the impact of the pandemic on inequality measures.

The positive coefficients of the interaction variable combined with negative coefficients of the *plant_sh* imply that the decline in the share of estate land in 1920s might have contributed to a decrease in inequality. The positive coefficients of the interaction variable and the negative coefficients of the *plant_sh* imply that the decline in the share of estate land in the 1920s might have lowered inequality. The better income distribution after the pandemic had something to do with the reallocation of land as well as labour movement from the sugar industry to the food crops. Thus, the downturn in the global trade could have had a strong effect on income distribution in late colonial Java. As explained in de Zwart (2022), the estate provides a surplus for the owner and the management but not for the plantation workers. As recorded, the plantation in late colonial Java produced commodities for the global market. This supports the argument that globalization tends to increase inequality in income distribution.

Based on the results, we find supports for the argument that the Spanish flu improves equality in income distribution, and this impact has been strengthened by the weakening of Java's sugar industry trade as part of a globalization process.

To check the consistency of the findings, we also regressed all explanatory variables on the alternative measures of inequality as adopted in de Zwart (2022). These included Gini_90, Gini_119, Gini Change, and Taxpayer Gini (see Appendix for the summary statistics). The OLS regression estimates presented in Table 3 and 4 showed that population loss still has a negative impact on the various alternatives of inequality. It is suggested that the pandemics improved equality across residencies in late colonial Java and this improvement has been strengthened by the weakening in global trade.

INCOME DISTRIBUTION IN POST-COVID-19 IN JAVA: LESSONS FROM THE PAST

In the modern era, Java Island consists of six provinces, which are Banten, Jakarta, West Java, Central Java, Yogyakarta, and East Java. All the capital of the provinces play a role as the center of the agglomeration areas in which large and medium manufacturing make a large contribution to the local economies, except for Yogyakarta where tourism and education are the main economic sectors. Population density in these agglomerations was high as well as their labour productivity. Agglomeration has been identified as one of the determinants of wage variation (Ridhwan 2021) while real wage influences the productivity of labour (Sari & Oktora 2021). Regarding the policy of response to the pandemic, especially at the beginning of its spread, Roziqin et al. (2021) found that the government of Indonesia reacted slowly to the COVID-19 pandemic. This is similar to the response of the Dutch colonial government to the Spanish flu in 1920s (Ravando 2020).

Based on our historical analysis of inequality patterns, what can we say about income distribution in Java in more contemporary times? To this end, Figure 4 first summarizes the provincial trends of Gini Index in Java for the last ten years. Currently in Indonesia, there are six provinces in Java, including Yogyakarta Special Province. In late colonial Java, residencies in Central and Eastern Java recorded unequal distribution of income. The top five residencies were Banyumas (now in Central Java), Madura (East Java), Madiun (East Java), Semarang (Central Java) and Pasuruan (East Java). It should be noted that the current administrative boundaries of the provinces do not fully correspond to those of the colonial era. For instance, the eastern area of the Batavia residency is now part of West Java province. Keeping this limitation in mind, a shift emerges when we compare this available data at the provincial levels

with the Gini Index in Figure 2. In recent years, Jakarta, West Java, as well as Yogyakarta are known as provinces with high income inequality. The Gini Index of these three provinces is more than 0.400, while the rest are below this level. The shift from high inequality areas from Eastern Java to Western Java occurred following the financial crisis in the 1990s (Asadullah & Maliki 2017). Hill (2021) also concluded that inequality in Indonesia has risen significantly for much of the past quarter century, during which the Indonesian policy regime has contributed to this rising trend.

This means that an inequality trap exists in Java in modern Indonesia, although its spatial pattern did not follow that of the late colonial era. Additionally, focusing on the Gini Index in Figure 3 for the last two years, it is quite clear that COVID-19 has reinforced inequality in the recent Java, especially in Jakarta, West Java, and Yogyakarta. Until March 2022, Gini Indices in all provinces in Java are still higher than those in Mach 2019. These figures provide an early indication that the recent pandemic may have a permanent impact, or at least a scarring impact on inequality over the provinces in Java (Brata et al. 2021b, Brata et al. 2022).

There are some similarities between the two pandemics in the context of Java. First, as with the Spanish flu (Wibowo et al. 2009, Ravando 2020), the leading regions in Java have been severely affected by COVID-19 (Olivia et al. 2020, Brata et al. 2021a). It is not surprising that Jakarta and Surabaya, the two largest cities in Java, are among the regions that recorded a high rate of COVID-19 attack, measured by the ratio of the number of cases to the number of population (*DW 1/7/2020*). Another study also indicated a strong positive correlation between human development, environmental quality, and several indicators of COVID-19 across regions in Java (Brata et al. 2021b). For human development, the findings are generally in line with those of other studies in different countries, such as Italy (Liu et al. 2020) and Brazil (Souza et al. 2020). As we know, the human development index (HDI) is widely used to represent the level of development of localities.

Second, there is a similarity in terms of the age group of the victims. The Spanish flu substantially killed individuals in the productive group, ages between 20 and 40 years (Athukorala & Athukorala 2020, Chandra 2020). Meanwhile, according to the Ministry of Health, the elderly (over 60 years) contributes 45% of total deaths caused by COVID-19 in Indonesia (*Katadata 21/1/2021*) indicating that the productive-ages also face the same risk of death depending on the pandemic. Third, the colonial government's response to the Spanish flu was also questioned. For instance, Ravando (2020) noted that the colonial government at the central and local level did not have the same policy in dealing with the pandemic, indicating that the colonial institutions did not sufficiently help institutional development in dealing with the pandemics. In the current pandemic, the Indonesian government has also been criticized for not responding quickly enough to the emergence of the pandemic (Olivia et al. 2020). Since health facilities were also weak and fragile, both pandemics caused many deaths.

Fourth, the weak export demand globally during the Spanish flu lowered commodity prices including sugar which was the most important primary commodity in colonial Java (Gallardo-Albarrán & de Zwart 2021). COVID-19 also affected the Indonesian economy due to weakening global demand for export as reflected

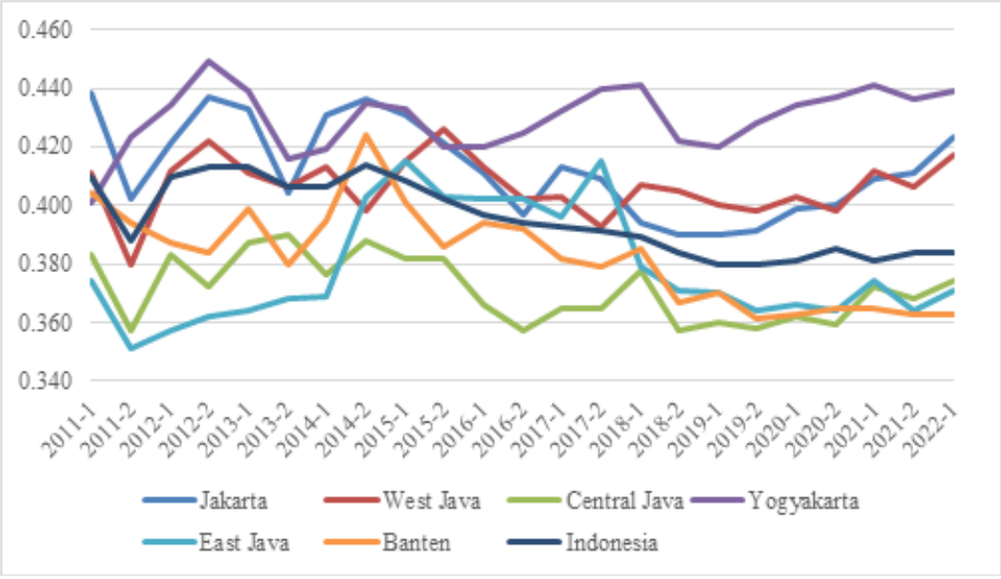

FIGURE 4. Gini Index at the provincial level in Java
Source: BPS (various editions)

in a sharp decline in commodity prices (Olivia et al. 2020). Based on a computable general equilibrium (CGE) exercise, Malahayati et al. (2021) projected that this global demand shock reduced approximately 2% of sectoral GDP for commercial plantation and wood compared to the business as usual (BAU) level. It was also revealed that although the predicted loss of trade in sectoral GDP in 2021 was only 10% compared to the BAU level, it was however important because the trade sector contributed the most to the national economy and employment. In other words, COVID-19 could have also caused reallocation of resources including labour. According to Malahayati et al. (2021), the agricultural sector could absorb the increase in unemployment caused by COVID-19 since this sector is characteristically labour-intensive in Indonesia.

In terms of the number of fatalities, the Spanish flu was more deadly than COVID-19 (van der Eng 2020, Ravando 2020). A comparison between the statistics of COVID-19 in Table 5 and the population loss during the Spanish flu shows that the human impact of the recent pandemic has been relatively small. In terms of the number of infections, almost 60% of the cases are in Jakarta and West Java. However, the spatial pattern of fatalities caused by COVID-19 seems partially to have followed the pattern of the pandemic in the late colonial Java. East Java and Central Java accounted for 62% and 41% to the total fatalities in Java and Indonesia, respectively. The last four columns in Table 4 also indicate that prior to COVID-19, East Java and Central Java were the two provinces with low Human Development Index and the high poverty rates confirmed that lagging regions tended to have higher fatalities. da Silva et al. (2022) also discovered the influence of poverty on COVID-19 cases across municipalities in Pernambuco, Brazil. Other factors may also explain these higher fatalities, such as the capacity of the health system to respond to the pandemic (Mahendradhata et al. 2021) and how people comply with health protocols in their daily activities (Riyadi & Larasati 2020). Surabaya and Kediri, for instance, are in the top 10 of the list of districts/cities in East Java with the highest number of fatalities.

The recent pandemic had exacerbated inequality in which the top income group became wealthier (Combs 2021), the poverty rate increased (Suryahadi et al. 2020), and inequality in urban areas also tended to increase (Brata et al. 2021a). A possible explanation behind these varying outcomes is the objective of some government policies to maintain economic growth during the COVID-19 crisis that inadvertently favor the rich such as the relaxation in luxury tax for the automobile industry (see Combs 2021). Further, although many sectors were highly affected by the COVID-19 crisis, certain activities closely related to the digital economy provided large benefits for the rich, which in turn contributed to widening of the income inequality.

The global scale of the COVID-19 pandemic has demonstrated the importance of anticipating the socio-economic impacts of similar events in the future. Experience in the late colonial Java shows that those with low per capita income, low food quality, and relatively weak general health conditions, are more vulnerable to pandemics such as COVID-19 (Bosma 2020). Although the pandemic can provide economic benefits including a distributive role as evident in this study or in Alfani (2022) and intuitively in Sayed and Peng (2021), this impact became possible since most of the population loss occurred among the poor. Improved equality after the pandemic was not straightforward in the form of an increase in the income of the poor, but due to most of the victims being poor residents with lower per capita incomes and the resultant shortage of labour eventually pushed up real wages.

Thus, focusing on the impact of a pandemic on income distribution alone, without sorting out the other causes for the increase in equality, can distort the overall picture of the impact. Since the characteristics of poverty in general make it more vulnerable to severe pandemic impact, mitigative efforts such as improving health infrastructures, providing better quality food, and providing adequate access to increase income,

TABLE 5. Statistics of COVID-19, Human Development Index (HDI), and Poverty Rate at the provincial level in Java

Province	COVID-19 infections & fatalities, 2022			HDI		Poverty Rate	
	Confirmed	Recovered	Dead	2018	2021	March 2018	Sept' 2021
Jakarta	1,406,981	1,381,320	15,505	80.47	81.11	3.57	4.67
East Java	600,394	567,894	31,748	70.77	72.14	10.98	10.59
West Java	1,171,620	1,142,353	15,936	71.3	72.45	7.45	7.97
Central Java	635,869	601,129	33,476	71.12	72.16	11.32	11.25
Banten	332,691	327,356	2,949	71.95	72.72	5.24	6.50
Yogyakarta	224,175	217,546	5,927	79.53	80.22	12.13	11.91
Indonesia	6,390,553	6,198,051	157,757	71.39	72.29	9.82	9.71

Source: https://covid19.go.id/peta-sebaran. (Accessed 10 September 2022), BPS (various editions)

especially for the poor, are crucial in safeguarding the economy against future pandemic in Indonesia or elsewhere in Asia.

The decline in the number of the productive age population and accompanied by weakening international trade during the pandemic (Gallardo-Albarrán & de Zwart 2021, de Zwart 2022), contributed to a decline in the demand for labour. This was the reason why the ultimate impact on wages and employment, as well as on equality, depends not only on the shortage of labour supply due to the pandemic, but also on the negative impact on labour demand caused by lower output during the pandemic. This fact implies that protecting the productive age group, especially those with low incomes, from the effects of a future pandemic may also mean the reduction in possible negative impact of the pandemic on the productive capacity of an economy.

This study nevertheless shows that the distributive role of the Covid-19 pandemic is, among other things, related to the decline in exports from plantations. de Zwart (2022) provided one possible explanation that most of the surplus in production of plantations in the late colonial Java only benefited the plantation owners and management, while most workers earned only relatively low incomes. Thus, the role of global trade in income distribution in this study once again demonstrates the importance of sorting out the distributive role of the pandemic in order to protect Indonesia and other economies, especially in Asia, in future occurrences.

CONCLUSIONS

This paper contributes to Indonesia's economic history from the perspective of spatial studies by way of studying the correlation between the population shock due to the Spanish flu and the income distribution across residencies in colonial Java. In addition, we discuss the implications of the historical lessons for post covid-19 Indonesia by also examining recent trends in income inequality in Java.

These results indicate that, contrary to the common belief, the Spanish flu improved the income distribution in the post pandemic years across residencies in Java. Adding the interaction variable between population loss and plantation land, improves the significance level of population loss thus confirming that the plantation variable moderated the distributive role of population loss. The coefficient of this interaction variable is positive confirming that the plantation land also represents the influence of the downturn of the global market to strengthen the distributive role of the pandemic. Additional estimations using alternative measures of inequality do not change the main findings. It is also found that an inequality trap exists in Java in modern Indonesia, although the spatial pattern did not follow the trend during late colonial Java. COVID-19 may have a permanent impact or at least a scarring impact on inequality over all provinces in Java.

Spanish flu as a historic pandemic provided some lessons learned that are important in facing current and future pandemics. Considering the similarities as well as differences between the Spanish flu and the current Covid-19 pandemic, further studies are also necessary to systematically elucidate other factors that are causal to the increase in inequality. In addition, protecting the productive group from the lethal impacts of future pandemics is also important, especially for those in the low income bracket.

REFERENCES

Akita, T. & Miyata, S. 2018 Spatial inequalities in Indonesia, 1996–2010: A hierarchical decomposition analysis. Social indicators research: an international and interdisciplinary. *Journal for Quality-of-Life Measurement* 138(3): 829-852.

Alfani, G. 2020 Pandemics and inequality: a historical overview. VoxEU, 15 October. https://voxeu.org/article/pandemics-and-inequality-historical-overview. (Accessed 1 November 2020).

Alfani, G. 2022 Epidemics, inequality, and poverty in preindustrial and early industrial times. *Journal of Economic Literature* 60(1): 3–40.

Asadullah, M.N. & Maliki, S.M.S. 2017 Bottling Indonesia's gini, the project syndicate, 01 Sep, 2017. https://www.project-syndicate.org/commentary/indonesia-income-inequality-by-m-niaz-asadullah-and-maliki-2017-09. (Accessed 6 September 2022).

Athukorala, P. & Athukorala, C. 2020 The great influenza pandemic of 1918-20: an interpretative survey in the time of covid-19, WIDER Working Paper, No. 2020/124, The United Nations University World Institute for development economics research (UNU-WIDER), Helsinki (Accessed 29 June 2022)

Bosma, U. 2020 Comparing Covid-19 and the Spanish Flu: Not so much the 'Great Leveler' but particularly hitting the poor. https://iisg.amsterdam/en/blog/comparing-covid-19-and-spanish-flu-not-so-much-great-leveler-particularly-hitting-poor-ulbe.

Brata, A.G., Rietveld, P., de Groot, H.L.F. & Zant, W. 2013 The Krakatau eruption in 1883: its implications for the spatial distribution of population in Java, *Economic History of Developing Regions* 28(2): 27-55.

Brata, A., Pramudya, E., Astuti, E., Rahayu, H. & Heron, H. 2021a. COVID-19 and socio-economic inequalities in Indonesia: a subnational-level analysis. eria discussion paper series no. 371, https://www.eria.org/uploads/media/discussion-papers/ERIA-Research-on-COVID-19/COVID-19-and-Socio-Economic-Inequalities-in-Indonesia_A-Subnational-level-Analysis.pdf. (Accessed 12 July 2022).

Brata, A., Pramudya, E., Astuti, E., Rahayu, H. & Heron, H. 2021b. The impacts of human development and environmental quality on the spatial distribution of the COVID-19 in Java, Indonesia. Paper presented at the Global Social Justice Conference 2021: "Bridging Theory and Practice to Empowering and Culminating

Social Justice towards COVID-19 Ramification", Bali 10 – 11 June 2021 (hybrid conference). (Unpublished paper)

Brata, A., Pramudya, E., Astuti, E., Rahayu, H. & Heron, H. 2022. Pandemic COVID-19 dan ketimpangan:

Beberapa temuan awal (COVID-19 pandemic and inequality: some early findings). A short note presented at diskusi dampak COVID-19 terhadap ketimpangan. Direktorat Kependudukan dan Jaminan Sosial, Kementerian PPN/ Bappenas, 1 September 2022. (Unpublished paper)

Chandra S. 2002. Race, inequality, and anti-chinese violence in the netherlands indies. *Explorations in Economic History* 39: 88–112.

Chandra S. 2013. Mortality from the influenza pandemic of 1918-19 in Indonesia. *Population Studies* 67(2): 185–193.

Chandra S. 2020. in https://www.ugm.ac.id/en/news/19487-1918-influenza-pandemic-lessons-learned-apply-to-today-s-covid-19-outbreak. (Accessed 6 June 2022).

Combs, S. 2021. Indonesia is a new COVID-19 epicenter. The peak has yet to come. National Geographic 27 July 2021. https://www.nationalgeographic.com/history/article/indonesia-is-new-covid-epicenter-but-the-peak-has-yet-to-come. (Accessed 12 July 2022)

da Silva CFA, Silva MC, Dos Santos AM, Rudke AP, do Bonfim CV, Portis GT, de Almeida Junior PM, Coutinho MBS. 2022 Spatial analysis of socio-economic factors and their relationship with the cases of COVID-19 in Pernambuco, Brazil. *Trop Med Int Health* 27(4): 397-407.

Deutsche Welle (DW). 2020. Pakar: attack rate provinsi dki Jakarta dan Kota Surabaya tertinggi di Indonesia (expert: attact rate in dki Jakarta and Surabaya is the highest in Indonesia). https://www.dw.com/id/pakar-attack-rate-provinsi-dki-jakarta-dan-kota-surabaya-tertinggi-di-indonesia/a-54007470. (Accessed 20 May 2021).

van Dijk, K. 2007 The Netherlands Indies and the Great War 1914-1918. Leiden: KITLV Press

van der Eng, P. 2020. Pelajaran dari pandemi flu Spanyol 1918-19 di Indonesia untuk menghadapi COVID-19 (Lesson from the Spanish flu 1918-19 in Indonesia to face COVID-19). https://theconversation.com/pelajaran-dari-pandemi-flu-spanyol-1918-19-di-indonesia-untuk-menghadapi-covid-19-136843. (Accessed 6 June 2022).

Ferreira, F., Sterck, O., Mahler, D. & Decerf. B. 2021. Death and destitution: the global distribution of welfare losses from the covid-19 pandemic. LSE Public Policy Review 1(4): 2.

Gallardo-Albarrán, D. & de Zwart, P. 2021. A bitter epidemic: The impact of the 1918 influenza on sugar production in Java. *Economics & Human Biology* 42: 101011

Galletta, S. & Giommoni, T. 2022. The effect of the 1918 influenza pandemic on income inequality: evidence from Italy. *The Review of Economics and Statistics* 104 (1): 187–203.

Gibson, J. & Olivia, S. 2020. Direct and indirect effects of covid-19 on life expectancy and poverty in Indonesia. *Bulletin of Indonesian Economic Studies* 56:3: 325-344.

Hill, H. 2021. What's happened to poverty and inequality in indonesia over half a century? *Asian Development Review* 38(1): 68–97.

Johnson N.P. & Mueller J. 2002. Updating the accounts: global mortality of the 1918-1920 "Spanish" influenza pandemic. *Bulletin of the History of Medicine* 76(1): 105-15.

Katadata. 2021. 45% Kematian Covid-19 Indonesia berusia di atas 60 tahun (45% of deads due to covid-19 in Indonesia are 60-years-olds). https://databoks.katadata.co.id/datapublish/2021/01/21/45-kematian-covid-19-indonesia-berusia-di-atas-60-tahun. (Accessed May 20, 2022).

Kawamura, K. 2019. Politics of Inequality in Indonesia: Does Democracy Matter? in K. Tsunekawa & Y. Todo (eds.), Emerging States at Crossroads. Singapore: Springer Nature Singapore pp. 231–53

Knight, G.R. 2000. The sugar industry of colonial Java and its global trajectory. *Southeast Asia Research* 8(3): 213–238.

Lam, D. 1986. The dynamics of population growth, differential fertility, and inequality. The American Economic Review 76(5): 1103–1116. http://www.jstor.org/stable/1816471

Lam,D. 1997. Handbook of Population and Family Economics Volume 1 Volume 1 || Chapter 18 Demographic variables and income inequality. 1015–1059.

Leigh, A. & van der Eng, P. 2010. Top Incomes in Indonesia, 1920–2004, in A.B. Atkinson & T. Piketty (eds.), Top Incomes: A Global Perspective. Oxford: Oxford University Press pp.171–219

Liu, K., He, M., Zhuang, Z., He, D. & Li., H. 2020 Unexpected positive correlation between human development index and risk of infections and deaths of COVID-19 in Italy. *One Health* 10: 100174–100174.

Mahendradhata, Y, Andayani, N.L.P.E, Hasri, E.T, Arifi, M.D, Siahaan, R.G.M, Solikha, D.A. & Ali, P.B 2021. The Capacity of the Indonesian Healthcare System to Respond to COVID-19. Front. Public Health 9:649819.

Malahayati, M., Masui, T. & Anggraeni, L. 2021. An assessment of the short-term impact of COVID-19 on economics and the environment: A case study of Indonesia. *EconomiA* 22(3): 291-313.

Olivia, S., Gibson, J. & Nasrudin, R. 2020. Indonesia in the time of Covid19. *Bulletin of Indonesian Economic Studies* 56(2): 143–74.

Ram, R. 1984 Population increase, economic growth, educational inequality, and income distribution: Some recent evidence. Journal of Development Economics 14(3): 419-428.

Ravando 2020. Perang Melawan Influenze: Pandemi Flu Spanyol di Indonesia Masa Kolonial 1918-1919. Jakarta: KPG

Ridhwan, M.M. 2021 Spatial wage differentials and agglomeration externalities: Evidence from Indonesian microdata. *Economic Analysis and Policy* 71: 573-591.

Riyadi & Larasaty, P. 2021. Faktor Yang Berpengaruh Terhadap Kepatuhan Masyarakat Pada Protokol Kesehatan Dalam Mencegah Penyebaran Covid-19 (Factors affecting public compliance with health protocols in preventing the spread of Covid-19). Seminar Nasional Official Statistics 2020(1): 45–54.

Roser, M. & Cuaresma, J.C. 2016. Why is income inequality increasing in the developed world? *Review of Income and Wealth* 62(1): 1–27.

Roziqin, A., Mas'udi, S.Y.F. & Sihidi, I.T. 2021 An analysis of Indonesian government policies against COVID-19. *Public Administration and Policy: An Asia-Pacific Journal* 24(1): 92-107.

Sari, R.D.P. & Oktora, S.I. 2021. Determinan produktivitas tenaga kerja industri manufaktur besar dan sedang di Pulau Jawa (Determinants of productivity large and medium manufacturing industries in Java). *Jurnal Ekonomi dan Pembangunan Indonesia* 21(2): 185–203.

Souza, C., Machado, M. & do Carmo, R. 2020. Human development, social vulnerability, and COVID-19 in Brazil: A study of the social determinants of health. *Infectious Diseases of Poverty* 9: 1-10.

Sayed A. & Peng B. (2021) Pandemics and income inequality: a historical review. SN Business & Econonomic 1: 54.

Suryahadi, A., Izzati, R.A. & Suryadarma, D. 2020. Estimating the impact of covid-19 on poverty in Indonesia. *Bulletin of Indonesian Economic Studies* 56(2): 175–92.

Thaariq, R.T., Wahyu, M.F.R., Ningrum, D.W. & C.N. Aidha, C.N. 2020. Multidimensional Poverty and the Risk of COVID-19 in Indonesia, PRAKARSA Working Papers, No. 01. Jakarta: PRAKARSA. https://repository.theprakarsa.org/media/publications/310304-prakarsa-working-paper-no-01-kemiskinan-c64b2902.pdf. (Accessed 3 March 2021)

Taubenberger, J.K. & Morens, D.M. 2020. The 1918 Influenza Pandemic and Its Legacy. Cold Spring Harb Perspect Med. 10(10): a038695.

de Zwart P. 2022 Inequality in late colonial Indonesia: new evidence on regional differences. *Cliometrica* 16: 175–211.

van Zanden, J.L. 2012. Economic growth in Java 1815–1939: the reconstruction of the historical national accounts of a colonial economy. Maddison Project working paper, WP-3. https://www.cgeh.nl/sites/default/files/jvz-reconstruction.pdf. (Accessed 30 September 2022).

Wibowo, P. et al. 2009. Yang Terlupakan: Pandemi 1918 Influenza di Hindia Belanda (The Forgotten: The 1918 Influenza Pandemic in the Dutch East Indies). Depok: Dep Sejarah Fak IPB UI-Unicef-Komnas FBPI. https://covid19.go.id/storage/app/media/Materi%20Edukasi/2020/Juli/Yang%20Terlupakan-3.pdf. (Accessed 6 June 2022).

Wicaksono, E., Amir, H. & Nugroho, A. 2017. The Sources of Income Inequality in Indonesia: A Regression-Based Inequality Decomposition. ADBI Working Papers, No. 667. Tokyo: Asian Development Bank Institute. https://www.adb.org/publications/sources-income-inequality-indonesia (Accessed 3 March 2021)

World Bank. 2015. Indonesia's Rising Divides. Jakarta. https://openknowledge.worldbank.org/handle/10986/24765 (Accessed 3 March 2021)

Aloysius Gunadi Brata*
Faculty of Business and Economics
Atma Jaya Yogyakarta University
Jalan Babarsari No.43, Sleman,
Yogyakarta, 55281, INDONESIA.
Email: gunadi.brata@uajy.ac.id

Sigit Triandaru
Faculty of Business and Economics
Atma Jaya Yogyakarta University
Jalan Babarsari No.43, Sleman,
Yogyakarta, 55281, INDONESIA.
Email: sigit.triandaru@uajy.ac.id

Yenny Patnasari
Faculty of Business and Economics
Atma Jaya Yogyakarta University
Jalan Babarsari No.43, Sleman,
Yogyakarta, 55281, INDONESIA.
Email: yenny.patnasari@uajy.ac.id

Rini Setyastuti
Faculty of Business and Economics
Atma Jaya Yogyakarta University
Jalan Babarsari No.43, Sleman,
Yogyakarta, 55281, INDONESIA.
Email: rini.setyastuti@uajy.ac.id

Agustinus Edi Sutarta
Faculty of Business and Economics
Atma Jaya Yogyakarta University
Jalan Babarsari No.43, Sleman,
Yogyakarta, 55281, INDONESIA.
Email: edi.sutarta@uajy.ac.id

Andreas Sukamto
Faculty of Business and Economics
Atma Jaya Yogyakarta University
Jalan Babarsari No.43, Sleman,
Yogyakarta, 55281, INDONESIA.
Email: andreas.sukamto@uajy.ac.id

*Corresponding author

APPENDIX

Summary statistics of inequality indices

Inequality indices	Note	1920	1924	1928
		mean (sd)	mean (sd)	mean (sd)
Gini	the most common measure of inequality, which ranges from 0, implying perfect equality, to 100, perfect inequality	38.68	39.18	39.94
		(12.77)	(15.00)	(15.17)
Theil	more sensitive to income differences at the top end of the distribution, compared with the Gini	25.86	28.45	30.17
		(17.18)	(18.67)	(18.35)
Inequality Extraction Rate	considering variations in average incomes and prices across regions	82.00	62.21	57.93
		(18.76)	(16.50)	(17.11)
Top Income Rate	capturing only the top and the bottom	40.07	48.67	51.59
		(24.43)	(31.58)	(33.47)
Gini 90	average income of the “subsistence” households is f. 90 per annum	42.57	42.76	43.56
		(14.03)	(15.71)	(15.86)
Gini 119	earning below f. 120 (exempted from the income tax)	38.09	38.64	39.40
		(12.60)	(14.91)	(15.08)
Gini Change		38.09	40.56	39.94
		(12.60)	(15.26)	(15.17)
Taxpayer Gini	based on income tax data	61.14	60.36	61.78
		(8.55)	(9.00)	(8.45)