Tracing the Impact of Famine Through Child Mortality: A Study of 1940s Indonesia

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Abstract

This thesis examines child mortality patterns in Indonesia during the 1940s as an indicator of famine incidence, analysing both temporal trends and regional variations during the Japanese occupation (1942-1945) and the Indonesian War of Independence (1945-1949). Using data from the 1980 Integrated Public Use Microdata Series (IPUMS), the study analyses child mortality rates across different birth cohorts of women born between 1895 and 1944, employing birth cohort analysis, Geographic Information System (GIS) mapping, and logistic regression to identify patterns of famine impact across Indonesia's diverse regions.

The analysis reveals complex regional patterns in child mortality across Indonesia during the 1940s. The regression analysis shows increased child mortality from 1942-1944 and 1946-1947. Previous research concentrated on Java; however, this study finds that many outer island regions, particularly West Sumatra, Bengkulu, and West Nusa Tenggara, exhibited higher absolute child mortality rates. When examining changes from 1935 baseline levels, even Java's regions experienced substantial increases in relative mortality risk during peak periods. The analysis is constrained by methodological challenges, including potential recall bias and data heaping in the 1980 census data, particularly evident in the unexpected drop in reported mortality for 1945.

The research contributes to the existing literature by expanding the understanding of famine impact beyond Java, which is traditionally the focus of most studies. It demonstrates the utility of child mortality as an indicator of famine severity while highlighting the methodological challenges of using retrospective data to study historical demographic patterns. These findings enhance our understanding of how war and famine affected different regions of Indonesia during this critical period, suggesting the need for a more detailed, geographically comprehensive approach to studying historical famines in Indonesia.

Keywords: Child mortality, birth cohorts, Famine, Indonesia, Japanese occupation, War of Independence, Historical demography

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CHAPTER I

Introduction

1.1 Problem statement

During the Second World War (WWII), Japan occupied the Netherlands East Indies (now Indonesia) from March 1942 until August 1945 (Mark, 2019). This three-and-a-half-year occupation began with hope and determination for Indonesians, as the Japanese "freed" them from Dutch colonial rule, but ultimately led to significant suffering and displacement (Post et al., 2010). Japanese occupation caused major disruptions to the region's food production and distribution systems (Huff, 2020b; Van Der Eng, 2000a, 2008). These conditions caused widespread deprivation, social upheavals, and population shifts, significantly affecting fertility and mortality rates (Nitisastro, 1970). According to one United Nations (UN) report, around 4 million people died in Indonesia as a result of the war and famine conditions during the Japanese occupation (Benda, 1956).

However, the end of WWII, one of which was marked by Japan's surrender after the atomic bombings of Hiroshima and Nagasaki, did not bring an end to the suffering in Indonesia. The power vacuum following the bombings of Hiroshima and Nagasaki was used by Sukarno and Muhammad Hatta to declare the country's independence on 17 August 1945 on behalf of the Indonesian people. This declaration did not stop the Dutch from re-establishing its power in Indonesia. When the British army came to Indonesia on 29 September 1945, followed by the return of Dutch troops, the four-year-long war of independence began (Nitisastro, 1970). This conflict, known today as the Indonesian National Revolution or the Indonesian War of Independence, lasted from 1945 to 1949 (Nitisastro, 1970). The war directly impacted economic conditions, leading to widespread scarcities, particularly in food, clothing, and fuel (Vickers, 2013).

Most famine research in Indonesia during the 1940s focussed on the causes of famine, particularly the decline of food supply, drought that resulted in a reduction of agricultural yields, and changes of power (Huff, 2019, 2020a, 2020b; Van Der Eng, 2000b, 2008, 2010). A few scholars have examined the demographic consequences of famine and have reported an estimation of net loss population, including excess deaths and lost births, specifically in

Java, during the 1942–1945 (De Vries, 1946; Nitisastro, 1970; Van Der Eng, 2024). Unfortunately, the precise demographic repercussions remain unclear because of missing vital statistics on births, infant mortality, and deaths (van der Eng, 2002; van der Eng, 2024).

Nevertheless, several scholars have provided estimates of the net population loss as a result of the war and famine. First, an agricultural economist, Egbert de Vries (1946), estimated a net population loss of 2.45 million individuals in Java during 1943–1945 due to heightened mortality and decreased birth rates. As van der Eng also argued, this estimate may be inaccurate (Van Der Eng, 2024). A recent working paper by van der Eng (2024) discusses mortality rates during the Japanese occupation of Java between 1942 and 1945, estimating 1.9 million excess deaths, with 0.7 and 1.2 million excess deaths in 1944 and 1945, respectively. The estimate of excess mortality mirrors that of De Vries (1946). However, a distinction arises because of the latter's corrections on birth and death rates as well as the inclusion of missing births (Van Der Eng, 2024). Van der Eng (2024) estimated a total population loss of 3.4 million people in Java, which included approximately 1.5 million lost births during this period, associated with malnutrition among women of childbearing age and separation of couples, among others, due to Japanese forced labour campaigns (Van Der Eng, 2024). However, Van der Eng (2024) does not provide detailed estimates of birth losses or excess mortality for each specific region in Java. Instead, he offers only general figures. Furthermore, he does not examine the impact of the famine on infants and children, who are the most vulnerable population (Van Der Eng, 2024).

While there are important studies on food distribution and the importance of rice during the revolutionary years (Cribb, 2015; Pham, 2019; Van Der Eng, 2008; Vu, 2003; Zara, 2021), there is limited knowledge about the demographic impact of this war and subsequent food shortages. Specifically, there is only one research that estimated the net loss of population of 2,526,000 people in Java from 1946 to 1949 (van der Eng, 2024), and none has pointed the presence of famine during this era.

Despite the net loss population estimations in Indonesia during the 1940s, studies on infant and child mortality rates during the famine period remain absent, primarily due to the lack of systematic demographic data collection during the wartime occupation and the immediate post-war period. Concurrently, other literatures have reported excess mortality

of infants and children during famines (de Waal, 1989; Razzaque et al., 1990; Scott et al., 1995; Stein et al., 1975). In times of famine, infants are often most affected, where infants have the highest mortality rate and highest proportional mortality increase. Therefore, infant mortality is the most sensitive indicator to studying famine (de Zwarte et al., 2023; Kiros & Hogan, 2001). The vulnerability of infants during famines has also been identified in other countries, making it a relevant parameter for famine research in Indonesia.

Another significant gap in the research on the 1940s famine in Indonesia is the limited focus on regions outside Java. Most previous studies have concentrated on Java, leaving the question of whether other regions, such as Sumatra, Sulawesi, or eastern Indonesia, were similarly affected by famine largely unexplored (Huff, 2020b; Van Der Eng, 2002, 2008, 2024). This research addresses this gap by examining regional variations in famine impact across Indonesia, focusing on areas outside Java. Doing so provides a more comprehensive understanding of how different regions were affected by the crisis, considering factors such as food production, distribution, and political instability, which may have contributed to varying experiences during this critical period in Indonesian history.

The primary objective of this study is to examine child mortality patterns in Indonesia during the 1940s as an indicator of famine. The research will utilize data from the 1980 Integrated Public Use Microdata Series (IPUMS), which contains detailed demographic, economic, and household information. IPUMS provides harmonized microdata from various censuses and surveys, enabling longitudinal and comparative analyses (Sobek, 2016; Steven Ruggles et al., 2024a). This study will leverage the 1980 IPUMS dataset to reconstruct birth cohorts and estimate child mortality rates during the 1940s in Indonesia. Using backward projection techniques, the research will trace demographic trends from the data from the 1980s to the 1940s.

A fundamental assumption guiding this research is that child deaths increase during famine. The study aims to identify potential child mortality shocks during the 1940s wartime era in Indonesia that could suggest the presence of famine conditions. The analysis encompasses mortality rates of children from different birth cohorts of women who gave birth across various regions of the Indonesian archipelago during this period. Despite the inherent limitations of backward projection methodologies, particularly survival bias,

where our data only captures information from women who survived until 1980, our detailed estimations of child mortality patterns across time and geography contribute new perspectives on potential famine impacts during the 1940s in Indonesia. These findings, considered within the constraints of retrospective analysis, may inform understanding of famine effects in other regions and the timeframes in which they occur.

1.2 Research questions

The central question guiding this research is: How do child mortality patterns in Indonesia provide insights into the incidence and regional variation of famine impact during the 1940s?

This question will be answered by addressing the following questions:

1. How did child mortality rates vary across birth cohorts of women (born between 1895 and 1944) in Indonesia during the 1940s wartime period?
2. How did child mortality vary across different regions of Indonesia in the 1940s?
3. To what extent can the IPUMS data from 1980 provide reliable insights into historical child mortality rates in Indonesia during the 1940s, particularly as an indicator of famine impact?

1.3 Research Objectives:

The objectives of this thesis are three-fold. Firstly, this thesis provides detailed descriptions of the incidence and regional variation of famine impact throughout Indonesia based on birth cohorts, specifically from 1894-1944. Secondly, the thesis showcases the role of the IPUMS data from 1980 in giving insights into historical child mortality rates in Indonesia during the 1940s. These descriptions may help identify where and when other shocks may have taken place during this period. Scholars can utilise these insights for more in-depth research using other data sources and/or approaches. Lastly, the research enriches the scientific evidence of child mortality patterns as indicators of famine.

1.4 Structure of The Thesis:

This thesis is organized into six chapters. Chapter II establishes the theoretical framework of famine, provides historical context, reviews current research, and presents the study's hypotheses. Chapter III outlines the methodology, detailing the IPUMS data, sample population, variable selection, and analytical models employed. Chapter IV presents the research results, including regional variations in child mortality rates based on birth cohorts, estimates of last child death probability across time and regions, and verification of research hypotheses. Chapter V discusses the findings of relevant studies, examines their implications, and addresses the limitations of the research. Finally, Chapter VI summarizes the key findings and offers recommendations for future famine-related research in Indonesia.

CHAPTER II

Review of Literature and Theoretical Framework

This chapter presents an extensive review of the literature and theoretical framework crucial for understanding the intricate relationships between historical events, demographic trends, and famine theories that form the foundation of this study. The chapter begins by exploring the historical context of Indonesia in the 1940s, a period characterized by significant upheaval, including Japanese occupation (1942-1945), the struggle for independence (1945-1949), and widespread food shortages. It then examines existing research on demographic trends and famine impacts during this era, particularly on Java and the other islands of Indonesia, often referred to as the outer islands. The review highlights current knowledge gaps, especially concerning child mortality as an indicator of famine conditions. Subsequently, the chapter investigates theoretical frameworks for understanding famine, its causes, and its demographic impacts, with specific attention to the role of child mortality as a sensitive measure of famine severity. This comprehensive background establishes the context for the study's methodology. It provides the necessary

framework for interpreting the research findings on child mortality patterns across different regions of Indonesia during the 1940s.

2.1 Historical Context and Literature Review

2.1.1 Food Supply in Indonesia prior to the war

During the 1920s, the total food supply averaged around 1,970-2,017 kcal/day, with rice supply specifically contributed about 826-838 kcal/day, representing approximately 42% of total caloric intake (Van Der Eng, 2000a). According to van der Eng (2008), before 1930, approximately 10% of Indonesia's rice supply was imported to meet the needs of urban populations and labourers working on plantations and in mines across the country. This imported rice was distributed throughout Indonesia, with large portions going to Java and other regions to ensure that essential sectors and urban centres had adequate food supplies (Van Der Eng, 2008). This reliance on imported rice highlights the critical role that international trade played in maintaining food security in Indonesia during this period, underscoring the interconnectedness of global food systems even in the early 20th century.

During the early 1930s, Indonesia's per capita food supply slightly declined compared to the levels seen in the 1920s (van der Eng, 2000). Specifically, the total food supply averaged 1,920 kcal/day, as rice supply specifically contributed 795 kcal/day (Van Der Eng, 2000a). The global economic downturn, particularly following the Great Depression, reduced the demand for Indonesian commodities, leading to a significant price drop (Van Der Eng, 2000a, 2008). Rice, Indonesia's staple food, saw a sharper price decline than other commodities, creating difficulties for local producers struggling to compete with imported rice. Farmers in Java faced increased competition from rice producers in Burma, Thailand, and Indochina, which further contributed to the drop in rice prices (Van Der Eng, 2000a, 2008). In response, the colonial government took steps to stabilize the situation. In March 1933, the Rice Import Ordinance (*Rijstinvoerordonnantie*) was introduced to restrict imports and support local production (Van Der Eng, 2008). In July 1933, the government subsidized inter-island rice shipments to further assist domestic producers. These interventions succeeded in maintaining local rice production and reducing the country's

import dependence, though domestic rice prices remained higher than international prices (Van Der Eng, 2000a, 2008). This shows that Indonesia's agricultural sector in the early 1930s was highly vulnerable to global economic fluctuations, requiring colonial government intervention to stabilize local production and reduce import dependence.

In the mid-1930s, Indonesia faced increasing pressure to boost food production, particularly on Java, where limited land for agricultural expansion strained food supplies. To address this, the colonial government introduced policies to increase rice yields (Van Der Eng, 2008). Starting in 1934, as the economy began to recover, the government invested in irrigation infrastructure and introduced superior rice varieties to improve agricultural productivity (Van Der Eng, 2008, 2010). In 1935, despite a severe El Niño-induced drought, the government continued its efforts, expanding irrigation systems and promoting agricultural extension services (Van Der Eng, 2008, 2010). This expansion led to an increase around irrigated land in Java, which grew from 0.8 million hectares in 1928 to 1.2 million hectares by 1938, followed by an enhancement in the cropping ratio from 125% to 145%, indicating that by 1938, 45% of the land produced two crops annually (Van Der Eng, 2008).

By 1936, these initiatives had significantly boosted rice production, and Java became self-sufficient in rice. The same year, the government devalued the currency to align domestic rice prices with international markets, encouraging farmers to increase production (Van Der Eng, 2000a, 2010). As a result, Indonesia’s rice imports fell from an average of 596,000 tons in 1926-1930 to just 147,000 tons by 1937, with Java’s imports dropping from 225,000 tons to only 9,000 tons (Van Der Eng, 2008). In 1938, to further diversify the food supply and support cassava production, the government established the Cassava Board to improve the quality of cassava products. These combined efforts helped secure Indonesia’s food supply as the population grew (Van Der Eng, 2008). This shows that the colonial government's strategic investments in irrigation, improved rice varieties, and agricultural policies in the mid-1930s significantly increased rice production, making Java self-sufficient and reducing Indonesia's reliance on imports while ensuring food security amid population growth.

As geopolitical tensions escalated and World War II approached, the Dutch colonial government in Indonesia shifted its focus from simply protecting rice producers to securing

the nation's domestic food supply in anticipation of the impending war. In 1939, the administration established the *Voedingsmiddelenfonds* (VMF/Foodstuffs Fund) to finance the purchase, storage, and distribution of essential food supplies, with a particular focus on Java and other strategic regions (Van der Eng, 2008; Sato, 2006). The fund aimed to stabilize rice prices and build emergency buffer stocks to ensure food security.

Java was designated the primary rice supplier to the deficit areas in the Outer Islands in response to the disruption of international rice imports caused by the war (Sato, 2006). Although Java became a net rice exporter, regions like Sumatra's East Coast, West Sumatra, Riau, Jambi, Bangka, Belitung, West Kalimantan, and parts of Sulawesi, which specialized in export crops such as rubber, copra, and tin, continued to rely on imported rice. Although several regions beyond Java, such as Lampung, segments of Aceh, South Sulawesi, and the islands of Sumbawa, Bali, and Lombok, generated surplus rice for export, many parts of Sumatra, Riau, and Kalimantan continued to rely on rice imports to support their populations and plantation laborers (Sato, 2006; Van Der Eng, 2008).

On the other hand, According to Booth (2012), Indonesia, particularly Java, faced severe malnutrition in 1939. Average calorie consumption per capita in Java was well below 2000 per day for most population groups, with protein consumption under 50 grams daily. A survey in the Bojonegoro region of Java found many families receiving well below the minimum of 1,500 calories per day, leading to hunger edema and increased susceptibility to diseases like malaria. Rice availability per capita in Java was deficient compared to other Southeast Asian parts. The growing dependence on cassava as a source of calories was also causing dietary problems in other parts of Java. Despite some improvements in food supply earlier in the century, malnutrition remained a severe issue for poorer populations in Indonesia by 1939.

In 1940, the colonial government further centralized control over rice distribution by establishing the Rice Sales Centre (*Rijst Verkoop Centrale*). This initiative mandated that rice mills sell exclusively to the Centre, enabling the authorities to regulate the rice market and prevent price inflation during the uncertain war period (Sato, 2006; Van Der Eng, 2008). That same year, rice import into deficit regions was substantial: Sumatra imported 128,000 tons, Riau, Bangka, and Belitung imported 71,000 tons, and Kalimantan imported 63,000

tons (Van Der Eng, 2008). By 1941, these policies had significantly strengthened Indonesia's food security. For the first time since the 1880s, the country achieved rice self-sufficiency. The VMF had amassed a stockpile of 230,000 tons of rice by December 1941, providing a crucial buffer against potential shortages (Van Der Eng, 2008). These developments show how the Dutch colonial government effectively adapted its food policies to secure Indonesia's domestic supply in response to the impending global conflict. They achieved rice self-sufficiency for the first time since the 1880s by centralizing rice production and managing inter-island dependencies.

The historical context of Indonesia's food supply and agricultural policies in the 1930s provides a crucial background for understanding child mortality patterns during the 1940s. Despite the colonial government's efforts to boost rice production, centralize distribution, and achieve rice self-sufficiency, severe malnutrition remained widespread, particularly in Java, where many people could not meet basic nutritional needs by 1939. This pre-war vulnerability, exacerbated by regional reliance on imported rice and growing dependence on less nutritious crops like cassava, set the stage for the uneven impact of food shortages during World War II. These historical factors are essential for analysing how economic and agricultural policies influenced the incidence and regional variation of famine's potentially impact on child mortality in Indonesia during the 1940s.

2.1.2 Pre-war Indonesian Demography

Understanding pre-war Indonesian demographic patterns is essential for contextualizing the changes in births, deaths, and child mortality that occurred during and after the Japanese occupation. This section examines key demographic indicators from 1930 to 1942, providing a baseline for comparison with later periods. Nitisastro (1970) employed a systematic approach to estimate demographic trends in Java from 1930 to 1960 by using the concept of a stable population as an approximation. His analysis was based on critical assumptions, including constant fertility and mortality rates and minimal migration impact on population structure. This method allowed Nitisastro to assess Java's population growth and structure over the thirty years. He could estimate past population trends by applying the reverse survival technique to the 1961 census data. This involved calculating

the number of people alive in earlier periods based on known mortality rates, enabling him to trace demographic changes over time. Through these projections, Nitisastro provided insights into the population dynamics of Java, highlighting the effects of fertility, mortality, and overall population stability during that era (Nitisastro, 1970).

Table 2.1 Estimated Population of Java by Age, 1930-1940 (by thousands)

Age group	1930	1935	1940
0-4	6,584	7,218	7,941
5-9	5,316	5,925	6,402
10-14	4,777	5,007	5,711
15-19	4,302	4,589	4,830
20-24	3,816	4,073	4,366
25-29	3,340	3,569	3,833
30-34	2,896	3,100	3,338
35-39	2,483	2,664	2,878
40-44	2,098	2,256	2,447
45-49	1,738	1,873	2,040
50-54	1,401	1,513	1,655
55-59	1,088	1,178	1,293
60-64	800	868	958
65-69	541	589	653
70-74	323	351	393
75-79	158	173	195
80-84	57	64	73
85+	-	12	18
Total	41,718	45,022	49,024

Source: Nitisastro (1970)

Table 2.1 illustrates the estimated population of Java by age group between 1930 and 1940, showing a consistent increase across all age ranges (Nitisastro, 1970). The most significant growth occurred in the youngest cohorts, particularly in the 0-4 and 5-9 age groups, reflecting a high birth rate during this decade. Java's total population grew by approximately 7.3 million over this period, with the largest increase seen in the 0-4 age group, which expanded by 1.36 million. The adult and elderly populations also grew steadily, with improvements in survival rates and a modest rise in the 65+ age group, indicating better healthcare or living conditions. These demographic trends highlight the growing population pressures in Java, which had important implications for food supply and resource management, particularly as the region faced the uncertainties of World War II.

Alternatively, Pierre van der Eng's (2002) methodology for estimating demographic trends from 1930-1942 differs from Nitisastro's 1970 approach using a more detailed, regional focus. While Nitisastro worked with broader national estimates, van der Eng reconstructed population data at the residency level for Java and the regional/provincial level for the Outer Islands, allowing for a more precise analysis of regional differences. He used the 1930 census as a baseline and interpolated between the 1930 and 1961 census data, adjusting for key events during the intervening years. For Java, he estimated growth rates for individual residencies based on reported birth and death data, assuming an overall annual growth rate of 1.5% from 1931 to 1942. For the Outer Islands, he worked backward from 1961 data to align growth rates with earlier estimates, ensuring that 1930-1940 rates were consistent with trends from the 1950s. In contrast, Nitisastro's method used broader assumptions about birth and mortality rates for national estimates. Van der Eng's approach offers a more detailed view of regional population dynamics, though it still relies on some assumptions due to limited data (Van Der Eng, 2002).

During the 1930s and up to 1942, Indonesia experienced steady population growth, with overall annual rates estimated at 1.43% for Java and 1.83% for the Outer Islands (Van Der Eng, 2002). This period saw significant regional variations in growth rates, ranging from 2.5% in Jakarta to just 0.5% in Madura. Inter-regional migration was a key feature, with substantial movement from Java to the Outer Islands, particularly to areas like Lampung. The early 1930s saw a temporary reversal of this trend due to the economic crisis, with Javanese workers returning from Outer Island plantations. By 1937, outward migration from Java resumed, reaching a peak of 75,000 people that year. International migration had a minor impact, with a small net inflow. The 1930 census provided a reliable baseline for population estimates, but the planned 1940 census was postponed due to World War II. By 1940, Java's population had grown from about 41.7 million in 1930 to an estimated 47.5 million, while the Outer Islands increased from about 19.3 million to an estimated 23.1 million. These demographic trends reflected Indonesia's evolving economic and social landscape in the final decade of Dutch colonial rule.

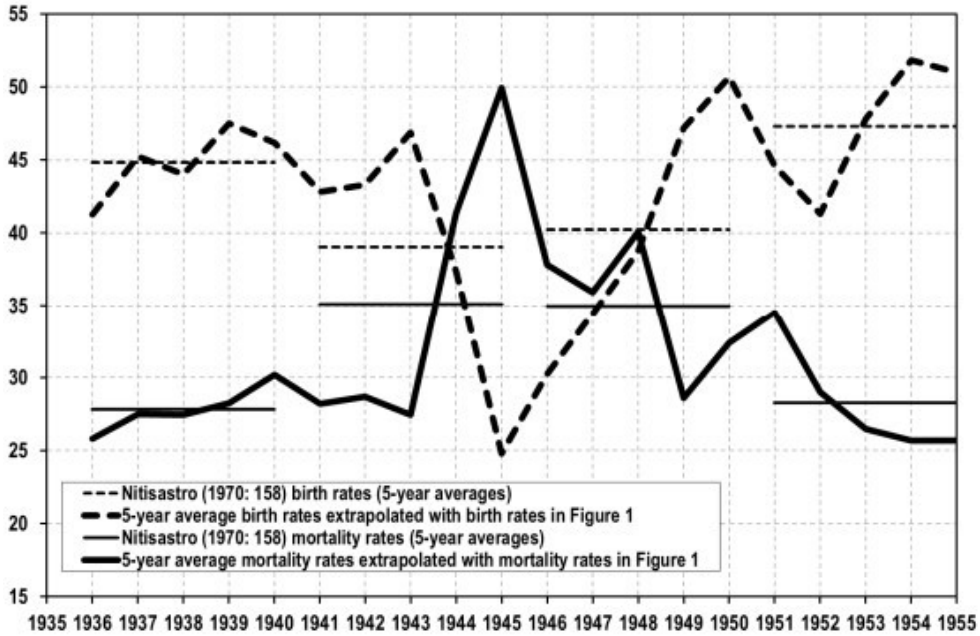
The demographic trends established in Java and the Outer Islands during the 1930s and early 1940s are essential for understanding the socio-economic context leading up to World

War II. By examining vital rates and regional variations in population growth, we can gain insights into how these factors may have influenced child mortality patterns before the onset of famine during the war. The steady population growth and fluctuations in birth and death rates reflect a period of relative stability that could mask underlying vulnerabilities. This stability is particularly relevant for analyzing how demographic pressures may have set the stage for increased child mortality during subsequent crises, providing a foundational understanding of the potential impact of food scarcity in the years following the 1940s.

Estimates of vital rates for Java in the 1930s, drawn from registration systems (mainly in urban areas) suggest that crude birth rates exceeded 40 per 1,000, with life expectancy between 30 and 35 years (Nitisastro, 1970). According to Van der Eng 2002, Java's birth and death rates during 1930-1942 remained relatively stable, with the birth rate ranging from 2.5% to 3% annually. It dipped slightly in the mid-1930s, rising to 3% by the decade's end. The death rate slightly declined, from 1.8% in the early 1930s to 1.7% mid-decade, before increasing to around 1.9-2% by the early 1940s. This resulted in a yearly net population growth rate of roughly 1%. However, based on reported births and deaths, these figures may understate the reality due to underreporting, particularly in remote areas, and primarily reflect trends in Java rather than the entire Indonesian archipelago (Van Der Eng, 2002).

This demographic stability in Java during the late 1930s and early 1940s provides a baseline for understanding the subsequent changes in population dynamics. Recent research by Van der Eng (2024) offers updated insights into these trends, shedding new light on the region's demographic history.

Figure 2.1 Average Birth and Mortality Rates in Java Corrected for Under-Recording, 1936-1955 (‰)



Sources: Van der Eng (2024)

According to Van der Eng's latest working paper (2024), the estimate birth and death rates for Java in the 1930s and early 1940s were reconstructed using disparate sources of vital statistics from various regions in Java. His methodology involved collecting and analyzing birth and death rate data from newspaper reports, official documents, and other historical sources to estimate average rates for Java during this period (Van Der Eng, 2024). Based on figure 2.1, the trend from 1935 to 1942 shows relatively stable birth and mortality rates in Java, with some minor fluctuations. The birth rate (dotted line) remains relatively constant, around 45-50 per thousand, while the mortality rate (solid line) stays steady between 25-30 per thousand. There is a slight downward trend in mortality rates from about 28 per thousand in 1935 to around 26 per thousand by 1942. The birth rate shows small oscillations but maintains an overall level of approximately 47-48 per thousand throughout this period (Van Der Eng, 2024). This stability in birth and mortality rates suggests relatively consistent demographic conditions in Java during these pre-war years, before the significant disruptions in the 1940s.

The demographic data for the Outer Islands during 1930-1942 is limited compared to Java, revealing significant gaps in data collection and analysis (Van Der Eng, 2002). Despite

this, estimates suggest that the Outer Islands experienced higher overall population growth (1.8-2% annually) than Java (1.4-1.5%) (Van Der Eng, 2002). Within the Outer Islands, growth rates varied dramatically. West Sumatra consistently showed the lowest growth (0.55-0.75%), while Lampung, Riau, and Jambi exhibited the highest rates (4-7%). Most provinces maintained stable 1-2% growth rates. North Sumatra notably increased from 1.73% to 2%. These disparities likely reflect differing economic conditions, migration patterns, and possibly variations in birth and mortality rates, though precise data on these factors is unavailable. The stark contrasts between slow-growing and rapidly expanding provinces highlight the diverse demographic dynamics across the Outer Islands during this period.

Lastly, Infant mortality in Indonesia during the 1930s provides a critical foundation for understanding the patterns of child mortality and regional famine impacts in the 1940s. Throughout the decade, Java, the most populous region, experienced alarmingly high infant mortality rates, with estimates ranging from 225 to 250 per 1,000 live births, significantly higher than in other parts of Southeast Asia (Booth, 2012). Urban areas, particularly overcrowded kampongs in Batavia, recorded even more severe rates, reaching as high as 500 per 1,000 live births, while rural areas like Purwokerto saw relatively lower rates, below 100 per 1,000 (Booth, 2012). Several factors contributed to this crisis, including undernutrition, inadequate healthcare, and poor living conditions. Additionally, cultural and administrative practices led to the underreporting of both birth and death statistics, further obscuring the true extent of infant mortality, particularly in Java (Baten et al., 2013; Van Der Eng, 2024). Parents often waited until an infant survived its first few months before registering the birth, a practical approach given the high infant mortality rates of around 200‰ by 1940 (Van Der Eng, 2024; Van Der Eng & Sohn, 2019). Economic setbacks during the Great Depression, which reduced income and slowed improvements in public health, also played a role in sustaining these high mortality rates (Baten, 2012). Understanding the baseline of high infant mortality in the 1930s is essential for analysing how subsequent food shortages and regional famines during the 1940s exacerbated these vulnerabilities, offering insights into how famine differentially impacted child mortality across Indonesia.

The demographic trends of the 1930s provide important context for understanding regional vulnerabilities to famine during the 1940s. Despite limited data from this period, available evidence indicates persistently high infant mortality rates in Java, reaching up to 250 per 1,000 live births and escalating further in urban areas, particularly Batavia. The stark contrast between urban and rural infant mortality rates and significant regional variations in population growth between Java and the Outer Islands suggests pre-existing disparities in health outcomes and resource distribution. These underlying vulnerabilities would become particularly relevant during the food shortages of World War II and the Japanese occupation. This context is essential for addressing the central research question on how child mortality patterns reveal the incidence and regional variation of famine impact in Indonesia during the 1940s.

2.1.3 Japanese Occupation and Cause of Java Famine

The Japanese occupation between 1942 and 1945 is one of the pivotal moments in Indonesian history (Ricklefs, 2001). Some scholars (Mark, 2019; Post et al., 2010; Sato, 1994; Vickers, 2013) have examined the extensive mass violence during the Japanese occupation (1942-45). However, there has been relatively less focus on the famine. Research on famine conditions in Indonesia during the Japanese occupation has predominantly concentrated on Java, examining various potential causes such as diminished food availability, drought, Japanese policies enforcing low fixed rice prices, and distribution challenges stemming from transportation shortages and trade restrictions (Brennan et al., 2017; Huff, 2020a; Kurasawa, 1983; Van Der Eng, 2000b, 2008)

Several publications have explored the reasons behind the decline in food output from 1940-46 and the resulting famine in Java during 1944-45. As mentioned above, in 1941, the Netherlands Indies was self-sufficient in rice, and Java produced a significant surplus. The occupation began in March 1942, with the Japanese quickly imposing a rigid system to seize rice supplies for their armed forces, detention camps, and urban areas (Van Der Eng, 2024). They implemented a "forced delivery of paddy" policy, requiring peasants to surrender most of their rice harvest to the government at low prices (Kurasawa, 1983). Combined with

the Dutch "scorched earth" policy, this severely disrupted rice production and distribution systems (Brennan et al., 2017).

The consequences of the Japanese-imposed "forced delivery of paddy" regulations were apparent in 1943. Reports of widespread malnutrition emerged, with one hospital in Semarang treating 532 people for malnutrition in just six months, resulting in 366 deaths (Kurasawa, 1983). The Japanese banned the inter-residency rice trade, further disrupting Java's previously integrated rice market (Huff, 2020b). Rapid inflation due to Japanese monetary policies and controlled rice prices destroyed incentives for farmers to grow and sell rice (Huff, 2020b, 2020a). Birth rates started to decrease significantly, marking the beginning of a demographic crisis (Van Der Eng, 2024).

The situation worsened dramatically in 1944. A severe drought, attributed to El Niño and Indian Ocean Dipole events, significantly reduced rice yields, especially in the ordinarily surplus regions of West Java (Brennan et al., 2017). Rice production fell to only 80% of pre-war levels (Kurasawa, 1983). In most areas of Java, except Jakarta and Priangan, death rates exceeded birth rates, leading to a population decrease for the first time in modern Javanese history (Kurasawa, 1983). Peasant uprisings against the rice requisition policies broke out in Indramayu and other areas between April and August (Kurasawa, 1983). Severe transport shortages hindered food distribution, and Japanese suppression of the black market in rice eliminated an alternative distribution channel (Huff, 2020b, 2020a).

The famine peaked in 1945, with mortality rates at their highest and birth rates at their lowest (Van Der Eng, 2024). Rice production fell even further due to continued drought and lack of inputs (Van Der Eng, 2008). As the war situation worsened, the Japanese requisition system began to break down, leading to severe food shortages and famine conditions in many areas. Hyperinflation made rice prices extremely unstable (Van Der Eng, 2008). Although the Japanese occupation ended in August 1945, the effects of the famine persisted into subsequent years (Van Der Eng, 2024).

Throughout the occupation, the Japanese mobilized 2.6 million labourers from Java, separating many married men from their wives and reducing agricultural productivity (Van Der Eng, 2024). The war disrupted standard trade patterns and prevented rice imports that would typically supplement domestic production during shortages (Brennan et al., 2017).

The cumulative effects of drought, policy failures, trade disruptions, and inflation resulted in widespread food shortages and famine, particularly among poorer rural Javanese (Brennan et al., 2017; Huff, 2020b; Van Der Eng, 2008). Despite these reports of severe conditions, some scholars present a different perspective. Post et al. (2010) explicitly state that Indonesia did not experience a catastrophic famine during the Japanese occupation, unlike regions such as northern Vietnam or North-eastern India, where millions perished from starvation. Nevertheless, they acknowledge that Indonesia was teetering on the brink of economic collapse during this period (Post et al., 2010).

Based on the literature review, the dominant view suggests that Java experienced a severe famine during the Japanese occupation of 1942-1945, peaking in 1944-1945. This famine resulted from a complex interplay of factors, including Japanese policies like the "forced delivery of paddy," severe drought, disrupted rice production and distribution systems, rapid inflation, and labour mobilization. Multiple scholars have documented widespread food shortages, malnutrition, and increased mortality rates during this period, with demographic evidence showing a significant population decrease in most areas of Java. While the severity of the famine is generally accepted, Post et al. (2010) suggests these impacts were less severe than contemporaneous famines in other countries. Nevertheless, most of the evidence supports the occurrence of a significant famine with severe consequences for the Javanese population, the effects of which persisted beyond the end of the Japanese occupation in August 1945.

This historical context and literatures review are crucial for understanding the thesis because it provides a comprehensive backdrop against which the effects of famine on Indonesia's population can be analyzed. The complex interplay of factors that led to the famine - from Japanese occupation policies to environmental challenges and economic disruptions - directly influenced mortality patterns, particularly among children, making it essential for interpreting demographic changes and their relationship to the famine conditions across different regions of Indonesia.

2.1.4 Famine mortality in Indonesia During 1940s

During the 1940s, severe famines in Asia during World War II had a significant demographic impact, leading to a substantial loss of life and population displacement. According to Our World in Data, the excess mortality due to famines in Asia was reported to be 11,244,000 during the 1940s (Hasell & Roser, 2013). In the province of Henan in China, a combination of drought and famine caused by war resulted in the demise of approximately two million individuals during 1942-1943, with an additional 2-3 million individuals being compelled to evacuate their homes (Baker, 2018; Muscolino, 2014). Similarly, Vietnam lost a million lives during the 1944-45 famine, which resulted through the combination of poor agricultural yields and armed conflict (Huff, 2019). The estimated population loss during the 1944-45 Java famine amounts to approximately 2.4 or 2.45 million people (De Vries, 1946; Huff, 2020b; Van Der Eng, 2002). However, these figures remain rough estimates. The exact demographic consequences still need clarification due to insufficient vital statistics on births, infant mortality, and deaths (Van Der Eng, 2002; van der Eng, 2024).

The initial research on the 1944-45 famine victims was conducted by De Vries in 1946. He utilized magazine sources and extrapolated data to estimate crude birth and death rates for Java and Madura in 1945. This study suggested an excess mortality rate of 22 per 1,000 people. Based on De Vries' estimates, "around 2.4 million people died over and above the normal mortality rate" during the years of hardship in 1944 and 1945. (De Vries, 1946; Soal Makanan, 1946). In a later study, Nitisastro (1970) reported a net loss of 3.464 million people in Java from 1942 to 1945, consisting of excess deaths of 1.939 million people and lost births of 1.525 million people through data extrapolation (Nitisastro, 1970). Nitisastro's estimation of mortality and birth rates were presented as a 5-year average, hindering the usage for apportionment of net annual population loss in 1942-1945 (Van Der Eng, 2024).

According to Van der Eng's most recent working paper (2024), the estimate of 2.45 million deaths in Java from 1942 to 1945 is considered accurate, as initially reported by De Vries in (De Vries, 1946; Van Der Eng, 2024). This figure refers specifically to excess deaths during the period. It does not include the estimated 1.525 million lost births, which, while significant in understanding the demographic impact, are not categorized as direct famine

victims (Van Der Eng, 2024). The lost births reflect the broader consequences of the famine and war, particularly regarding reduced fertility and population growth. However, they are distinct from the individuals who perished during the crisis (Van Der Eng, 2024). To improve the accuracy of the calculation, Van der Eng Using multiple data sources, including residency-level vital statistics, newspaper reports, and the 1961 population census, Van der Eng estimated a total net population loss of 3.4 million people during 1942-1945. In this most recent study, Van der Eng also studied the excess mortality during Indonesia's war of independence and restricted food supply in the 1946-1949 (Van Der Eng, 2024). With a restricted quantity of data on birth and death frequencies in remote Java between 1946 and 1949, approximations of the overall population decline in these years are more hypothetical compared to the period of 1942-1945, with only 18 mortality and 14 birth rate observations for the entire period. Following underestimation correction, he estimated a net population loss of 1.27 million, consisting of 1.63 million excess deaths and -0.35 million missing births during the 1946-1949 (Van Der Eng, 2024).

Although the estimate of net loss resembles De Vries' (1946) findings, Van der Eng (2024) employs a different approach by accounting for missing births and underestimating mortality and birth rates (De Vries, 1946; Van Der Eng, 2024). Whitin De Vries reported an excess mortality of 2.45 million, Brennan et al (2017) estimated around 1.3 million, Van der Eng's analysis adjusts this figure to include an additional 1.5 million lost births, resulting in a total demographic impact of approximately 3.4 million (1.9 million excess deaths + 1.5 million lost births) (Brennan et al., 2017; De Vries, 1946; Van Der Eng, 2024). Nevertheless, it is crucial to acknowledge that these calculations depend on restricted data and numerous assumptions. Van der Eng (2024) identified that De Vries' use of data from the Jakarta residency did not fully represent the condition of Java because Jakarta, as an urban center, had different socio-economic and demographic characteristics compared to the predominantly rural areas of Java (Van Der Eng, 2024). The urban-centric data from Jakarta likely underestimated the broader impacts of the famine on rural populations, where food shortages and mortality rates may have been more severe. To address this, Van der Eng used a more representative model by extrapolating data from the Kendal Regency in Central Java (Van Der Eng, 2024). This rural area better reflects the conditions experienced by most

of Java's population. Moreover, Van der Eng only provides a general estimation without presenting detailed loss of births and excess mortality for each region in Java because of a lack of individual-level data. These limitations mean that although Van der Eng's methodology provides improved estimates over previous studies, the results should be understood as approximations based on the best available, but still incomplete, historical data.

For similar reasons, he also does not address the impact of famine on infants and young children, who are most prone to malnourishment and communicable diseases. The lack of data on mortality at different age groups hinders the study of child mortality as an indicator of famine. A limitation of the literature, which this thesis seeks to overcome, is the insufficient exploration of child mortality patterns during famine conditions. Previous research has emphasized that child mortality serves as a critical indicator of the severity of famine. (de Zwarte et al., 2023; Kiros & Hogan, 2001), No study has been conducted to examine child mortality as an indicator of famine in 1940s Indonesia.

However, by referring to Figure 2.1, which illustrates the average birth and mortality rates in Java, corrected for under-recording from 1936 to 1955 (‰), we can use it as a clue to infer child mortality patterns for the period of 1942-1949 in this thesis. The figure shows a dramatic divergence between birth and mortality rates during this period. From 1942 to 1945, mortality rates increased substantially, peaking around 1945 at nearly 50 per thousand. Simultaneously, birth rates plummeted from about 45 per thousand in 1942 to a low of about 25 per thousand in 1945. After 1945, mortality rates began declining but remained above pre-1942 levels until about 1949. Birth rates recover more slowly, not returning to pre-1942 levels until the early 1950s. This pattern suggests a severe demographic crisis during 1942-1945, likely due to famine and war conditions, with lingering effects persisting through 1949.

In conclusion, the literature review reveals a complex picture of famine mortality in Indonesia during the 1940s. While various studies have attempted to quantify the demographic impact, significant challenges remain due to data limitations and methodological differences. The estimates of excess mortality range from 1.3 to 2.45 million deaths, with additional considerations for lost births. However, a notable gap exists in the

literature regarding the specific impact on child mortality and regional variations in famine severity. The lack of detailed age-specific mortality data and comprehensive geographical analysis presents an opportunity for further research to enhance our understanding of this critical period in Indonesian history. Another significant challenge in studying this period is disentangling the mortality impacts of famine from those of war and occupation. The simultaneous occurrence of food shortages, military conflict, and societal disruption creates complex cause-and-effect relationships that are hard to separate in demographic analyses. This challenge is particularly acute given the limited data availability and the fact that both war and famine can lead to similar demographic outcomes, such as increased mortality rates and decreased fertility.

This research utilizes the 1980 IPUMS data, which provides retrospective information on births and deaths during the 1940s, allowing for a detailed examination of child mortality trends. By employing indirect estimation techniques, we can analyze these trends to gain insights into the impact of famine. Although the IPUMS dataset offers detailed microdata, analyzing historical demographic patterns through backward projection has inherent limitations. Additionally, Geographic Information System (GIS) mapping is used to assess the spatial and temporal patterns of child mortality, visually representing the consequences of famine across various regions. This study covers data from all provinces in Indonesia over an extended period, before, during, and after 1942-1949. By presenting new child mortality pattern estimations, the results will contribute new insights into the impact of famine in Indonesia during the 1940s.

2.1.5 Regional variation during the famine

To date, researchers have only investigated the impact of famine on net population loss derived from mortality and birth loss data, in which their studies are only limited to Java (De Vries, 1946; Huff, 2020b; Nitisastro, 1970; Van Der Eng, 2024). The famine in Java began to emerge in 1943, with initial indications of food scarcity reported in August in major urban centres such as Jakarta and Semarang, as well as in the residencies of Madiun, Madura, Kediri, and Surabaya (Van Der Eng, 2008). The average daily calorie supplies per capita across Java decreased from 2,099 calories in 1941 to 1,705 calories in 1943, a

reduction of approximately 19% (Huff, 2020b). As 1944 advanced, the situation deteriorated markedly, with severe famine reported in traditionally rice-deficient regions such as Bojonegoro (Van Der Eng, 2008). The average calorie supply plunged to 1,349 per capita per day, with five of Java's 17 Residencies experiencing average per capita calorie supplies below 1,100 per day (Huff, 2020b). East Java was particularly affected, with Madiun and Bojonegoro recording the lowest calorie supplies at 835 and 899 calories, respectively (Huff, 2020b).

The famine reached its peak in 1945, with the food crisis remaining severe across most of Java. The average calorie supply remained perilously low at 1,333 per capita daily (Huff, 2019). Regional disparities persisted, with eight Residents registering less than 60% of calorie supplies of their 1941 levels (Huff, 2020b). Bojonegoro in East Java endured the most severe conditions, with only 39.5% of its 1941 calorie levels plummeting to 690 calories per day (Huff, 2020b). Urban areas, particularly impoverished neighborhoods, and West Java also experienced harsh famine conditions (Van Der Eng, 2008). Throughout this period, the coefficient of variation in calorie supply between Residencies increased from 0.22 in 1943 to 0.30 in 1944 and 1945, indicating widening regional disparities (Huff, 2020b). The crisis was intensified by Japanese policies prohibiting inter-regional food transfers, resulting in a concentration of famine-related deaths in urban areas as people migrated to cities in search of sustenance (Huff, 2020b; Van Der Eng, 2008).

Table 2.2 Region in Java with highest population decline during 1943-1945

Region	1943-44	1944-45
Pekalongan	-1.23	-1.1
Semarang	-2.38	-0.3
Pati	-1.79	-1.25
Bojonegoro	-2.18	-1.75
Surakarta	-1.02	-1.4
Surabaya	0.23	-0.8
Malang	-0.52	-0.6
Madura	-0.43	-1.5

Sources: Van der Eng (2000)

Van der Eng's (2002) analysis reveals significant regional variations in the effects of famine on population decline across Java during 1943-1945 (see Table 2.2). 1943-1944, Semarang experienced the most severe population decline at 2.38%, closely followed by Bojonegoro at 2.18%. Other regions, including Pati (-1.79%), Pekalongan (-1.23%), and Surakarta (-1.02%), also saw substantial decreases. Notably, Surabaya showed a slight increase of 0.23% during this period. The pattern shifted in 1944-1945, with Bojonegoro being heavily impacted, showing the highest decline of 1.75%. Madura's situation worsened significantly, reaching a 1.5% decline. Semarang, previously the most affected region, saw a dramatic improvement, with its decline rate dropping to 0.3%. Surabaya's population trend reversed, shifting from growth to a 0.8% decline. The data indicates that the intensity of population decline generally decreased in most regions during 1944-1945 compared to 1943-1944, with notable exceptions like Madura. This regional variation underscores the uneven impact of famine across different areas of Java during the Japanese occupation, likely influenced by factors such as local food production, distribution systems, and Japanese policies in different regions, as explained above.

The regional variation in the impact of the 1944-1945 famine on Java's population shows a chronological progression and geographical differences in severity (Van der Eng, 2024). In 1943, the situation was not yet critical across Java, with only slight increases in mortality rates in Semarang city. However, by 1944, the famine's effects became more pronounced, with Central Java hit hardest. Wonosobo regency, for instance, saw mortality rates soar to 53.7 per 1,000. West Java, including Jakarta, also worsened but not as severely as Central Java. The famine peaked in 1945, dramatically increasing mortality across Java, particularly in Central Java, where Kendal regency's mortality rate reached 56 per 1,000. West Java, while affected, fared somewhat better. Central Java consistently suffered the most throughout this period, likely due to its high population density and pre-existing food deficits. The demographic impact was evident in increased mortality and reduced birth rates, leading to significant net population loss across Java, with the most severe effects concentrated in Central Java. Though data is limited, East Java likely experienced severe effects similar to Central Java (Van der Eng, 2024).

The literature on the famine in Java during 1943-1945 reveals significant regional variations in its impact across the island. Data on calorie supplies and population decline demonstrate that while the famine was widespread, its severity differed markedly between regions. The variation in impact is evident from the increasing coefficient of variation in calorie supply between Residencies and the diverse population decline rates across regions (Huff, 2020a; Van Der Eng, 2008). Factors contributing to these disparities included local food production capacities, Japanese policies prohibiting inter-regional food transfers, and varying degrees of urbanization. The effects of famine were not static, with some regions experiencing improvement while others deteriorated over time, as seen in the contrasting trends of Semarang and Madura from 1943-44 to 1944-45. This regional heterogeneity underscores the complex nature of the famine and highlights the importance of considering local contexts when analysing its impacts across Java.

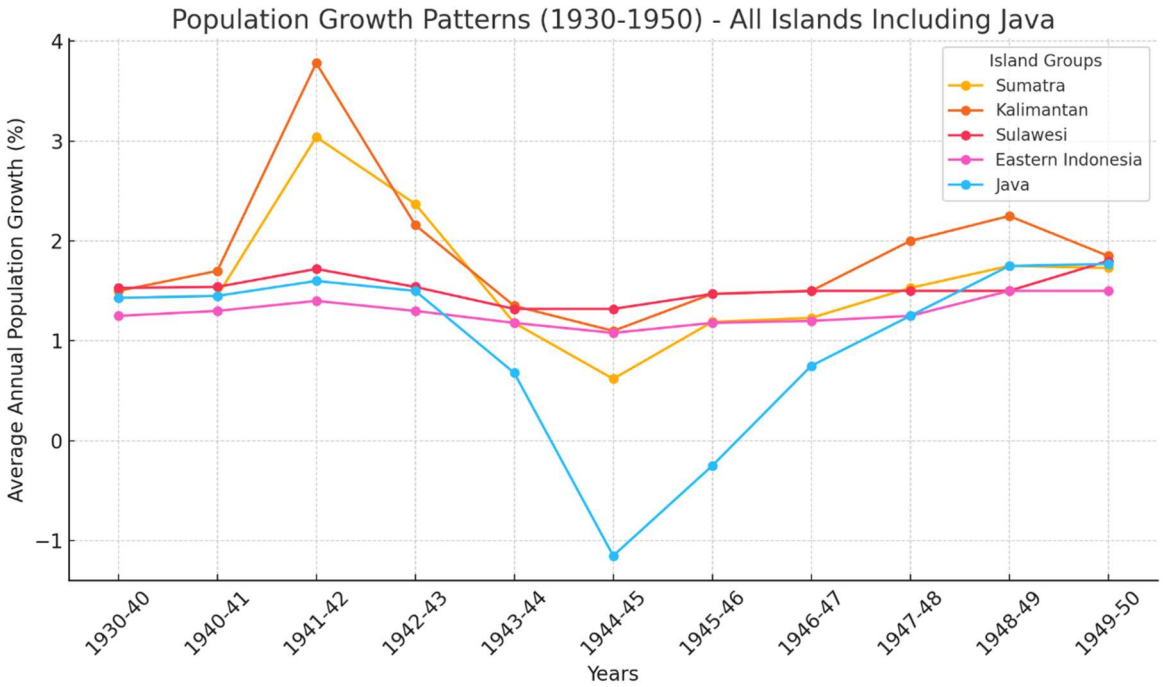
Due to several key factors, famine studies during the Japanese occupation of Indonesia primarily focused on Java rather than the Outer Islands. Java's extremely high population density (316 people per square kilometre compared to much lower densities in the Outer Islands) made it more vulnerable to food shortages (Huff, 2020a; Van Der Eng, 2008). As the administrative centre, Java likely had better record-keeping, providing researchers with more data. The low population density in the Outer Islands allowed people to grow subsistence crops on available land, acting as a "safety valve" unavailable in densely populated Java (Huff, 2020a). Furthermore, Japanese policies such as fixing rice prices and banning inter-regional trade severely impacted Java's complex food distribution system (Huff, 2020a; Van Der Eng, 2008). These factors combined to create a catastrophic famine in Java that has drawn more research attention. In contrast, the relative lack of severe famine in the Outer Islands left less to study regarding famine impacts and causes.

Food shortages across the Outer Islands of Indonesia worsened progressively, with considerable variation between regions. In 1942, several areas, including the Riau archipelago, Bangka, Belitung, Borneo, Manado, Maluku, and Sumatra's east coast, maintained sufficient food supplies, thanks to Dutch-established rice reserves (Huff, 2020a). However, by 1943, food crises began to emerge in places like Sumatra's east coast, Bangka, Belitung, Timor, and Maluku, where Allied military action further disrupted fishing and food

production. Sulawesi also reported growing difficulties (Huff, 2020a). The situation turned critical in 1944 and 1945, as severe shortages hit East Sumatra, leaving only 15-25% of plantation workers fit for work due to malnutrition, and South Sulawesi, where crop failures led to widespread starvation. Although food supplies in Makassar improved slightly in 1944, Manado continued to experience severe famine, and Maluku remained deeply affected. In contrast, regions with lower population densities and access to subsistence farming, like northeast Sulawesi, fared better and avoided the severe famine conditions in Java (Huff, 2020a).

The analysis of Nitisastro (1970) indicates that during the 1940s, as in Java, the other Indonesian islands also experienced a five-year decline. Thus, these regions experienced an increase in mortality, a decrease in fertility, or both (Nitisastro, 1970). According to Nitisastro (1970), the impact of the war on Indonesia's outer islands was significant but generally less severe than in Java. The 1961 census data reveals fewer survivors from births in 1947-1951 compared to 1952-1956, indicating demographic disruption during the war years. However, unlike Java, the outer islands showed a higher or equal percentage of survivors from 1942-1946 births compared to 1937-1941, suggesting a less severe impact. Despite increased mortality and probably decreased fertility leading to reduced population growth, the outer islands experienced less severe food shortages and population displacements than Java. However, Nitisastro's analysis has limitations, including a lack of specific wartime data for the outer islands, limited regional specificity, absence of detailed mortality and fertility data, potential census inaccuracies, and reliance on age structure data from later censuses. These constraints make it challenging to draw more specific conclusions about the war's demographic impact on individual outer islands or regions.

Figure 2.2 Population Growth Trends in Indonesia's Outer Islands and Java (1930-1950)



Source: Van Der Eng (2002) (constructed from appendix 11)

A later study by Van der Eng (2002) provided the population growth data which I used to create the graph in Figure 2.2. From 1930 to 1950, the Outer Islands of Indonesia, including Sumatra, Kalimantan, Sulawesi, and Eastern Indonesia, showed distinct population growth trends. Notably, Kalimantan experienced a sharp peak in growth around 1941-42, reaching nearly 4%, followed by a significant decline during the war years, aligning with the broader trend across the Outer Islands. Sumatra, Sulawesi, and Eastern Indonesia saw more moderate declines but began a steady recovery from 1945 onward. In contrast, Java faced a more severe and prolonged decline in population growth from 1942 to 1945, with growth rates turning negative, particularly during the 1944-45 period when Java's population shrank by over 1%. This stark decline suggests that Java, compared to the Outer Islands, likely faced harsher conditions, possibly due to wartime disruptions, resource shortages, and a potential famine that may have contributed to the sharp population contraction during those years.

The existing literature primarily focuses on Java's experience of famine during the 1940s, revealing significant regional variations in its impact across the island. Although

some data exists on food shortages and demographic changes in the outer islands, the evidence is limited and fragmented. Studies suggest that these regions generally experienced less severe conditions than Java, partly due to lower population densities and greater access to subsistence farming. However, areas like East Sumatra and parts of Sulawesi faced critical food shortages. Despite evidence of food crises and urban population increases in these regions, famines' occurrence and demographic impact in Indonesia's outer islands during the 1940s remain largely unexplored. Their potential progression to famine conditions and subsequent demographic effects are unknown. This study aims to address this significant gap in the literature by investigating the possibility of famines beyond Java using the IPUMS 1980 Indonesia dataset, employing child mortality as an indicator of famine conditions.

2.1.6 Food shortages during the National Revolution

The Indonesian National Revolution, which took place from 1945 to 1949, was a crucial period in Indonesia's history, starting with the declaration of independence by Sukarno and Hatta on August 17, 1945, shortly after Japan's surrender in World War II (Pham, 2019; Van Der Eng, 2008). This proclamation sparked a complex struggle as the newly declared Republic of Indonesia fought to maintain its independence against the returning Dutch colonial forces, who sought to reestablish control over the archipelago (Cribb, 1981; Pham, 2019). The revolution involved armed resistance, diplomatic negotiations, and social upheavals, including two major Dutch military offensives in 1947 and 1948-49 (Van Der Eng, 2008; Vu, 2003). Despite initial Dutch military successes and growing international pressure, particularly from the United States, it ultimately compelled the Netherlands to recognize Indonesian sovereignty. The conflict officially ended in December 1949 with the Dutch transfer of power, though disputes persisted over some territories (Pham, 2019; Van Der Eng, 2008; Vu, 2003). This revolutionary period was crucial in shaping Indonesia's national identity and political landscape as it emerged as an independent nation.

After declaring independence in August 1945, the newly formed Republic of Indonesia swiftly began establishing civil administration and armed forces across the archipelago (Cribb, 1981; Van Der Eng, 2008). However, their control was soon challenged as Allied

forces, primarily British troops, arrived in September and October to handle the post-war situation (MAJ Barry G.L. Rockx, 2016). These forces occupied significant cities in Java and Sumatra, including Jakarta, Surabaya, Semarang, Bandung, Medan, Padang, and Palembang (Van Der Eng, 2008; Vu, 2003). Despite this, most rural areas in Java and Sumatra remained under de facto Republican control (see figure 2.3). The conditions in eastern Indonesia, including Sulawesi, Maluku, and the Lesser Sunda Islands, were distinct as these areas fell under Allied and Dutch control with relatively little resistance (Van Der Eng, 2008).

Figure 2.3 Map of British Key areas on Java and Sumatra 1945-1946.

Sources: (MAJ Barry G.L. Rockx, 2016)

As 1946 progressed, a gradual transition occurred, with British forces withdrawing and Dutch troops arriving to reassert colonial authority. The Dutch established civilian administration in Allied-controlled urban areas of Java and Sumatra early in the year (MAJ Barry G.L. Rockx, 2016). However, their control remained primarily limited to these urban enclaves and key economic zones. Meanwhile, the Republican government, forced to relocate from Jakarta to Yogyakarta in January, maintained control over most of Java's interior and rural areas (Van Der Eng, 2008). This created a divided landscape where Dutch authority was concentrated in major cities and strategic economic areas, while Indonesian Republicans held sway over most outlying regions. The year ended with a clear territorial division that would set the stage for ongoing conflict between Dutch colonial forces and Indonesian independence fighters. This period was also marked by violence, including the "Bersiap" period of late 1945 and a brutal counterinsurgency campaign by Dutch special

forces in South Sulawesi in late 1946 and early 1947 (Luttikhuis & Moses, 2012; MAJ Barry G.L. Rockx, 2016).

According to Van der Eng (2008) and Vu (2003), during 1945-1946, Java experienced widespread food shortages and localized famines under both Republican and Allied/Dutch control. In late 1945, famines affected parts of Priangan and Sumatra, with rice distribution problems arising in Besuki. Local groups took advantage of the power vacuum to seize control of food resources and distribution networks. In response, the Republican government established the People's Food Agency (PMR) in October 1945, aiming to stabilize food supplies (Van Der Eng, 2008; Vu, 2003).

By early 1946, before the main harvest, famines were anticipated across Java, particularly affecting Bojonegoro, Madura, Surabaya, Malang, and Kediri (Van Der Eng, 2008). In March 1946, the government introduced a comprehensive rice collection and distribution plan, targeting 20% of total rice production. However, the government struggled to meet this goal, managing to collect only 6% by February 1947 (Van Der Eng, 2008; Vu, 2003; Zara, 2021). Meanwhile, rural areas throughout 1946 suffered from food shortages and malnutrition, hitting the poor and displaced populations hardest. The situation worsened in major cities like Jakarta, Surabaya, Semarang, and Bandung, exacerbated by an influx of refugees and logistical challenges (Van Der Eng, 2008; Vu, 2003).

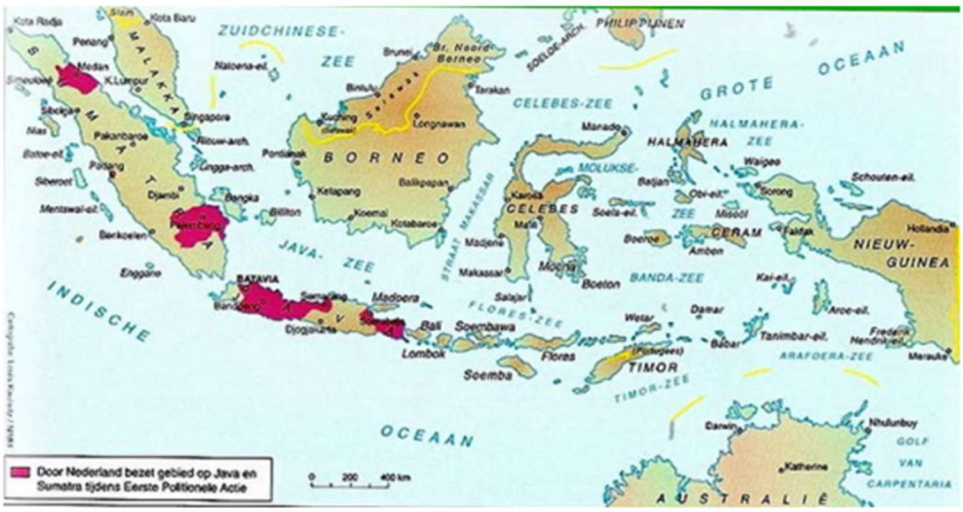
Both Republican-controlled areas and Allied/Dutch-controlled urban zones faced severe distribution issues. While Republican territories struggled with internal food distribution, Allied and Dutch forces in urban centers depended heavily on imports and faced protests over unfair rationing systems. This period saw a contest over control of rice resources between the central government, local groups, and occupying forces, turning food supply into a central political issue during the early years of Indonesia's revolution and state formation (Pham, 2019; Van Der Eng, 2008; Vu, 2003).

In early 1947, food shortages were reported in several key areas, particularly in Dutch-controlled urban regions (Van Der Eng, 2008). Surabaya saw severe deprivation, with the average diet estimated to provide only 600 Kcal per person, while in Semarang, the average diet amounted to just 900 Kcal. Jakarta, especially in its urban kampungs, also faced significant shortages, with Bandung and Bogor experiencing less severe but notable food

insecurity. These shortages were primarily the result of the Republican economic blockade and difficulties in obtaining food supplies from Republican-held territories. By June and July 1947, the situation had worsened, with reports of deteriorating food conditions in Madura, the areas surrounding Jakarta, Bogor, and Surabaya, as well as in Medan, Sumatra. These growing shortages contributed to the Dutch decision to launch their first military action in July 1947 (MAJ Barry G.L. Rockx, 2016; Van Der Eng, 2008).

In July 1947, the Netherlands launched its first significant military action in Indonesia, known as Operation Product or the First Police Action. This operation, despite its euphemistic name, was a large-scale military offensive involving over 100,000 Dutch troops (Luttikhuis & Moses, 2012; MAJ Barry G.L. Rockx, 2016). The primary impetus for this action was a critical food supply issue, particularly access to rice (Van Der Eng, 2008). Dutch-controlled areas, especially urban centers, faced a deteriorating food situation exacerbated by a food blockade imposed by the Republican government (Van Der Eng, 2008; Vu, 2003). Despite efforts to obtain rice through international allocations and imports, Dutch authorities struggled to meet the population's needs (Van Der Eng, 2008; Vu, 2003). Intelligence reports suggested substantial rice stocks in Republican-controlled ports, and the Dutch feared potential reductions in international rice allocations due to misconceptions about Java's self-sufficiency following the Linggarjati Agreement (MAJ Barry G.L. Rockx, 2016; Van Der Eng, 2008). These factors, combined with the possibility of capturing rice stocks in Republican territory, significantly influenced the Dutch government's decision to launch the military action on July 21, 1947. The operation's objectives extended beyond food security to include securing valuable commercial plantations and resources on Java and Sumatra and pressuring the Republic of Indonesia to accept the Linggadjati Agreement fully. By the time international pressure and an UN-imposed ceasefire halted the operation on August 5, 1947, Dutch forces had occupied approximately 70% of rubber plantation acreage in Java and 60% in Sumatra, along with many vital roads, towns, and bridges (see figure 2.4) (MAJ Barry G.L. Rockx, 2016). However, while achieving significant territorial gains, this military action failed to resolve the underlying political conflict and led to increased guerrilla warfare by Indonesian nationalist forces (Van Der Eng, 2008).

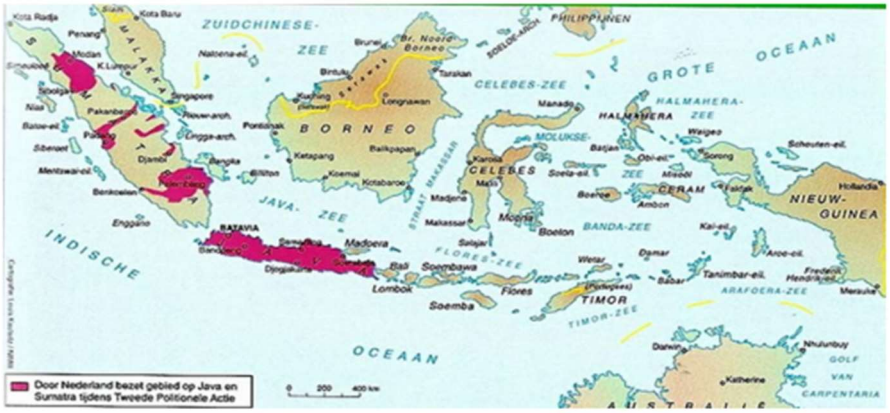
Figure 2.4 Map of occupied territory by the Dutch during the first police action on Java and Sumatra 1947.



Source: (MAJ Barry G.L. Rockx, 2016)

During 1948-1949, Java faced significant food supply challenges, with conditions varying across regions and fluctuating with shifts in military control. Early 1948 saw improved food supply in Dutch-controlled areas, comprising about 55% of Java's irrigated rice land. A severe drought in mid-1948 led to poor harvests, affecting both Dutch and Republican-controlled territories. Shortages were reported in various regions, including parts of Wonosobo, Bojonegoro, Blora, Wonogiri, Ponorogo, and Tulungagung. The situation deteriorated in Republican areas by late 1948, particularly in Central Java and urban centers like Yogyakarta (Van Der Eng, 2008).

Figure 2.5 Map of occupied territory by the Dutch during the second police action on Java and Sumatra 1948-1949.



Source: (MAJ Barry G.L. Rockx, 2016)

In December 1948, the Dutch launched their second military action, Operation Crow, citing Indonesian violations of the Renville Agreement (MAJ Barry G.L. Rockx, 2016). This operation brought most of Java under nominal Dutch control (see Figure 2.5) and initially improved food distribution through more effortless supply movement (MAJ Barry G.L. Rockx, 2016; Van Der Eng, 2008). However, it failed to suppress armed resistance or end guerrilla warfare, which continued to disrupt rural food production and distribution (Van Der Eng, 2008). Multiple factors contributed to the ongoing food shortages: adverse weather, conflict-related disruptions to transportation and trade, hoarding and speculation, ineffective distribution systems, and rural insecurity impacting cultivation (MAJ Barry G.L. Rockx, 2016; Van Der Eng, 2008; Vu, 2003).

Operation Crow resulted in a military stalemate, damaging Dutch international credibility while boosting global support for Indonesian independence. Increased pressure from the U.S. and U.N. for negotiations accelerated Indonesia's path to independence, formally recognized in December 1949 (MAJ Barry G.L. Rockx, 2016; Pham, 2019). Despite initial military gains, the operation backfired politically and strategically, marking a pivotal moment in Indonesia's sovereignty struggle. As of 1949, food supply had generally improved in Dutch-controlled areas, but malnutrition remained widespread in many rural regions, especially in formerly Republican-held territories. This persistent issue highlighted

the complex interplay of military actions, political developments, and socioeconomic conditions during this turbulent period in Java's history (Van Der Eng, 2008).

The aftermath of the Japanese occupation and the Indonesian War of Independence (1945-1949) continued to impact Java's population significantly. Van der Eng's (2024) study reveals a complex pattern of crisis and recovery during this period (Van Der Eng, 2024). Based on Figure 2.1, Java's demographic trends suggest that mortality rates peaked at about 50‰ in 1945, coinciding with the lowest birth rate of around 25‰. A sharp recovery followed in 1946-1947, with mortality rates declining to about 35‰ and birth rates rising to 35‰. However, 1948 saw an unexpected spike in mortality to 40‰, possibly due to ongoing conflicts or health issues, while birth rates continued to climb. The most dramatic shift occurred in 1949, with mortality rates dropping to 30‰ and birth rates surging to 50‰, indicating a significant demographic rebound. After correcting for underestimation, this period saw a net population loss of 1.27 million, comprising 1.63 million excess deaths. The negative figure for missing births (-0.35 million) highlights data limitations. Van der Eng emphasizes that food shortages and precarious living conditions persisted in parts of Java, contributing to elevated mortality rates compared to pre-war levels. This non-linear recovery pattern reflects the complex political, social, and economic factors during Indonesia's struggle for independence (Van Der Eng, 2024).

The reliability of demographic estimates during the Indonesian War of Independence (1945-1949) is significantly hindered by limitations in mortality data, as highlighted by Van der Eng (2024). Key issues include a lack of sufficient data, with only 18 mortality and 14 birth rate observations for 1946-1949, and an urban bias that may misrepresent rural Java. Additionally, communication breakdowns, administrative vacuums from military advances, and chronic underreporting—especially of infant mortality—further complicate data accuracy. Variations in data quality across regions, potential skewing due to malnourished rural refugee influxes, and challenges in distinguishing combat from civilian deaths add to the difficulties (Van Der Eng, 2024). These factors reflect the chaotic wartime conditions that disrupted normal data collection processes, creating significant gaps and inconsistencies that necessitate cautious interpretation of mortality estimates, thereby complicating the assessment of the War of Independence's full demographic impact.

This thesis aims to identify demographic shocks that may indicate famine during the Indonesian National Revolution (1945-1949). Although existing studies have documented widespread food shortages in Republican and Dutch-controlled regions, precise data on their demographic impact, particularly in rural areas, remains limited. By focusing on child mortality as a sensitive indicator of nutritional crises and health conditions, this research will provide a clearer understanding of potential famine patterns during Indonesia's independence movement.

2.2 Theoretical Framework of Famine

Famine is a complex phenomenon, reflected in the lack of consensus on its definition and the varied causalities involved (Devereux, 2000; Howe & Devereux, 2004; Ó Gráda, 2007, 2009). Mayer (1975) defines *famine* as a severe food shortage accompanied by a significant increase in local or regional mortality, framing it as a natural disaster (Mayer, 1975). In contrast, Walker (1989) views famine as a socioeconomic process that causes "accelerated destitution," leading to death (Walker, 1989). However, these definitions are often criticized for imprecision and limited practical application (Howe & Devereux, 2004). Recent approaches emphasize using measurable indicators, such as early warning systems, nutrition status monitoring, and coping strategies, to understand better and prevent famine (Hasell & Roser, 2013; Howe & Devereux, 2004). In line with most recent studies, this thesis adopts Ó Gráda's (2009) definition, which describes famine as an extensive food shortage or access to food that results in excess mortality due to starvation or hunger-induced diseases (Ó Gráda, 2009).

Famine typically results from a complex interplay of 'technical' and 'political' factors. The historical perspective, rooted in Thomas Malthus's theory, viewed famine as an inevitable consequence of population growth outpacing food production (Commander, 1986). However, Amartya Sen challenged this Malthusian view with his entitlement theory, arguing that famines often occur not due to food scarcity but because people lack access to food due to market failures and entitlement breakdowns (Sen, 1983). This shifted the focus to economic and social factors in famine causation. More recent perspectives emphasize political culpability, considering factors such as war, government policy, and failures of

international response (Devereux, 2000; Hasell & Roser, 2013). De Waal further challenges the Malthusian misconception, highlighting how famines often stem from political actions or failures and how starvation has been used as a tool in genocide and warfare. He argues that the spread of democracy, the promotion of human rights, and the cessation of conflicts have significantly reduced famine occurrences (De Waal, 2018). This comprehensive understanding of famine causation informs our approach to analysing child mortality patterns across different regions of Indonesia in the 1940s, as it prompts us to consider how political and economic factors may have contributed to regional variations in famine impact.

Before the 20th century, the majority of famines that occurred in Asia, Europe, and Afrika were primarily caused by natural phenomena such as extreme cold, drought, pests, and animal farm disease (Devereux, 2000). However, these famines were usually also connected to weak economies and lack of logistics aptitude and political will. The advancement of transportation and communications infrastructure has greatly decreased susceptibility to famine, even in case of a natural disaster, because these advancements have greatly improved access to food. Since the mid-20th century, it is evident that famines have been mostly triggered by political chaos, where conflict and/or non-democratic regime exists, creating famines as a "man-made" incident (Hasell & Roser, 2013).

This thesis examines these evolving perspectives on famine causation through the lens of child mortality patterns in 1940s Indonesia. By examining child mortality patterns in Indonesia during the 1940s, this study aims to bridge the gap between these historical perspectives and provide insights into regional variations of famine impact. Understanding the interplay between natural, economic, and political factors in famine occurrence is crucial for this research, as it allows for a more nuanced analysis of the Indonesian context during a period of significant political upheaval and potential food insecurity. This framework shapes our approach to interpreting child mortality data as a proxy for famine impact, considering environmental and socio-political influences on food availability and access across different regions of Indonesia.

According to the Integrated Food Security Phase Classification (IPC) scale, a situation is classified as famine (IPC Phase 5) when at least 20% of households in an area face an extreme lack of food and other basic needs, acute malnutrition rates exceed 30%, and the

death rate exceeds two people per 10,000 per day (IPC, 2022). Malnutrition is the most direct and severe consequence of famine. People who suffer from malnutrition have a weakened immune system, which makes them susceptible to infections and diseases (Bourke et al., 2016). Severe malnutrition may lead to wasting and stunting, which can ultimately lead to death if not addressed (Young & Jaspars, 1995). Famine-related mortality occurs through both direct and indirect pathways. Diseases directly linked to malnutrition cause many deaths, and other infectious diseases spread due to famine-induced conditions such as population displacement, overcrowding, and breakdown of hygiene practices (Ó Gráda, 2009; Young & Jaspars, 1995). During famine, it is common that access to clean water and sanitation facilities may be severely compromised, which increases the likelihood of waterborne diseases, such as dysentery, typhoid fever, and cholera. This further contributes to mortality (Young & Jaspars, 1995). Infants and children are disproportionately affected by famine (Hugo, 1984). They have higher mortality rates because they usually have greater dietary needs and are less resilient. As such, infants and children are at a greater risk of death (Ó Gráda, 2009), highlighting them as a promising indicator of famine (de Zwarte et al., 2023; Kiros & Hogan, 2001), which forms an important background for this study.

This thesis builds on the assumption that child mortality serves as an indicator of famine. To illustrate this relationship, we can examine historical instances where famine and conflict have significantly impacted child survival rates. For example, during the Ethiopian famine of the 1980s, severe food shortages and prolonged conflict led to widespread hunger, displacement, and mass migration of families and communities. The resulting public health crisis had a disproportionate impact on children, with a study revealing that 54% of deaths were among children aged five years or younger (Kiros & Hogan, 2001). This highlights the extreme vulnerability of young children during periods of famine and societal upheaval. Similarly, the Dutch famine of 1944-45 demonstrated how malnutrition and food scarcity increase the vulnerability of children, leading to higher mortality rates, particularly among infants and young children (de Zwarte et al., 2023). These historical examples underscore how child mortality can serve as a sensitive marker of the severity of famine on a population's health and well-being. By examining child mortality patterns, this thesis aims

to gain insights into the incidence and regional variation of famine impact in Indonesia during the 1940s, a period marked by significant social and economic upheaval.

2.3 Hypotheses

1. Child mortality rates were higher among women born between 1915 and 1924 (who were of prime childbearing age during 1940-1945) compared to women born in earlier (1895-1914) or later (1925-1944) cohorts, reflecting the possible impact of famine conditions during wartime 1942-1949.
2. Analysis of regional child mortality rates shows notably higher rates in Java regions during 1944-1945 compared to outer islands, with similar elevated patterns in urban areas under Dutch control and Central Java during 1948-1949. These patterns in child mortality rates could help identify regions that potentially experienced famine conditions.
3. The IPUMS 1980 data can provide insights into historical child mortality rates in Indonesia during the 1940s through birth cohort reconstruction. However, its reliability as an indicator of famine impact is primarily limited by survival bias, as the dataset only captures individuals who survived until 1980, potentially underestimating mortality rates during severe historical periods.

CHAPTER III

Data and Methodology

This chapter outlines the study's data and research methods, focusing on child mortality among five birth cohorts of women born in 10-year intervals between 1895 and 1944, particularly those of childbearing age during the 1940s. Utilizing Integrated Public Use Microdata Series (IPUMS) data, this thesis employs a methodology that integrates a computation of descriptive analysis of child mortality rates with Geographic Information System (GIS) mapping at the province level. The purpose is to investigate the geographical and temporal characteristics of child mortality patterns as indicators of famine incidence in the 1940s of Indonesia.

3.1 IPUMS Data

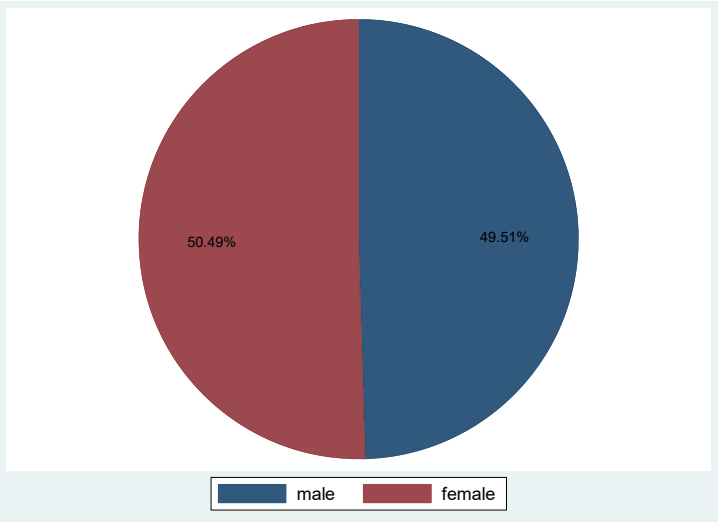
IPUMS is a Minnesota Population Center-led project that provides users with access to vast amounts of individual data from global censuses and surveys. It includes information on fertility, nuptiality, mortality, migration, disability, labor force participation, occupational structure, education, ethnicity, and household composition (Jeffers et al., 2017; Kugler & Fitch, 2018; Ruggles et al., 2015). The dataset contains data from the first US Census in 1790 to the most recent in 2020 (Rogers, 2023), as well as international census microdata from over 100 countries spread across five continents, with samples ranging from 1960 to 2011 (Jeffers et al., 2017). IPUMS distinguishes itself from other sources of census data by harmonizing variable codes across nations and time periods, allowing for direct comparisons even when various categorization systems are used. The harmonization method guarantees the preservation of precise information without any loss, enabling efficient comparative study (Sobek, 2020). In addition, IPUMS offers user-friendly interfaces, integration at the level of individual records, and thorough documentation, all of which closely adhere to the FAIR principles of data findability, accessibility, interoperability, and re-usability (Kugler & Fitch, 2018). This further establishes IPUMS as a valuable and easily accessible data source for various fields of study.

IPUMS data has been utilized in research studies to examine diverse demographic patterns in numerous countries. For example, it has simplified the examination of city growth in the Global South by emphasizing the importance of international migration in population changes across 377 cities in seven countries (Lerch, 2020). In addition, IPUMS DHS has enhanced the examination of population and environmental matters by integrating environmental variables into the Demographic and Health Surveys. This expansion creates new study opportunities in countries with low or middle incomes (Boyle et al., 2020). These studies demonstrate the adaptability and credibility of IPUMS data in a variety of demographic and health research applications. IPUMS data is particularly useful for this study because of its ability to analyse individual-level data, larger data set and standarlized allowing for a more comprehensive understanding of the factors influencing child mortality in a variety of settings (Boyle et al., 2020; Jeffers et al., 2017). IPUMS data includes key variables such as age, birth year, province of residence, number of children born, surviving, and deceased, and socioeconomic status. These variables investigate child mortality patterns as indicators of famine during the challenging periods of Indonesian history in the 1940s.

3.2 Population and Sample

This study's population was obtained from the IPUMS dataset, which consists of the Indonesian population spread across 27 provinces based on the 1980 census (Steven Ruggles et al., 2024b). This dataset consists of 7,234,577 observations, each of which has 121 variables that describe demographic and socioeconomic conditions, such as geographic identifiers, demographic data, household characteristics, education level, and employment status (Minnesota Population Center, 2020).

Figure 3.1 Gender distribution in IPUMS Indonesia 1980



Source: IPUMS

As we can see from the figure 3.1 above, 50.49% of the population are women. In this study, we excluded males to focus specifically on the factors influencing child mortality directly related to maternal characteristics and behaviours. Since childbearing is biologically limited to females, including males would not provide relevant data for analysing child mortality patterns (Martinez et al., 2012). The analysis focuses on women who experienced their childbearing years (ages 15-49, as defined by the World Health Organization) throughout the 1940s period, specifically those born between 1895 and 1944 (Chivese et al., 2016; Martinez et al., 2012; Riccò et al., 2023). Data-cleaning procedures were implemented to ensure the robustness and reliability of the analysis. From the initial dataset of 7,234,577 observations, we implemented several exclusion criteria. First, we removed 3,581,414 male respondents. Second, we restricted the sample to women born between 1895 and 1944, excluding 2,769,358 observations. Third, after filtering out women who had migrated from their original location, 806,780 observations remained. Finally, after cleaning missing values in key variables (number of children born, surviving children, and child deaths), our final analytical sample consisted of 806,133 observations. This carefully curated subsample provides a comprehensive basis for examining fertility patterns and child survival outcomes across this historical timeframe while maintaining data quality and analytical integrity.

Table 3.1 Descriptive Statistics of Selected Sample of Women

Variable	Obs	Mean	Std. Dev.	Min	Max
age new	806,133	50.46416	11.0428	36	85
birthyr new	806,133	1929.536	11.0428	1895	1944

Source: IPUMS

The descriptive statistics table 3.1 for a selected sample of 806,133 women reveals that the average age was approximately 50.46 years, with a standard deviation of 11.04 years, and the ages range from 36 to 85 years in 1980. Correspondingly, the mean year of birth is 1929.54, also with a standard deviation of 11.04, ranging from 1895 to 1944. These statistics indicate a moderately dispersed distribution of ages and birth years around their respective means, representing a sample of predominantly middle-aged to older women at the time of the 1980 census.

3.2.1 Variables use.

Variable selection in this study was conducted with the aim of calculating the number of children ever born, survive, and child deaths. Therefore, the selected variables are presented in Table 4 below:

Table 3.2 List of Selected Variables

Variables	Unit	Description
geolev1	6-digit numeric code	A 6-digit numeric variable used to identify subnational geographic levels
Age	1-2-digit numeric code	A numerical variable that states the age of respondents in years at the time the survey is conducted

age2	1-2-digit numeric code	A variable that represents the age of respondents who have been grouped into a specific age interval
Sex	1/2	A variable that indicates the sex or gender of the respondent, using a numeric code to represent gender, 1 for males and 2 for females
birthyr	4-digit numeric code	Variables that refer to the year in which the respondent was born
chborn	1-2-digit numeric code	Number of children ever born to respondents
chsurv	1-2-digit numeric code	Number of respondents' children who survived during data collection
chdead	1-2-digit numeric code	Number of respondents' children who have died during data collection
Bplid	2-digit numeric code (11-94)	Numeric code reflecting the province or region in Indonesia where the respondent was born. Numbers 11 for "Special Region of Aceh", 12 for "North Sumatra", 13 for "West Sumatra", and so on.(indicates the person's province of birth within Indonesia.)
Lastbyr	4-digit numeric code	Indicates the year of birth of the last child born by the respondent. The data refer to live births.
Lastbmort	0/1/2/9 code	Indicates the mortality status of the last child born to a woman. There is no constraint on how long ago the child may have been born. Only live births are considered.

Source: IPUMS

The key variables from Table 3.2—**chborn**, **chsurv**, and **chdead**—are fundamental to calculating child mortality rates. **Chborn** captures the total number of children a mother has given birth to, serving as the foundation for analyzing fertility and reproductive patterns. **Chsurv** indicates the number of surviving children, providing direct insight into child survival rates. At the same time, **chdead** records the number of deceased children, a crucial metric for determining mortality rates among offspring.

Geolev1, **birthyr**, and **bplid** also enhance the analysis by offering geographic and temporal context. **Geolev1** and bplid allow for identifying and analyzing patterns at provincial levels, highlighting specific provinces in Indonesia where child mortality may have been high or low and further refining the spatial analysis. **Birthyr**, which represents the mother's year of birth, situates each mother within a historical framework, enabling the correlation of child mortality with significant events, such as the famine of the 1940s. Collectively, these variables do more than merely calculate child mortality rates; they provide a comprehensive understanding of how child mortality patterns serve as indicators of famine incidence.

3.2.2 Constructed Variables

This study created several new variables through recoding and data preparation to facilitate a more precise analysis of child mortality patterns in Indonesia during the 1940s. These constructed variables address missing data and inconsistencies in the original dataset, ensuring reliable and accurate results. The new variables include a cleaned numeric age variable, a calculated birth year, modified versions representing the number of children surviving, death, and ever born, the respondent's province of birth decoded from IPUMS codes, and a binary indicator of the last child's survival status. These variables were created to provide a more robust foundation for analysing child mortality patterns in Indonesia during the target period, allowing for a more detailed and precise examination of the data. The details are briefly explained in Table 3.3, which explains the variable's name, unit, and description.

Table 3.3 Constructed Variables for Analysis

Variables	Unit	Description
age_new	year(s) old	A numeric variable indicating the respondent's age in years at the time of the survey. This variable was cleaned to remove phrases like "less than 1 year", "year", or "years", as well as any missing data in the 'age' variable.
birthyr_new	4-digit number	The variable referring to the year of birth of respondents was created by subtracting the age from the census year, which was 1980. This was done to address missing or unknown data in the original variable, 'birthyr'.
chsurv_str	person	The number of children respondents had who were alive during the data collection. This variable was modified from its original form, 'chsurv', which was cleaned of unknown and missing data, and additional words such as "child" or "children"
chdead_str	person	The number of children respondents had who had died during the data collection. This variable was modified from its original form, 'chdead', which was cleaned of unknown and missing data, and additional words such as "child" or "children".
chborn_str	person	The number of children ever born to the respondent. This variable was modified from its original form, 'chborn', which was cleaned of unknown and missing data, and additional words such as "child" or "children".

birth_province	label (province name)	The province of birth of the respondent, obtained by decoding the 2-digit code ranging from 11-94, which corresponds to the IPUMS code for each province in Indonesia.
New_lastbmort	0/1	Indicates status of last childbirth 1 for dead and 0 for alive.

Source: IPUMS

3.2.3 Descriptive Statistics

Table 3.4 presents descriptive statistics for key variables used to analyse child mortality patterns in Indonesia. From the 806,133 observations the average age of respondents is approximately 50 years, with birth years ranging from 1895 to 1944. On average, respondents had about 5.5 children born, with four surviving and 1.5 deceased. The data shows considerable variation in family size and child mortality, with some respondents having no children and others having up to 30 children born or surviving. The maximum number of deceased children reported is 20. These statistics provide a snapshot of the study population's demographic characteristics and child mortality experiences, setting the stage for more detailed analyses of child mortality patterns during the 1940s in Indonesia.

Table 3.4 Descriptive Statistics of Important Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
age new	806,133	50.46416	11.0428	36	85
birthyr new	806,133	1929.536	11.0428	1895	1944
chborn_str	806,133	5.534	3.435992	0	30
chsurv_str	806,133	4.072	2.61985	0	30
chdead_str	806,133	1.461	1.856743	0	20

Source: IPUMS

3.3 Analysis Method

This section outlines the methodological framework employed to analyse Child Mortality Rates (CMR) during the 1940s. The analysis integrates demographic and statistical techniques to assess how child mortality patterns reflect the impact of wartime famine. First, we categorize mothers into birth cohorts, facilitating the comparison of child mortality across generational groups. We then calculate CMR by dividing the number of child deaths by the total number of births within each cohort, using this as a key indicator of famine-related stress.

Geographic information system (GIS) technology is employed to enhance the spatial understanding of these patterns, mapping child mortality rates across different regions of Indonesia. This visualization helps identify temporal and geographic variations in child mortality patterns that may indicate mortality shocks most affected by war and/or famine. Additionally, logistic regression models are applied to estimate the probability of last-child mortality, factoring in temporal (year of last childbirth) and geographic variables. Control variables such as family size, age of married, and literacy are included to isolate the specific effects of famine and conflict on child mortality. This comprehensive approach allows for an in-depth exploration of how demographic and regional factors interacted to shape child mortality during this turbulent period.

3.3.1 The average number of children ever born and dead over time and across region

A comprehensive examination of the average number of children born, children who survived, and children who died among mothers born between 1895 and 1944 across different regions requires a detailed analysis involving data aggregation and the calculation of summary statistics. First, the data will be segmented by the period, focusing specifically on mothers born within the specified years, and categorized by region to understand regional variations in fertility and child mortality rates. We will calculate the means for the number of children ever born, as well as the number of children who survived and those who died. These averages will clearly measure central tendency, offering insights into the typical number of births and survival rates across the different cohorts and regions. To assess the variability within these groups, we will also calculate the standard deviations,

which will help us understand the extent of variation around these averages and indicate the consistency of these demographic patterns. The analysis will further explore temporal trends, examining how these averages have evolved within the specified cohort. By calculating and summarizing these key statistics, we aim to provide a clear and detailed understanding of the demographic patterns concerning children ever born, children who survived, and children who died among mothers born from 1895 to 1944. This approach allows us to capture how these metrics vary over time and across different regions, offering a descriptive overview of the demographic trends within the population.

3.3.2 Calculating Child Mortality rate (CMR)

This study examines the Child Mortality Rate (CMR) by categorizing mothers into birth cohorts, which enables me to explore differences in child mortality among various generational groups. The CMR for each cohort is determined by dividing the number of children who died by the total number of children born to mothers within that cohort. For example, if a cohort comprises mothers born between 1895 and 1905, the CMR for this group would be calculated by tallying the total number of child deaths and births among these women.

The child mortality rate is calculated using the formula:

$$CMR_{Cohort} = \frac{\sum(Number\ of\ Children\ Who\ Died_{cohort})}{\sum(Total\ Number\ of\ Children\ Born_{cohort})} \quad 3\text{-}1$$

Where:

CMR_{Coho} is the Child Mortality Rate for a specific birth cohort.

$\sum Number\ of\ Children\ Who\ Died_{coho}$ is the total number of children who died within that cohort, which is on this data, is **chdead_str**.

$\sum Total\ Number\ of\ Children\ Born_{coho}$ is the total number of children born to mothers within that cohort, which is on this data, is **chborn_str**.

This analysis aims to reveal the demographic shifts across different generational groups by examining the Child Mortality Rate (CMR) within specific birth cohorts. By categorising mothers into distinct birth cohorts and calculating the CMR for each, this study particularly focuses on revealing child mortality patterns as an indicator of famine incidence during the 1940s in Indonesia. The study highlights how wartime conditions and the associated famine influenced child mortality rates by analysing the CMR during this period. The findings will provide insights into how these external factors, especially the famine, impacted mortality trends, serving as a crucial indicator of the broader demographic changes and challenges faced by populations during this critical period in Indonesian history.

3.3.3 Birth Cohorts Analysis

For this study, women have been categorized into different birth cohorts to analyse child mortality rates in Indonesia during the 1940s. This approach enables us to assess the effects of famine incidence during this period, with a particular focus on the Japanese Occupation and the Indonesian National Revolution from 1942 to 1949, where we anticipate shocks in child mortality due to war and famine.

This study's categorization of birth cohorts is structured with 1945 as the reference year, a significant period marked by the famine during the Japanese Occupation and the Indonesian National Revolution. This method allows for a detailed examination of child mortality rates concerning women's age and childbearing ability at that crucial time. Cohort 1 (1895-1904) comprised women aged 41-50 years in 1945, typically beyond their peak childbearing age. Cohort 2 (1905-1914) included women aged 31-40 in 1945 who were in their later reproductive years. Cohort 3 (1915-1924) includes women aged 21-30 in 1945, aligning with their peak childbearing years. Cohort 4 (1925-1934) comprised individuals aged 11-20 in 1945, representing women beginning or approaching their reproductive years. Finally, Cohort 5 (1935-1944) consists of women aged 1-10 in 1945 who were too young to bear children at the time but whose experiences during this period may have long-term implications.

This study employs a comparative cohort analysis examining the impact of the 1942-1949 crisis period on Child Mortality Rates (CMR), focusing on the contrast between women in their reproductive years during the crisis and those who were either past or had not yet reached childbearing age. Our primary analysis group combines Cohorts 2 and 3 (women born 1905-1924), representing women aged 21-40 in 1945. This combined cohort is particularly significant as they span the complete reproductive age range during the crisis period, with their childbearing years directly coinciding with both the Japanese Occupation and National Revolution. Their CMR data expected to capture the possible impact of the 1945 peak famine year and provides continuous mortality data throughout the crisis.

We analyse this primary group against two distinct comparison groups to establish meaningful comparisons. The first comparison group comprises Cohort 1 (1895-1904), past their peak reproductive years during the crisis, aged 41-50 in 1945. This cohort's CMR data, primarily from the pre-crisis period, serves as a historical baseline for child mortality patterns and enables the identification of crisis-specific mortality trends. The second consists of Cohorts 4 and 5 (1925-1944), who experienced the crisis before their reproductive years, aged 1-20 in 1945. Their CMR data reflects post-crisis childbearing and allows examination of delayed effects on child mortality patterns.

Our analytical framework examines CMR across three key temporal phases: the pre-crisis baseline (before 1942), the crisis period (1942-1949) - which includes the Japanese Occupation phase (1942-1945), peak famine year (1945), and the Revolutionary period (1946-1949) - and the post-crisis period (after 1949). This temporal division allows for systematic comparison of CMR between the primary analysis group and comparison groups, assessment of mortality patterns based on maternal age during crisis, and examination of temporal variations in CMR across different phases. The framework focuses explicitly on identifying CMR spikes during critical periods, comparing trends before and during the crisis, evaluating recovery patterns in the post-crisis period, and analyzing differential impacts based on the timing of exposure.

This focused methodology enables us to utilize Child Mortality Rates (CMR) as a critical demographic indicator to identify and measure the severity of famine conditions in Indonesia during the 1940s. By analysing CMR patterns across different maternal cohorts,

we can trace the trajectory of potential famine conditions throughout the Japanese Occupation and National Revolution period, with particular attention to the peak famine year of 1945. The comparison between women of reproductive age during the crisis and other cohorts allows us to detect variations in CMR that signal the presence and intensity of famine conditions. Examining these mortality patterns can identify possible disruptions in periods of acute food shortage and broader crisis impacts, providing a demographic lens for understanding the severity and timing that suggests famine conditions across different regions of Indonesia. This approach contributes to the historical documentation of famine in 1940s Indonesia by using CMR as a quantitative measure of crisis intensity, helping to establish a more precise timeline of famine conditions and their demographic impact during this critical period of Indonesian history.

3.3.4 Geographic Information System (GIS)

This study employs Geographic Information System (GIS) mapping technology to analyse spatial patterns of child mortality rates (CMR) in Indonesia during the 1940s, focusing on 1942 to 1949. GIS is utilized to map demographic data onto specific regions, enabling the identification of spatial patterns and regional disparities in CMR, which serves as a critical indicator of famine conditions. The methodology involves thematic mapping, using a colour gradient from yellow to red to visualize CMR across regions. This approach effectively highlights areas most severely impacted by famine conditions, providing an intuitive visual representation of the data. Alongside thematic mapping, spatial clustering analysis is conducted to identify high or low CMR clusters, revealing geographic concentrations of famine impact. This technique allows for detecting hotspots where famine conditions were particularly severe and areas that may have been relatively less affected.

Temporal analysis is also a vital component of this methodology. By examining CMR patterns across different birth cohorts, the study aims to understand how famine conditions evolved. This temporal dimension provides insights into the progression of the famine and its varying impacts on different generations. Integrating statistical and spatial analysis is a crucial aspect of this approach. By combining demographic data with GIS-based

mapping, the study enhances the interpretation of CMR patterns. This integration allows for a more sophisticated understanding of the relationships between geographic factors, historical events, and population health outcomes. This comprehensive approach enables a detailed examination of how CMR, as a famine indicator, varied temporally and spatially within Indonesia during significant historical upheaval. In this context, GIS facilitates the visualization of complex demographic data and enables a more robust analysis of the relationship between geography, historical events, and population health outcomes.

By employing these advanced GIS techniques, the study identifies potential mortality shocks across different geographic regions, which may indicate localized impacts of famine during this period. The methodology demonstrates the utility of CMR as an indicator for detecting unusual demographic patterns that could suggest famine conditions in specific areas of Indonesia during the 1940s. The resulting spatial and temporal analysis provides insights into mortality variations across regions, highlighting areas that experienced significant deviations in child mortality rates that align temporally with documented periods of food insecurity and warrant further investigation to understand their relationship with potential famine events.

3.3.5 Estimates Probability last child dead over time and regions (1935-1955)

To further refine our understanding of famine's impact, this research phase focuses on last-child mortality as a specific indicator of famine in Indonesia during 1940s. By examining the probability of last-child mortality during the Japanese occupation (1942-1945) and the Indonesian War of Independence (1945-1949), we aim to identify mortality spikes that may signal famine conditions on individual families. This approach allows us to detect sudden spikes in child mortality that may signify periods of intense food scarcity or societal disruption, providing a more sensitive measure of famine's temporal and geographic patterns. The analysis of last-child mortality offers a unique window into how famine affected families at critical moments, potentially revealing the impact of food shortages, economic collapse, and conflict on child survival rates during these historically significant periods.

The logistic regression model is a suitable choice for analysing the relationship between predictor variables (the year of the last childbirth and the geographic location of her residence) and a binary variable (mortality of the last child) (Agresti, 2013; Chutinantakul et al., 2013). We use a logistic regression model in this analysis to examine the factors associated with child mortality at last birth (new_lastbmort), specifically focusing on regional variations (geolev1_cat), last child year of birth (lastbyr), and the control variables such as family size, number of children, age at marriage, literacy, and educational attainment. The primary goal of the analysis is to understand how child mortality rates varied across provinces and over time, especially during the Japanese occupation of Indonesia (1942-1945) and the Indonesian War of Independence (1945-1949), with the expectation that the peak shock to child mortality occurred between 1944 and 1945. Mathematically, the logistic regression model can be expressed as follows:

The logistic regression model may be theoretically represented as:

$$log\left(\frac{p}{1-p}New\_lastmort\right) = \beta_0 + \beta_1 \cdot Lastbyr + \beta_2 \cdot Geographic\ Location + \beta_3.famsz + \beta_4.agemar + \beta_5.Lit \quad 3\text{-}2$$

Where:

- p is the probability of mortality of the last child,
- $\beta_0, \beta_1, \beta_2, \beta_3 - \beta_5$ are the regression coefficients to be estimated from the data,
- *new_lastbmort* is the dependent variable representing last-child mortality (1 = child dead, 0 = child alive). This variable is derived from the lastbmort variable, which documents the survival status of a woman's final live-born child, irrespective of the temporal distance from the birth event. The analysis is restricted exclusively to live births, with no imposed temporal constraints on the birth interval.

  Independent Variables:

- *Lastbyr* represents the indicates the year of birth of the last child born by the respondent. The data refer to live births.
- "Geographic Location" is a categorical variable representing the province of individuals place of birth.

  Control Variables:

- *Famsz* counts the number of the person's own family members living in the household with her/him, including the person her/himself. These include all persons

related to the person by blood, adoption, or marriage as indicated by the census forms or inferred from them.

- *Agemar* indicates the person's age at first marriage or consensual union.
- *Lit_new* indicates whether the respondent could read and write in any language. A person is typically considered literate if he or she can both read and write. All other persons are illiterate, including those who can either read or write but cannot do both. Constructed from Lit variable, with the value 0 = illiterate and 1 = literate

Model Explanation:

This logistic regression model predicts the log-odds of a binary outcome, specifically whether the last child is deceased (new_lastbmort), as a function of various independent variables. One key variable is geolev, which captures regional differences in child mortality by comparing each region to a reference category (with the lowest CMR regions from birth cohorts' analysis as the baseline). Lastbyr measures the impact of the last child's birth year on mortality, comparing each year to a baseline year (i.lastbyr). Several control variables are included to account for other factors that could influence child mortality: famsz controls for family size, as larger families may face resource constraints that affect child survival; agemar captures the effect of parents' age at marriage on child mortality; lit_new controls for literacy status, assuming that literacy improves access to healthcare and knowledge of child-rearing.

The main objective of the study is to investigate how two key periods of conflict, the Japanese occupation (1942–1945) and the Indonesian War of Independence (1945–1949), affected child mortality, with a particular focus on the famine-like conditions during 1944–1945. The year of birth variable (*lastbyr*) will allow us to capture potential temporal shocks in child mortality, especially during wartime, when food insecurity, economic disruption, and health crises were likely prevalent. The inclusion of geolev1_cat helps to account for geographic variation, as certain regions may have experienced these shocks differently based on their exposure to conflict, famine, or the strength of local infrastructure.

Interpretation of the results:

1. Interpreting Key Variables:

    a. Year of Last Birth (*Lastbyr*)

The coefficient for *lastbyr* indicates how the birth year of the last child affects the probability of mortality. A positive β for a particular year suggests that children born in that year faced a higher risk of mortality compared to the reference year (1935), whereas a negative β suggests a lower risk. Peaks in the last-child mortality rates during the years 1944-1945, for instance, would confirm the hypothesis that famine-like conditions during the late Japanese occupation severely impacted child survival.

    b. Geographic Location (*geolev1_cat)*:

The variable geolev1_cat reflects the influence of the respondent's region on child mortality. Regions with higher β coefficients have higher odds of last-child mortality than the baseline region (the province that had the lowest average number of children). This would show how regional factors, such as local food availability, healthcare access, or proximity to conflict zones, contributed to variations in child mortality during wartime. Significant regional variations may suggest that certain provinces were more vulnerable to famine and conflict-related disruptions.

2. Control Variables:

Including control variables in the logistic regression model is crucial for accurately estimating the effects of primary independent variables (e.g., year of last birth and geographic location) on last-child mortality. Control variables help isolate the impact of regional and temporal variations by accounting for other factors that could influence child survival, such as family size, parental age at marriage, literacy, and education. Without these controls, the model might produce biased or misleading results. By incorporating these additional variables, the analysis provides a more comprehensive understanding of how famine, conflict, and socio-economic factors collectively affected child mortality during the period under study.

    a. Family Size (*Famsz*):

A positive β coefficient for family size (famsz) suggests that children in larger families face higher mortality risks, likely due to competition for limited resources like food and healthcare. This aligns with existing research showing that larger families often experience higher child mortality rates and poorer health outcomes (Taylor et al., 1976; Wagner et al., 1985). Conversely, a negative β would indicate that larger families have lower child mortality, possibly due to extended support networks - though this would contradict most empirical evidence.

b. Age at Marriage (Agemar):

A younger age at marriage (negative β) could be associated with higher mortality, potentially due to maternal immaturity, lack of experience, or socio-economic disadvantages (Delprato & Akyeampong, 2017; Garcia-Hombrados, 2022). Conversely, an older age at marriage might correlate with improved maternal health and child survival, as it often aligns with better economic and social conditions.

c. Literacy (Lit_new):

Literacy is typically associated with better knowledge of health practices, access to information, and healthcare resources. A negative β for lit would indicate that literacy decreases the odds of child mortality, supporting the notion that educated parents are better equipped to ensure their children's survival (Murthi et al., 1995; Smith-Greenaway, 2013).

3. Temporal and Regional Effects

a. Temporal Effects (Lastbyr): The key focus of this analysis is the impact of wartime and post-war conditions on last-child mortality. If the coefficients for lastbyr during 1944-1945 show a sharp increase in mortality, it supports the assumption that the famine conditions during the Japanese occupation directly impacted child survival.

b. More importantly, if 1945-1949 also shows elevated mortality, famine-like conditions continued during the Indonesian War of Independence. The years following Japanese Occupation were marked by food scarcity, displacement, and

continued conflict, which likely contributed to high mortality rates. These temporal peaks help to isolate when the famine conditions were most severe.

c. Geographic Effects (Geolev1_cat): Regional differences in last-child mortality during 1945-1949 could reveal uneven impacts of post-war famine and conflict. Certain regions may have been more affected by the collapse of local economies, disruptions in food supply chains, or continued fighting. Higher odds of mortality in specific regions would suggest that regional conflict localized or exacerbated famine conditions, indicating where the need for post-war aid and intervention was most critical.

4. Model Fit and Goodness-of-Fit Measures

After interpreting the coefficients, evaluating the overall model fit is crucial. Measures such as the pseudo R-squared, or the likelihood-ratio test will indicate how well the model explains variations in last-child mortality (Chutinantakul et al., 2013) . A significant model fit, particularly during famine years, would confirm that the predictors (e.g., year of last birth and geographic location) are strong indicators of child mortality in times of crisis.

The logistic regression results help illuminate how conflict and potential famine conditions during 1942-1949 affected last-child mortality, with a particular focus on the post-1945 period. Elevated child mortality rates during the Indonesian War of Independence would confirm that famine-like conditions persisted after the Japanese occupation, reflecting the severe disruptions to food supply, healthcare, and family stability. Regional differences would further highlight areas most affected by these conditions, offering valuable insights for historians and policymakers studying the demographic impacts of conflict and food insecurity during this critical period in Indonesian history.

Descriptive statistics

Table 3.5 presents the descriptive statistics for the key variables used in analysing child mortality at last birth across different regions and periods. The dataset consists of 121,275

observations, capturing important socio-demographic characteristics such as the year of the last child's birth, regional variation, family size, age at marriage, and literacy. These descriptive statistics provide an overview of the distribution and variation of the dependent variable (child mortality) and the control variables, which are crucial for understanding the socio-economic context in which child mortality occurs. This summary serves as a foundation for the subsequent logistic regression analysis, helping to contextualise how family characteristics and regional differences contribute to child survival outcomes, especially during periods of significant historical disruption such as the Japanese occupation (1942-1945) and the Indonesian War of Independence (1945-1949).

Table 3.5 Descriptive Statistics of logistic regression variables

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
new lastbmort	121275	.122	.327	0	1
lastbyr	121275	1947.992	5.731	1935	1955
geolev1 cat	121275	11.479	8.427	1	26
famsz	121275	4.439	2.652	1	28
agemar	121275	17.065	3.654	10	49
lit new	121275	.159	.365	0	1

Source: IPUMS

The descriptive statistics examines data from 121,275 observations spanning from 1935 to 1955. The dependent variable, new_lastbmort, shows that approximately 12.2% of last-born children did not survive (mean = 0.122), with a standard deviation of 0.327. The average year of last birth (lastbyr) was approximately 1948, with a standard deviation of 5.7 years. The geographical distribution across provinces (geolev1_cat) spans 26 different provinces, with a mean of 11.48 and a standard deviation of 8.43, indicating a broad spatial distribution of the sample.

The demographic characteristics reveal that the average family size (famsz) was about 4.44 members, ranging from 1 to 28, with a standard deviation of 2.65. Women in the sample married relatively young, with the mean age at first marriage (agemar) being 17.07 years, ranging from 10 to 49 years, with a standard deviation of 3.65 years. Literacy levels (lit_new) were notably low, with only 15.9% of respondents able to read and write (mean

= 0.159, SD = 0.365), indicating significant educational constraints during this historical period.

3.4 Limitations

This study faces several limitations that could impact the interpretation and robustness of its findings. A significant limitation is our data's multiple layers of survival bias. First, since the IPUMS data from 1980 only includes information from women who survived until that year, women who died during or shortly after the wartime 1940s are not represented in the dataset. Second, there is likely a selection bias among the recorded births, as children born during this period may represent those conceived and delivered under relatively better circumstances, thus having higher survival probabilities. Additionally, the severe conditions during this period likely led to reduced fertility rates and 'lost births' that are inherently unobservable in our data. These combined selection effects could lead to an underestimation of both child mortality rates and the full demographic impact of the period, as women who experienced higher child mortality or severe hardship may have been more likely to die before 1980, thus not being captured in the study (Elston, 2021).

A second major limitation stems from the lack of precise temporal data in the IPUMS dataset. The absence of exact dates for children's births and deaths creates significant analytical challenges. Without this crucial temporal information, we cannot calculate age-specific mortality rates or differentiate between infant and under-5 mortality (Hug et al., 2017; Ve. et al., 1978). This temporal gap also makes it challenging to link deaths to specific historical events or understand how the famine affected children at different developmental stages.

The study is further constrained by the limited availability of relevant control variables, as the 1980 census data from IPUMS does not fully reflect the socioeconomic conditions of the 1940s, particularly during the period under investigation (1942-1949). This issue arises not because such information is absent from the historical record but because some control variables available in the 1980 census are not relevant or appropriate for the specific context of the 1940s. For example, key variables that might have been relevant to

understanding mortality during the 1940s famine, such as rural-urban distinctions, are not applicable when using 1980 census data, as these geographic and demographic classifications may have changed significantly over the decades. Similarly, migration patterns—which could have played a critical role in influencing mortality rates during and after the famine—cannot be accurately captured or reconstructed from the 1980 census alone. This further limit our ability to track population movements or shifts in settlement patterns, which are essential for understanding how the famine impacted different regions and communities.

Table 3.6 The year of last birth frequency 1935-1955

year of last birth	Freq.	Percent	Cum.
1935	3646	3.01	3.01
1936	1146	0.94	3.95
1937	1480	1.22	5.17
1938	2098	1.73	6.90
1939	1739	1.43	8.34
1940	**8056**	6.64	14.98
1941	2163	1.78	16.76
1942	5078	4.19	20.95
1943	3305	2.73	23.67
1944	3197	2.64	26.31
1945	**11098**	9.15	35.46
1946	3191	2.63	38.09
1947	3492	2.88	40.97
1948	5311	4.38	45.35
1949	4108	3.39	48.74
1950	**15774**	13.01	61.75
1951	4995	4.12	65.86
1952	7445	6.14	72.00
1953	7559	6.23	78.24
1954	7372	6.08	84.31
1955	**19022**	15.69	100.00
Total	121275	100.00	

Source: IPUMS

lastly, A notable limitation in this study is age heaping, a phenomenon where reported values tend to cluster or concentrate around specific numbers, typically due to rounding or recall bias in survey responses (Colvin et al., 2024; Schmertmann et al., 2024). This pattern is evident in our year of last birth (lastbyr) variable, as shown in Table 5.1. The data exhibits substantial clustering around years ending in '0' and '5', particularly concerning heaping in 1945, a critically important year marking the peak of the famine period according to existing

literature. The data shows 11,098 reported births (9.15%) in 1945, which is markedly higher than in adjacent years: 3,197 births (2.64%) in 1944 and 3,191 births (2.63%) in 1946. Similar heaping patterns are observed in 1950 (13.01%) and 1955 (15.69%). This systematic pattern of digit preference, where respondents appear to round their children's birth years, suggests significant recall bias that potentially compromises our ability to accurately assess the demographic impacts of the 1945 famine period, as it contradicts expected fertility decline during severe food shortages.

CHAPTER IV

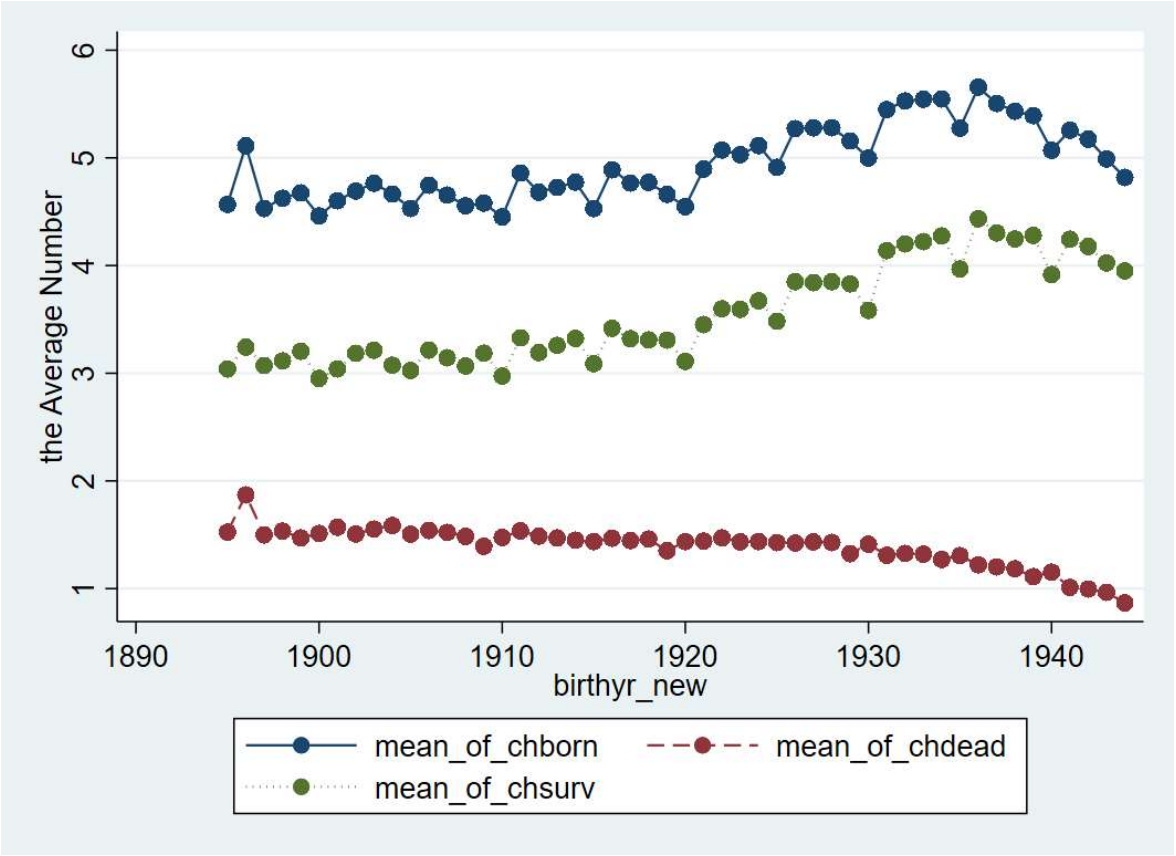
Results

This chapter presents the findings from the data analysis, focusing on descriptive and inferential assessments. First, the analysis of descriptive statistics for children ever born, deceased, and surviving will be discussed. Following this, examining child mortality rates (CMR) will be explored, focusing on birth cohorts and the regional variations visualized through Geographic Information Systems (GIS) mapping. Lastly, a regression analysis will be conducted to evaluate the probability of child mortality based on individual women's data, specifically analysing the likelihood of death of their last-born child. The objective is to identify patterns in child mortality, particularly those associated with famine in Indonesia during the 1940s.

4.1 Average Number of Children Born, Dead, and Surviving by Mother's Birth Cohort (1895-1944)

This section presents the analysis of the trends in fertility, child survival, and child mortality based on the birth cohorts of mothers from 1895 to 1944. The findings emerge from analysing trends in mean numbers of births, surviving children, and child deaths, as illustrated graphically and supported by statistical evidence in Appendix 1. The data reveals substantial changes in these demographic measures across different periods.

Figure 4.1 Trends in Average Number of Children Born, Surviving, and Deceased by Mother's Year of Birth (1895-1944)



Source: IPUMS

The figure 4.1 above, alongside the appendix 1, visually represents the trends in the average number of children born, dead, and surviving for mothers born between 1895 and 1944. The blue line representing the mean number of children born (mean_of_chborn) shows a relatively stable trend for mothers born from the late 1890s to the early 1940s. For mothers born in the late 19th century, the average number of children fluctuates slightly but remains consistent at approximately 4.5 to 5.0 children per mother. This average slightly increased among mothers born in the 1920s, peaking at around 5.5 for those born in the 1930s before declining for mothers born in the 1940s. The data suggest that family sizes remained relatively large across these maternal birth cohorts, although there was a slight decline among the youngest cohorts.

The green dotted line, representing the average number of surviving children (mean_of_chsurv), shows a steady increase across maternal birth cohorts, particularly for mothers born after the turn of the century. Among mothers born between 1895 and 1910, the average number of surviving children was around 3.0. As child survival improved for subsequent maternal cohorts, the number of surviving children rose, with mothers born in the 1940s having an average of around 4.0 surviving children. In contrast, the red dashed line, representing the mean number of child deaths (mean_of_chdead), exhibits a clear downward trend across maternal birth cohorts. For mothers born in the early decades, particularly before 1910, child mortality was relatively high, averaging between 1.4 to 1.5 child deaths per mother. However, this trend steadily decreases among later cohorts, especially for those born after the 1920s, with child deaths dropping to around 1.0 for mothers born in the 1940s.

In summary, the patterns shown in Figure 4.1 illustrate a significant demographic transition through the relationship between fertility and child mortality across different maternal birth cohorts from the late 19th to mid-20th century. Although the number of children born remained relatively stable across cohorts, averaging between 4.5 and 5.5 children per mother, there was a marked improvement in child survival for mothers born in later years. The convergence between the number of children born and those surviving, coupled with the declining child mortality rate across successive maternal cohorts, represents a crucial phase in the demographic development of this population.

4.2 Average Children per Mother Across Provinces: Born, Dead, and Survived by Maternal Birth Cohort (1895-1944)

Within this sub-chapter, we examine the regional disparities in the mean number of children born, the deaths of children, and the survival of children to detect possible occurrences of famine in Indonesia throughout the 1940s. It examines the data for mothers born between 1895 and 1944 across different provinces. The information, presented through tables and GIS mapping, enables a detailed exploration of how regional disparities in birth, death, and survival rates may indicate areas affected by famine during this period. Combining tables and GIS graphics enhances the visibility of trends and differences among

various locations, facilitating a more detailed comprehension of demographic changes throughout this period.

First, we observe the regional variations in the average number of children born, as presented in Table 4.1 below. This table details the average number of children born to mothers across various provinces in Indonesia, categorized by the mothers' birth years from 1895 and 1944, along with the standard deviation (SD) for each region. The data reveals significant regional differences in the average number of children born. North Sumatra had the highest average, with 6.313 children per mother, followed closely by Bengkulu (6.227) and Lampung (6.189). Other provinces with high averages include Riau and Kepulauan Riau (6.174) and West Nusa Tenggara (6.146).

Table 4.1 Average Number of Children Born to Mothers by Province, Based on Mother's Birth Year (1895-1944)

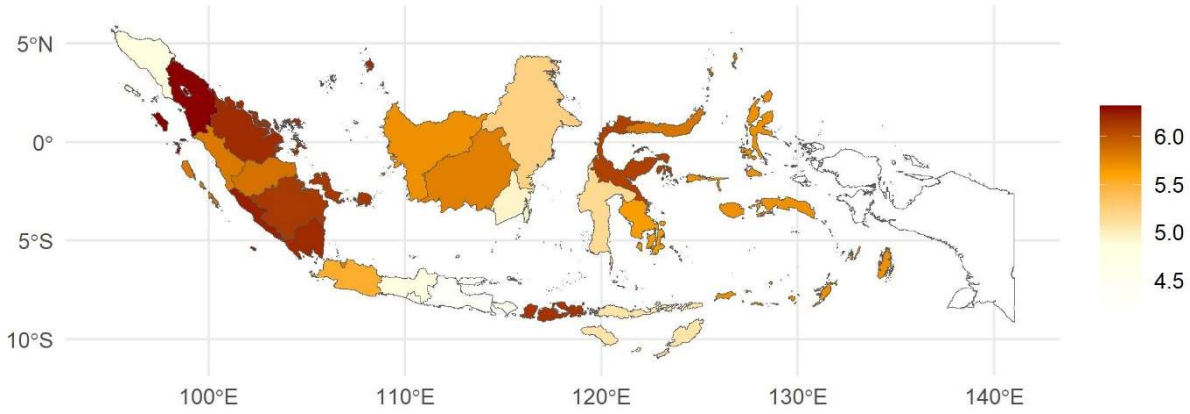
Provinces	mean	sd
Bali	4.415	3.387
Bengkulu	6.227	3.219
Central Java	4.839	3.286
Central Kalimantan	5.777	3.407
Central Sulawesi	6.078	3.632
East Java	4.261	3.212
East Kalimantan	5.224	3.476
East Nusa Tenggara	5.076	3.531
Jambi	5.846	3.248
Lampung	6.189	3.438
Maluku and North Maluku	5.692	3.579
North Sulawesi and Gorontalo	5.824	3.588
North Sumatra	6.313	3.443
Papua and West Papua	4.149	3.016
Riau and Kepulauan Riau	6.174	3.308
South Kalimantan	4.953	3.301
South Sulawesi and West Sulawesi	5.163	3.353
South Sumatra and Bangka Belitung	6.124	3.33
Southeast Sulawesi	5.628	3.414
Special Capital Region of Jakarta	5.769	3.72
Special Region of Aceh	4.869	3.054
Special Region of Jogyakarta	4.579	3.005
West Java and Banten	5.512	3.693
West Kalimantan	5.691	3.432
West Nusa Tenggara	6.146	3.501
West Sumatra	5.813	3.214

Source: IPUMS

Conversely, provinces such as Papua and West Papua had the lowest average, with 4.149 children per mother, along with East Java (4.261) and Bali (4.415). Central Java (4.839) and the Special Region of Aceh (4.869) showed moderate average births. The standard deviation for each province indicates some variability within regions, with Jakarta having a higher variability (3.72) compared to provinces like Yogyakarta (3.005), which showed more consistency in the number of children born. These findings highlight distinct regional differences in the average number of children born across the country during this period.

Following the analysis of Table 4.1, Figure 4.2 provides a visual representation of these variations. The map uses colour gradients to illustrate the disparities, with darker shades (red to yellow) indicating provinces where mothers had higher averages of children born and lighter shades (yellow to white) representing lower averages.

Figure 4.2 Average Number of Children Born to Mothers by Province, Based on Mother's Birth Year (1895-1944)



Source: IPUMS

Regions with the highest averages (over six children per mother) in the table, such as North Sumatra, Bengkulu, and Lampung, are highlighted in dark red on the map to emphasize their significantly higher fertility rates. Whereas provinces such as Papua and West papua, East Java, and Bali, with the lowest averages of 4 children per mother, are depicted by lighter colours (white colour), indicating lower birth rates. This picture

illustrates the geographical patterns, where greater averages are concentrated in Western Indonesia while lower averages are more characteristic of Eastern Indonesia.

After analysing the regional variations in the average number of children born, we now turn to the patterns in child mortality across provinces. Table 4.2 presents the average number of children dead by province in Indonesia, reflecting each region's mean and standard deviation and showcasing significant variability in child mortality across the country.

Table 4.2 The Average Children Dead per Mother by Region in Indonesia, Based on Mother's Birth Year (1895-1944)

Provinces	mean	sd
Bali	.991	1.634
Bengkulu	1.776	2.043
Central Java	1.201	1.815
Central Kalimantan	1.304	1.785
Central Sulawesi	1.666	1.924
East Java	.989	1.621
East Kalimantan	1.109	1.642
East Nusa Tenggara	1.357	1.746
Jambi	1.769	2.126
Lampung	1.603	2.049
Maluku and North Maluku	1.475	1.846
North Sulawesi and Gorontalo	1.29	1.753
North Sumatra	1.282	1.786
Papua and West Papua	.771	1.311
Riau and Kepulauan Riau	1.583	1.912
South Kalimantan	1.468	1.955
South Sulawesi and West Sulawesi	1.396	1.795
South Sumatra and Bangka Belitung	1.671	2.04
Southeast Sulawesi	1.638	1.894
Special Capital Region of Jakarta	1.346	1.97
Special Region of Aceh	1.005	1.511
Special Region of Jogyakarta	.847	1.489
West Java and Banten	1.632	2.104
West Kalimantan	1.369	1.85
West Nusa Tenggara	2.203	2.28
West Sumatra	1.786	1.973

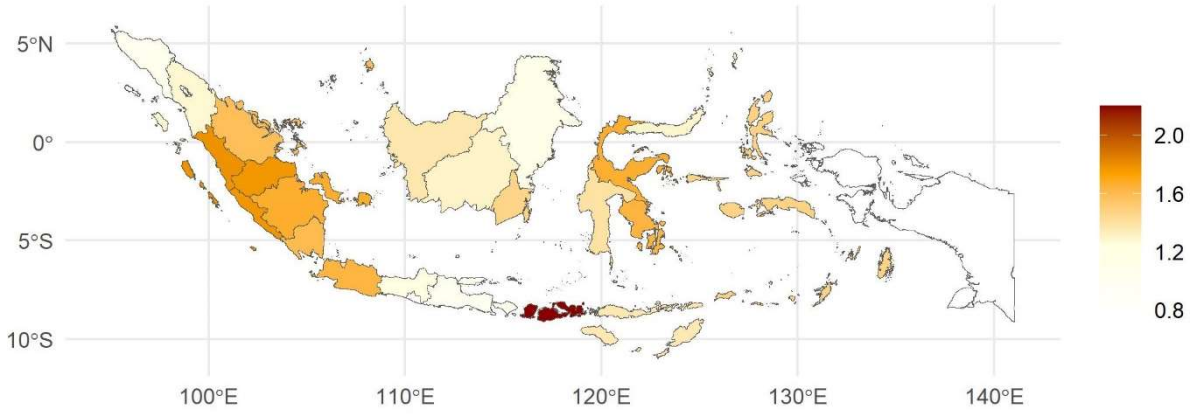
Source: IPUMS

West Nusa Tenggara had the highest average child mortality, with 2.203 child deaths per mother, followed by Bengkulu (1.776) and Jambi (1.769). On the contrary, Papua and West Papua had the lowest child mortality, with an average of 0.771 child deaths per

mother, along with Yogyakarta (0.847) and East Java (0.989). Provinces such as Central Java (1.201) and North Sumatra (1.282) exhibited moderate number of deceased children. The standard deviation values indicate variability within regions, with West Nusa Tenggara showing the highest variability (SD 2.28), suggesting a more comprehensive range of child mortality outcomes compared to more consistent regions like Yogyakarta (SD 1.489). This data highlights distinct regional differences in child mortality across Indonesia during this period.

Figure 4.3 visually presents the regional variations in the average number of children dead across Indonesia, from mothers' birth year between 1895 and 1944.

Figure 4.3 Average Number of Deceased Children per Mother by Region in Indonesia, Based on Mother's Birth Year (1895-1944)



Source: IPUMS

The map uses shades ranging from light yellow to dark red to represent the average number of children lost per mother, with darker colours indicating higher averages. The darkest areas on the map, such as West Nusa Tenggara, reflect the highest averages of child deaths (above 2.0), as shown in the table 4.2. Conversely, regions like Papua, Yogyakarta, and East Java, depicted in the lightest shades, indicate the lowest averages of child deaths (around 0.8 to 1.0). This visual representation highlights regional disparities, with higher averages clustering in Western Indonesia and parts of Nusa Tenggara, while Eastern Indonesia generally shows lower averages. The map effectively illustrates geographic

patterns in child mortality between 1895 and 1944, enhancing the understanding of these differences alongside the numerical analysis.

On the other hand, Table 4.3 presents a detailed overview of the average number of children who survived per mother across Indonesian provinces, focusing on mothers born between 1895 and 1944. The mean number of surviving children and the standard deviations (SD) vary considerably across provinces.

Table 4.3 Average Number of Surviving Children per Mother by Province in Indonesia, Based on Mother's Birth Year (1895-1944)

Provinces	mean	sd
Bali	3.426	2.603
Bengkulu	4.451	2.429
Central Java	3.637	2.52
Central Kalimantan	4.47	2.665
Central Sulawesi	4.41	2.817
East Java	3.271	2.505
East Kalimantan	4.115	2.813
East Nusa Tenggara	3.719	2.707
Jambi	4.08	2.498
Lampung	4.588	2.681
Maluku and North Maluku	4.214	2.789
North Sulawesi and Gorontalo	4.535	2.839
North Sumatra	5.032	2.804
Papua and West Papua	3.376	2.509
Riau and Kepulauan Riau	4.592	2.669
South Kalimantan	3.485	2.416
South Sulawesi and West Sulawesi	3.766	2.533
South Sumatra and Bangka Belitung	4.453	2.618
Southeast Sulawesi	3.995	2.636
Special Capital Region of Jakarta	4.422	2.914
Special Region of Aceh	3.865	2.524
Special Region of Jogyakarta	3.731	2.485
West Java and Banten	3.879	2.678
West Kalimantan	4.32	2.684
West Nusa Tenggara	3.943	2.492
West Sumatra	4.025	2.463

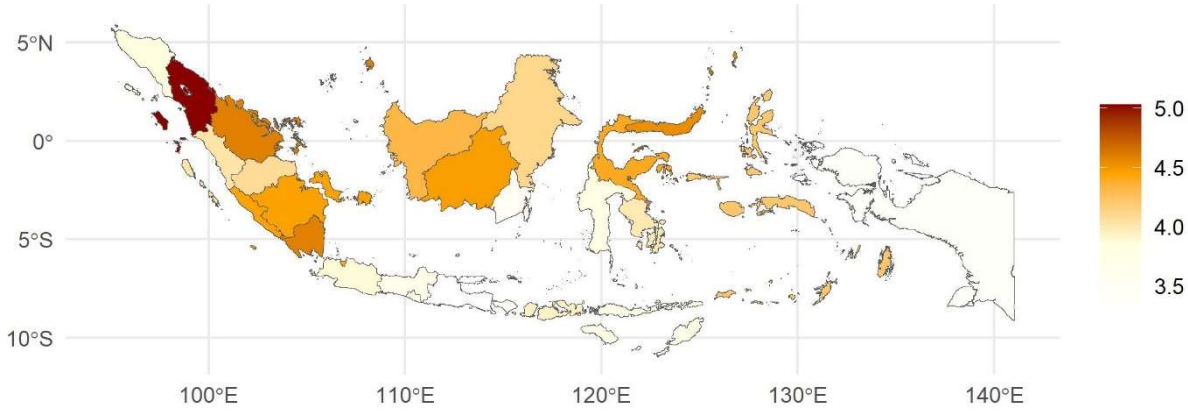
Source: IPUMS

Table 4.3 illustrates significant geographical disparities in child survival, with certain provinces displaying higher averages than others. North Sumatra has the highest average of surviving children (5.032), indicating better conditions for child survival in this region, whereas East Java has the lowest average (3.271), indicating less favorable outcomes.

There is a clear geographical pattern: provinces in Western Indonesia with higher average survival rates, including Lampung (mean = 4.588) and Riau and Kepulauan Riau (mean = 4.592), indicate better overall conditions. On the contrary, Eastern Indonesian regions such as East Nusa Tenggara (mean = 3.719) and Papua and West Papua (mean = 3.376) post lower averages, suggesting more difficult circumstances for children's survival during this period.

Figure 4.4 portrays the mean number of children who survived per mother throughout Indonesia, organized by color-coded provinces to indicate various survival rates. The darker shades, particularly in North Sumatra and parts of Western Indonesia, indicate higher averages of surviving children, with North Sumatra reaching values above 5.0. In contrast, lighter colours dominate Indonesia's eastern and central parts, especially in Papua and West Papua, reflecting lower averages of child survival, around 3.5 to 4.0. The gradient from dark red to light yellow highlights a distinct regional disparity, with Western Indonesia generally experiencing better child survival outcomes than Eastern Indonesia. The observed geographic pattern aligns with the data presented in Table 4.3, therefore emphasizing the observation of substantial variation in child survival rates across different provinces.

Figure 4.4 Average Number of Surviving Children per Mother by Province in Indonesia, Based on Mother's Birth Year (1895-1944)



Source: IPUMS

In brief, the details shown in the table and map provide a significant understanding of the variations in child survival, birth rates, and mortality throughout different regions of Indonesia in from mother born in the early 20th century. The significant disparity between Western and Eastern Indonesia underscores the necessity of addressing regional variations and limitations.

4.3 Child Mortality Rate (CMR) by Birth Cohorts

This sub-chapter analyses child mortality rates in Indonesia during the 1940s famine, based on the birth cohorts of women born between 1895 and 1944. We examine five cohorts, using women born between 1895-1904 as our reference category to compare with subsequent cohorts: 1905-1914, 1915-1924, 1925-1934, and 1935-1944. This allows us to analyse how child mortality patterns changed across generations of mothers. Additionally, we will explore regional variations in child mortality rates using map and GIS data, highlighting the spatial patterns of famine incidence across Indonesia.

4.3.1 Child mortality rate trends by birth cohorts

Table 4.4 below displays the child mortality rate per group of mothers born between 1895 and 1944, as well as the associated standard deviations. Over time, there has been a noticeable decrease in the child mortality rate (CMR) among these groups.

Table 4.4 CMR by birth cohorts

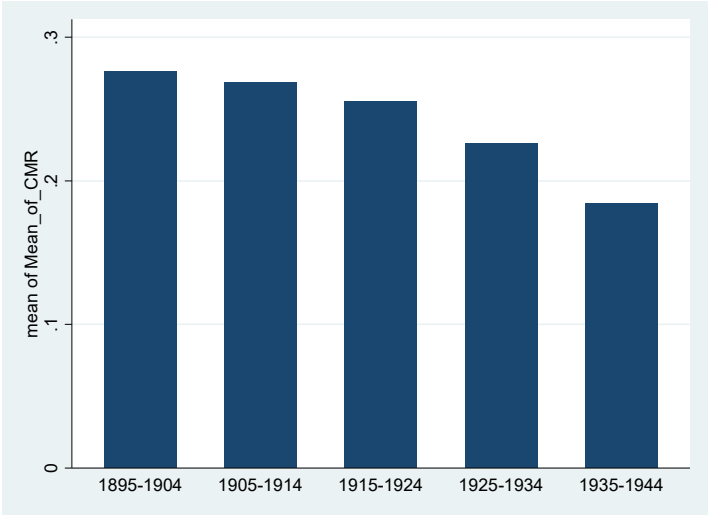
Cohorts	mean	sd
1895-1904	.276	.279
1905-1914	.268	.277
1915-1924	.255	.269
1925-1934	.226	.25
1935-1944	.184	.225

Source: IPUMS

Table 4.4 shows a consistent decline in child mortality rates (CMR) across five birth cohorts of women born between 1895 and 1944. The cohort born between 1895-1904 has

a mean CMR of 0.276 with a standard deviation of 0.279, indicating that 27.6% of children in this group died, with significant variability. For the cohort born between 1905-1914, the mean CMR decreases slightly to 0.268, with a standard deviation of 0.277. The downward trend continues with the 1915-1924 cohort, where the mean CMR drops to 0.255, and variability (sd = 0.269) also reduces. A more notable decline occurs in the 1925-1934 cohort, where the mean CMR is 0.226, and the standard deviation decreases to 0.250. The lowest mean CMR is observed in the 1935-1944 cohort at 0.184, with a minor standard deviation of 0.225. The data shows a consistent downward trend in the mean CMR and the variability (standard deviation) across the cohorts, pointing to an overall improvement in child mortality outcomes over time.

Figure 4.5 Child mortality rates trends by cohorts



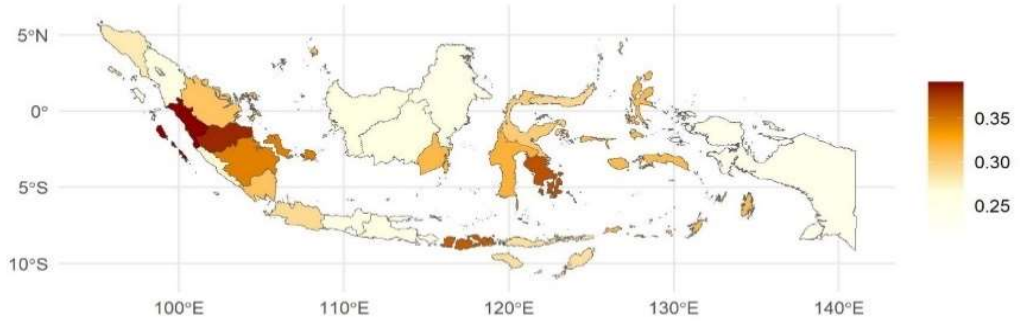
Source: IPUMS

Figure 4.5 confirms the analysis, showing a clear downward trend in the mean Child Mortality Rate (CMR) over time. The 1895-1904 cohort exhibits the highest mean CMR, followed by a consistent decline across successive cohorts, culminating in the lowest CMR for the 1935-1944 cohort. Both the figure and table highlight this steady decrease in CMR, indicating significant improvements in child survival for later-born mothers.

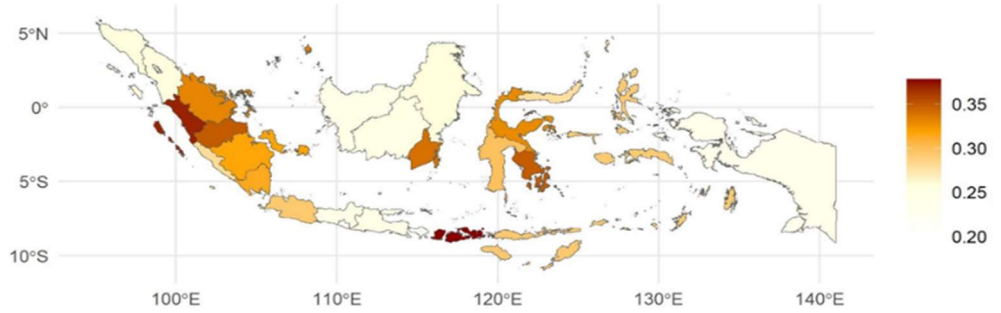
4.3.1 Regional Variation in Child Mortality Rates by Birth Cohorts

This section examines the regional variation in child mortality rates across different birth cohorts in Indonesia. By analysing data from women born between 1895 and 1944, we can observe how child mortality trends differed across various regions during the 1940s famine. By mapping CMR data across different regions and birth cohorts in Figure 4.6, these visualizations reveal distinct geographic patterns in child mortality rates. The expected results highlight the regions most affected by high child mortality rates and help pinpoint areas that potentially experienced particularly severe famine conditions.

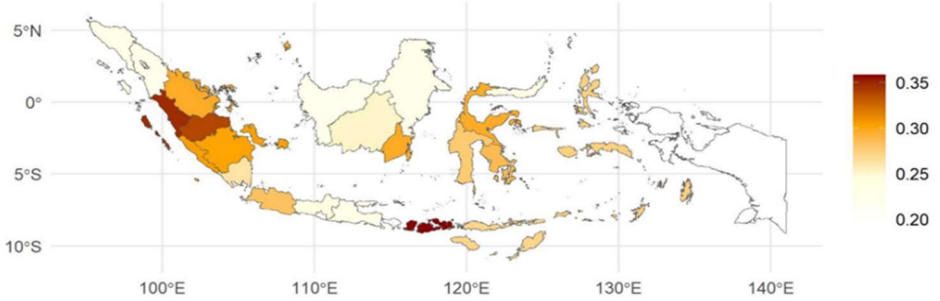
Figure 4.6 CMR Based on birth cohorts (1895-1944) across Indonesia



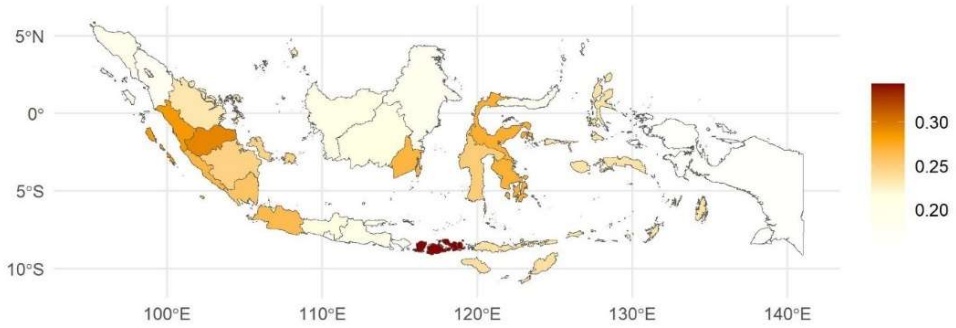
CMR birth cohorts 1 (1895-1905)



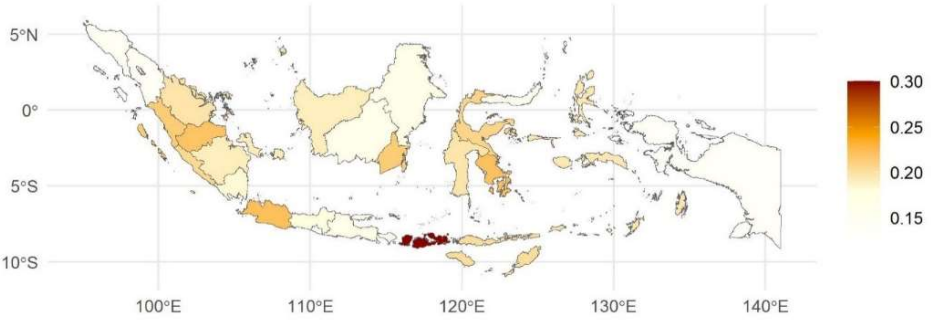
CMR birth cohorts 2 1905-1914



CMR birth cohorts 3 1915-1924



CMR birth cohorts 4 1925-1934



CMR birth cohorts 5 1915-1924

Source: IPUMS

From Figure 4.6 above and the appendix 2, across all birth cohorts (1895-1944), child mortality rates (CMR) show a consistent decline, with early cohorts (1895-1914) experiencing higher CMRs and later cohorts (1925-1944) exhibiting significant improvements. Several provinces emerge as outliers in the data due to consistently high or low child mortality rates (CMR) across multiple birth cohorts. The high CMR outliers are provinces where mortality rates remain significantly above the overall averages for most cohorts, and there is a noticeable darkening of the orange-to-red colour in the maps. Alternatively, the low CMR outliers consistently show rates well below the average yellow-to-white colour, indicating regions with low child mortality rates.

West Sumatra stands out as a high CMR outlier across all cohorts. In cohort 1 (1895–1904), its CMR was 0.392, one of the highest in the country, and although this figure declined over time, it remained elevated at 0.213 by cohort 5 (1935–1944). Similarly, West Nusa Tenggara consistently reports high CMR values, peaking at 0.378 in cohort 2 (1905–

1914) and remaining high in subsequent cohorts, with a CMR of 0.3 in cohort 5. Southeast Sulawesi also presents as an outlier, with a high CMR of 0.365 in cohort 1, maintaining elevated rates through cohort 5 despite gradual declines. Jambi follows a similar pattern, starting with a CMR of 0.382 in cohort 1 and sustaining relatively high levels at 0.219 in cohort 5. These provinces have experienced slower reductions in child mortality, with noticeable darkening and slowly brightening colour, making them persistent outliers with higher-than-average CMRs over time.

Some regions in Indonesia show moderate but relatively stable child mortality rates (CMR) across different cohorts without significant extremes. For example, Central Java consistently reports mid-level CMRs, starting at 0.255 in cohort 1 (1895–1904) and steadily dropping to 0.177 by cohort 5 (1935–1944). While not a notable outlier, Central Java illustrates continuous improvement in child mortality. Similarly, East Java exhibits a comparable pattern, decreasing its CMR from 0.258 in cohort 1 to 0.162 by cohort 5.

On the other hand, some provinces stand out as low CMR outliers, consistently showing child mortality rates well below the average. Papua and West Papua exhibit consistently low CMRs, starting at 0.245 in cohort 1 and dropping to 0.137 by cohort 5, making it one of the regions with the lowest child mortality rates. Similarly, the Special Region of Yogyakarta consistently reports low CMR across all cohorts, beginning at 0.205 in Cohort 1 and declining to 0.122 in Cohort 5, the lowest among all regions in that cohort. North Sumatra also follows a similar pattern, with CMR values decreasing from 0.259 in cohort 1 to 0.141 in cohort 5, showing consistent improvement in child survival over time. These provinces represent areas with better child survival outcomes and are outliers on the lower end of the CMR spectrum.

The potential impact of famine is most evident in regions and cohorts where child mortality rates (CMR) exhibit a noticeable increase or slower-than-expected decline instead of a decline over cohorts. This effect is particularly anticipated in birth cohorts 2 and 3 compared to earlier and later cohorts, encompassing women in or approaching their peak childbearing years during the 1940s. As illustrated in table 4.5, some regions display these patterns.

Table 4.5 Provinces with Notable Patterns in Child Mortality Rates Across Maternal Birth Cohorts (1895-1944)

Province	Cohort 1 (1895-1904)	Cohort 2 (1905-1914)	Cohort 3 (1915-1924)	Cohort 4 (1925-1934)	Cohort 5 (1935-1944)
West Sumatra*	0.392	0.370	0.348	0.285	0.213
Jambi*	0.382	0.349	0.339	0.294	0.219
Southeast Sulawesi*	0.365	0.348	0.288	0.271	0.221
West Nusa Tenggara**	0.360	0.378	0.359	0.344	0.300
South Sumatra and Bangka Belitung*	0.345	0.317	0.302	0.247	0.192
South Sulawesi and West Sulawesi*	0.320	0.298	0.278	0.251	0.197
South Kalimantan**	0.315	0.339	0.297	0.269	0.214
Maluku and North Maluku*	0.313	0.292	0.274	0.236	0.195
Lampung**	0.308	0.314	0.262	0.258	0.184
Riau and Kepulauan Riau**	0.307	0.331	0.297	0.233	0.198
Central Sulawesi**	0.301	0.328	0.297	0.273	0.208
West Java and Banten**	0.292	0.293	0.283	0.264	0.222
East Nusa Tenggara**	0.287	0.293	0.271	0.238	0.202
Bengkulu**	0.269	0.280	0.304	0.267	0.205
East Kalimantan**	0.252	0.259	0.230	0.188	0.165

Source: IPUMS

Note: *Indicates slower-than-expected decline in child mortality rates

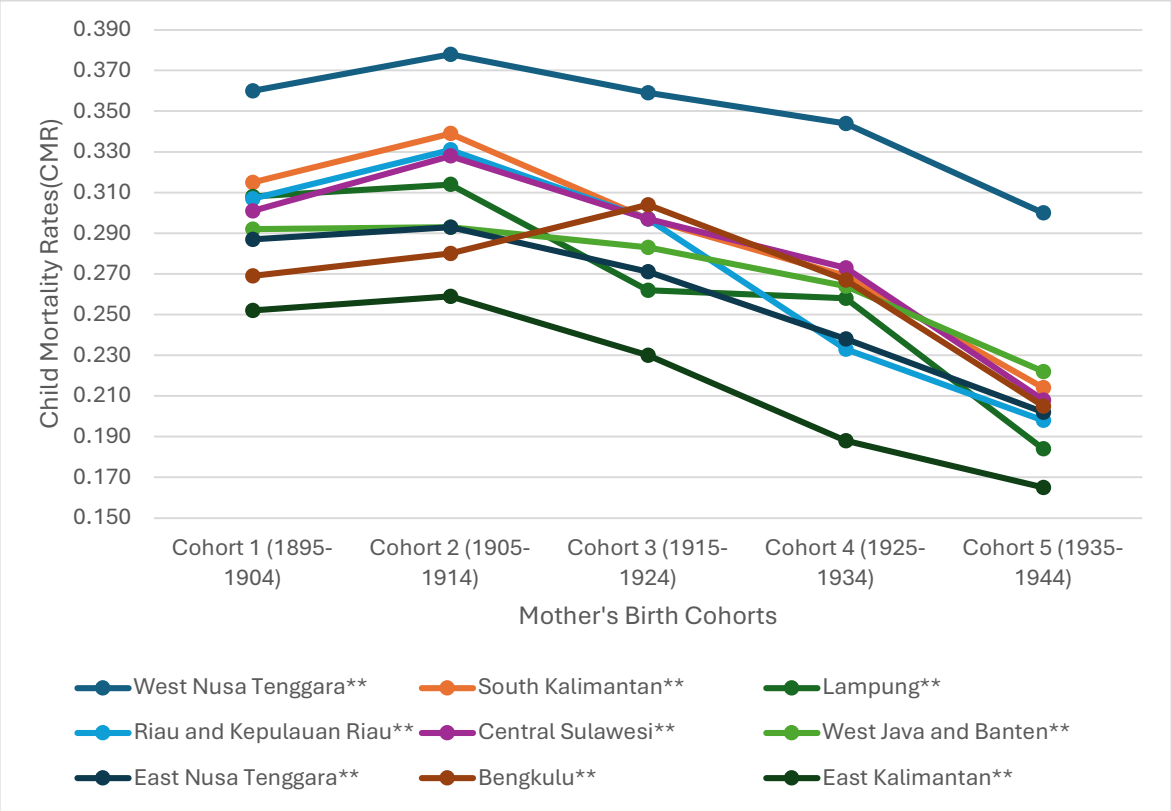
**Indicates increase in child mortality rates in cohort 2 or 3

Table 4.5 presents child mortality rates across five maternal birth cohorts (1895-1944) for selected Indonesian provinces exhibiting notable mortality rate trends. These patterns primarily fall into two categories: provinces with increased mortality rates during cohorts 2 or 3, marked with (**), and provinces with a slower-than-expected decline, marked with (*). Notable increases in mortality rates were seen in West Nusa Tenggara, South Kalimantan, Central Sulawesi, Riau and Kepulauan Riau, Lampung, East Nusa Tenggara, West Java and Banten, and Bengkulu, typically between cohorts 1 and 2, with Bengkulu showing an increase in cohort 3. Provinces such as West Sumatra, Jambi, Southeast Sulawesi, South Sumatra and Bangka Belitung, Maluku and North Maluku, and South

Sulawesi and West Sulawesi experienced a slower-than-expected reduction in child mortality rates. Additionally, West Nusa Tenggara has consistently high rates across all cohorts. Despite these notable patterns, all provinces demonstrated improvements by cohort 5 (1935-1944), indicating an overall decline in child mortality rates by the end of the observation period.

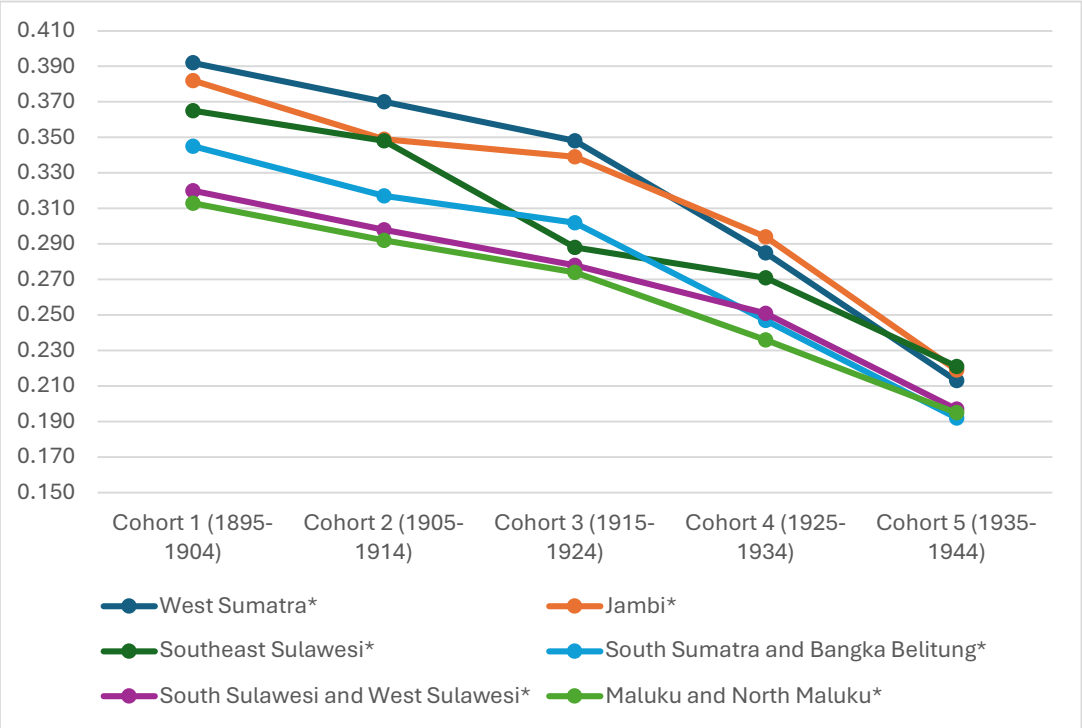
Figure 4.7 provides a detailed visualization analysis from Table 4.5 of CMR variations across different regions and birth cohorts, with some regions exhibiting significant fluctuations. These variations, especially during cohorts 2 and 3, may suggest the influence of wars and famine during the 1940s. The analysis emphasizes regions where CMR increased or declined more slowly than expected during this period, followed by a recovery in subsequent cohorts.

Figure 4.7 Trends in Child Mortality Rates Across Provinces with Increases in Cohort 2 or 3



The visualization reveals striking regional variations, with West Nusa Tenggara consistently maintaining the highest CMR throughout all cohorts, peaking at 0.378 during cohort 2 while showing only modest improvement by cohort 5. Other provinces, such as South Kalimantan, Riau and Kepulauan Riau, and Central Sulawesi, displayed similar patterns of increase during cohort 2, followed by gradual declines. Bengkulu's unique trajectory is particularly noteworthy, showing a delayed increase in cohort 3 (1915-1924), contrary to the general declining trend seen in other provinces by that period. The severity of these mortality rates is further emphasized in the accompanying GIS maps (figure 4.6), where darker shading corresponds to higher CMR values, providing a striking visual representation of the geographical distribution and intensity of child mortality across different cohorts. The darker colours in the maps mainly highlight the critical periods of cohorts 2 and 3, illustrating the spatial patterns of mortality increases during these timeframes.

Figure 4.8 Trends in Child Mortality Rates Across Provinces with Slight Decreases and Remaining High



The figure 4.8 reveals a consistent but gradual downward trend in child mortality rates across all six provinces from 1895 to 1944, although the pace of decline was slower than expected. As shown in Figure 4.8. In Jambi, CMR decreased from 0.382 in Cohort 1 to 0.349 in Cohort 2, though it remained elevated. Southeast Sulawesi experienced a similar trend, with CMR dropping from 0.365 in Cohort 1 to 0.348 in Cohort 2, though still high compared to other regions. Likewise, South Sumatra and Bangka Belitung decreased from 0.345 to 0.317 in Cohort 2, yet rates remained high. South Sulawesi and West Sulawesi, Maluku and North Maluku and West Sumatra followed similar patterns, with slight decreases in CMR during Cohort 2 but relatively high rates that persisted before further reductions in later cohorts.

4.4 Regression Results

The logistic regression model investigates the impact of various factors on child mortality, explicitly focusing on the last child's mortality as a function of the year of birth (*lastbyr*), regional variation (*geolev1_cat*), and other control variables. The key objective is to explore how different periods, particularly during conflict, affected child mortality while accounting for geographic disparities.

As shown in table 4.6 The variable *lastbyr* represents the last child's birth year, with 1935 as the baseline. Over the years, several key trends have emerged regarding child mortality. The coefficients and significance levels indicate how child mortality varies by year, with some years showing significantly higher mortality odds than the baseline. The results reveal distinct periods of heightened child mortality, particularly during conflict and post-conflict years.

The result reveals significant temporal patterns in last-child mortality across different years compared to 1935. The highest probabilities of last-child mortality were observed in 1936 (0.416, $p<0.01$) and 1947 (0.408, $p<0.01$), suggesting children born in these years faced significantly higher mortality risks. The elevated mortality risk persisted through the 1940s, with years like 1946 (0.352, $p<0.01$) and 1943 (0.272, $p<0.01$) showing significantly higher chances of child death. However, there was a notable improvement in the 1950s.

The later years show a decreasing probability of child mortality, with 1955 showing the most substantial reduction (-0.293, p<0.01), followed by 1953 (-0.183, p<0.01) and 1954 (-0.158, p<0.01).

From 1936 to 1941 (pre-war period), the coefficients are generally positive and significant for most years. The years 1936 (0.416, p<0.01), 1937 (0.307, p<0.01), and 1939 (0.323, p<0.01) show statistically significant increases in the probability of child death. 1938 shows a non-significant increase (0.107, p>0.05). 1940 also shows a non-significant effect (0.069, p>0.05). 1941 returns to a significant mortality risk increase (0.246, p<0.01). Overall, these fluctuations suggest that even before the Japanese occupation, Indonesia was experiencing periods of elevated child mortality risk.

Table 4.6 Logistic regression results

Logistic regression

new_lastbmort	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
1935b	0	.	.	.	.	.	
1936	.416	.096	4.33	0	.227	.604	***
1937	.307	.091	3.39	.001	.129	.484	***
1938	.107	.085	1.27	.205	-.059	.273	
1939	.323	.085	3.79	0	.156	.491	***
1940	.069	.062	1.10	.271	-.054	.191	
1941	.246	.081	3.02	.002	.086	.405	***
1942	.26	.066	3.94	0	.131	.389	***
1943	.272	.072	3.77	0	.131	.414	***
1944	.262	.073	3.59	0	.119	.406	***
1945	.002	.06	0.04	.972	-.116	.12	
1946	.352	.072	4.90	0	.211	.492	***
1947	.408	.07	5.85	0	.271	.544	***
1948	.234	.066	3.56	0	.105	.362	***
1949	.236	.069	3.42	.001	.101	.371	***
1950	.047	.058	0.82	.412	-.066	.161	
1951	-.028	.069	-0.41	.683	-.164	.107	
1952	-.111	.065	-1.73	.084	-.238	.015	*
1953	-.183	.065	-2.81	.005	-.31	-.055	***
1954	-.158	.065	-2.42	.015	-.285	-.03	**
1955	-.293	.058	-5.04	0	-.407	-.179	***
Bali	-.307	.226	-1.36	.173	-.75	.135	
Bengkulu	.296	.267	1.11	.268	-.228	.82	
Central Java	-.289	.215	-1.34	.179	-.71	.132	
Central Kalimantan	.083	.266	0.31	.757	-.44	.605	
Central Sulawesi	.268	.249	1.07	.283	-.221	.756	
East Java	-.304	.215	-1.42	.157	-.725	.117	
East Kalimantan	.075	.279	0.27	.789	-.472	.622	
East Nusa Tenggara	.404	.223	1.81	.07	-.033	.841	*
Jambi	.256	.245	1.05	.296	-.224	.737	
Lampung	.474	.248	1.92	.055	-.011	.959	*
Maluku and North Maluku	.415	.238	1.75	.081	-.051	.881	*

North Sulawesi and Gorontalo	.333	.225	1.48	.14	-.109	.774	
North Sumatra	-.077	.22	-0.35	.726	-.509	.355	
Papua and West Papua	0	.	.	.	.	.	
Riau and Kepulauan Riau	.306	.234	1.31	.191	-.152	.764	
South Kalimantan	.282	.225	1.26	.209	-.158	.723	
South Sulawesi and West Sulawesi	.329	.218	1.51	.131	-.098	.755	
South Sumatra and Bangka Belitung	.215	.223	0.97	.333	-.221	.651	
Southeast Sulawesi	.307	.247	1.24	.214	-.177	.792	
Special Capital Region of Jakarta	-.167	.234	-0.71	.475	-.625	.291	
Special Region of Aceh	.201	.224	0.90	.368	-.237	.64	
Special Region of Jogyakarta	-.578	.223	-2.60	.009	-1.015	-.142	***
West Java and Banten	-.229	.215	-1.07	.286	-.651	.192	
West Kalimantan	-.061	.232	-0.26	.793	-.516	.395	
West Nusa Tenggara	.469	.223	2.10	.036	.031	.907	**
West Sumatra	.594	.217	2.73	.006	.168	1.02	***
famsz	-.083	.004	-23.27	0	-.09	-.076	***
agemar	-.02	.003	-7.58	0	-.026	-.015	***
lit_new	-.122	.026	-4.74	0	-.173	-.072	***
Constant	-1.155	.227	-5.09	0	-1.601	-.71	***

Mean dependent var	0.122	SD dependent var	0.327
Pseudo r-squared	0.022	Number of obs	121275
Chi-square	1949.577	Prob > chi2	0.000
Akaike crit. (AIC)	87995.279	Bayesian crit. (BIC)	88470.864

*** $p<.01$, ** $p<.05$, * $p<.1$

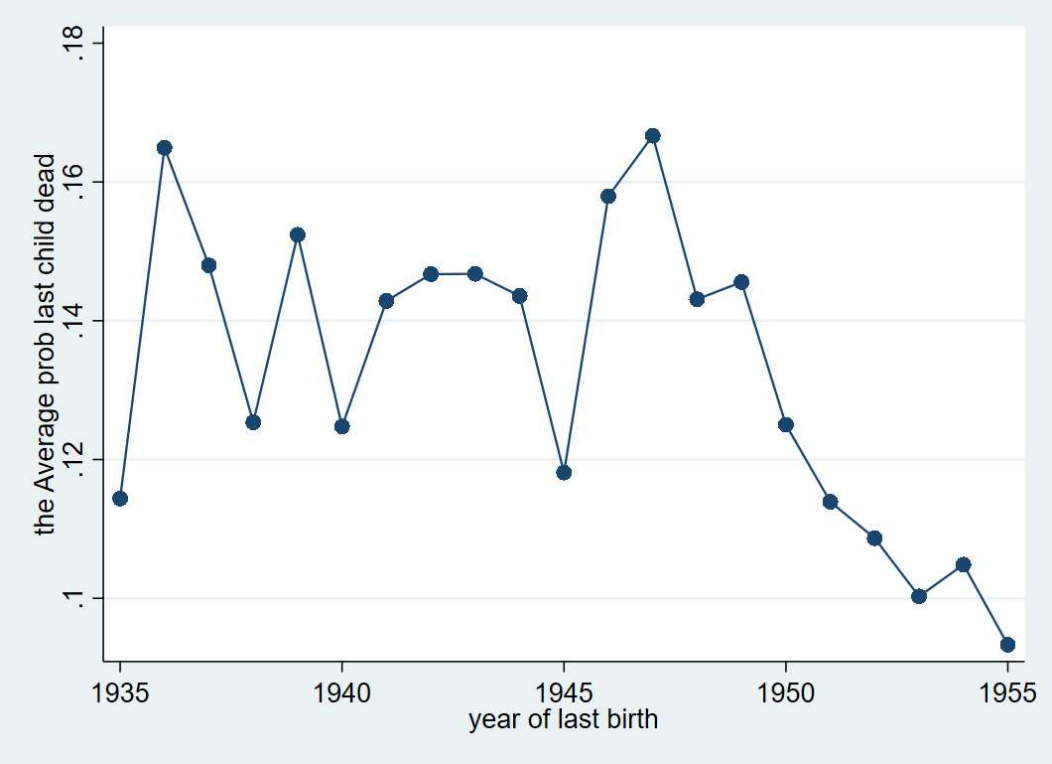
During the Japanese occupation period (1942-1945), the result shows consistently elevated probabilities of child death, though not as dramatically high as might be expected from historical accounts. The years 1942 (0.260, $p<0.01$), 1943 (0.272, $p<0.01$), and 1944 (0.262, $p<0.01$) show remarkably similar increases in mortality risk. However, interestingly, 1945, which historical accounts suggest was the peak of hardship during the occupation, shows no significant increase in child mortality (0.002, $p>0.05$) compared to 1935.

The Indonesian War of Independence period (1945-1949) shows some of the highest increases in child mortality risk during the entire study period. The immediate post-occupation years of 1946 (0.352, $p<0.01$) and 1947 (0.408, $p<0.01$) show exceptionally high increases in the probability of child death, with 1947 marking the second-highest coefficient in the entire time series. The elevated risk continued through 1948 (0.234, $p<0.01$) and 1949 (0.236, $p<0.01$), though at somewhat lower levels. The post-war period of the 1950s shows a marked improvement in child survival. From 1950 onwards, the coefficients become either non-significant (1950: 0.047, $p>0.05$; 1951: -0.028, $p>0.05$) or

significantly negative (1952-1955), with 1955 showing the most substantial reduction in child mortality risk (-0.293, p<0.01). This pattern suggests a substantial improvement in child survival conditions during post-independence.

The figure 4.9 visualizes the predicted probabilities of last child mortality based on the logistic regression model, highlighting trends from the *lastbyr* variable.

Figure 4.9 Probability of last child dead 1935-1950



The analysis of predicted probabilities of last child death for children born between 1935 and 1955 reveals distinct patterns across different historical periods (see Figure 4.9 and Appendix 9. The pre-war period (1936-1941) showed fluctuations with a notable peak probability of 0.165 in 1936, followed by variations between 0.124 and 0.152 through 1939-1940. During the Japanese occupation years (1942-1945), the predicted probabilities remained elevated at around 0.147 for children born in 1942-1943 before declining to 0.118 for those born in 1945 and the Independence War period (1946-1949) witnessed the

highest predicted probability of 0.167 for children born in 1947, maintaining relatively high levels between 0.143 and 0.158. Finally, for children born in the post-war period (1950-1955), the predicted probabilities demonstrated a consistent downward trend, declining from 0.125 in 1950 to its lowest point of 0.093 in 1955. These results reflect temporal variations in child mortality over the different periods.

Using Papua and West Papua as the baseline region, there is substantial geographic (*geolev1_cat)* variation in last-child mortality across Indonesia's provinces. West Sumatra shows the highest positive effect (0.594, $p<0.01$), indicating a 0.594 higher probability of last-child death than Papua. In contrast, the Special Region of Yogyakarta shows the most substantial negative effect (-0.578, $p<0.01$), suggesting a 0.578 lower probability of last-child death. West Nusa Tenggara (0.469, $p<0.05$) and Lampung (0.474, $p<0.1$) also demonstrate notably higher probabilities of last-child mortality than Papua. Most Java regions (West, Central, and East Java) show negative coefficients, though not all reach statistical significance, suggesting a general trend toward lower last-child mortality risk in Java. Most other provinces show no statistically significant difference from Papua, though many of their point estimates are positive. The Special Capital Region of Jakarta shows a negative but non-significant coefficient (-0.167), and Bali also shows a negative but non-significant effect (-0.307).

We calculated the relative probability using 1935 as the reference year from the predicted probabilities (Appendix 10). Figure 4.10 illustrates how these relative probabilities (see Appendix 12) evolved across the five provinces that exhibited the highest average relative probabilities during the wartime period of 1942-1949.

Figure 4.10 Provinces with the Highest Relative Probability of Last Child Death by Birth Year (1935-1955)

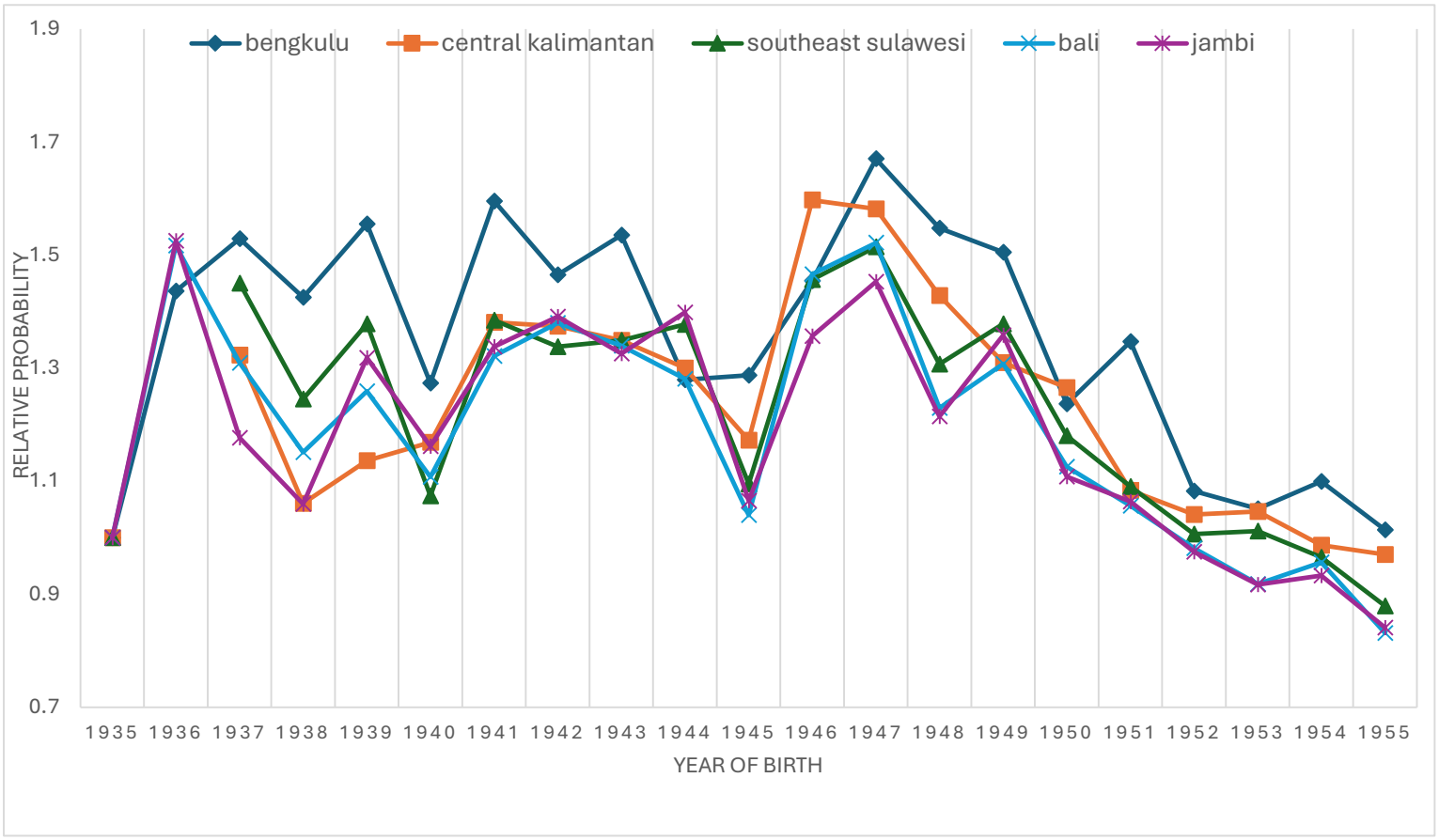
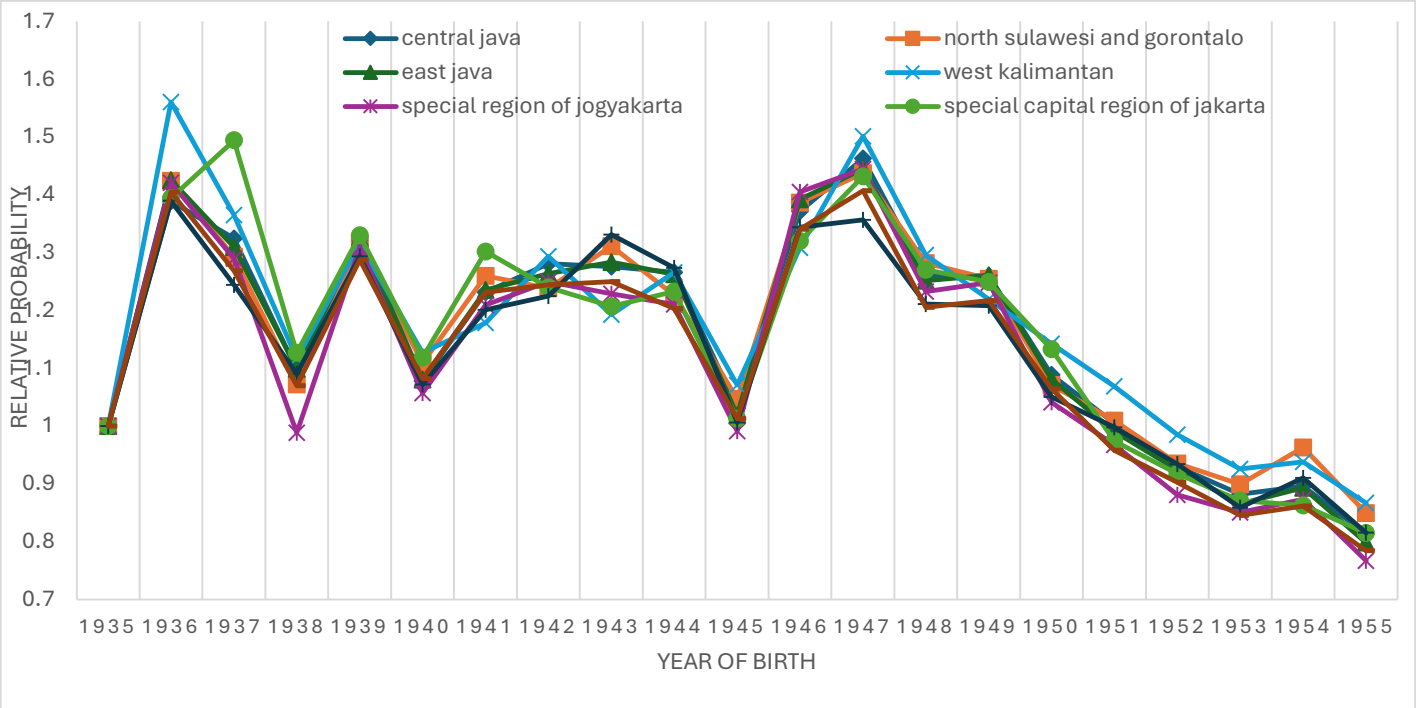


Figure 4.10 shows the five provinces with the highest relative probabilities of last child death (Bengkulu, Central Kalimantan, Southeast Sulawesi, Bali, and Jambi); clear temporal patterns emerge across pre-war, wartime, and post-war periods. In the pre-war years (1935-1941), these provinces already showed elevated risks compared to the 1935 baseline, with relative probabilities ranging from 1.2 to 1.5, suggesting pre-existing vulnerabilities in child survival. The relative probability markedly increased during 1942-1945, ranging from 1.040 to 1.535, with Bengkulu experiencing the most severe impact (reaching 1.535 in 1943). The situation further deteriorated during 1945-1949, as all five provinces reached their peaks - Bengkulu showed the highest increase, where children were 67% more likely to die compared to 1935, followed by Central Kalimantan (59.7%), Southeast Sulawesi (51.5%), Bali (52.2%), and Jambi (45.3%). A turning point occurred after 1950, marking the beginning of a recovery period where relative probabilities steadily

declined. By 1955, all five provinces had remarkably improved beyond their 1935 baseline levels - Bali demonstrated the most significant improvement (16.9% lower risk than 1935), followed by Jambi (15.9% lower), Southeast Sulawesi (12.1% lower), and Central Kalimantan (3% lower). Bengkulu nearly returned to baseline levels (1.013).

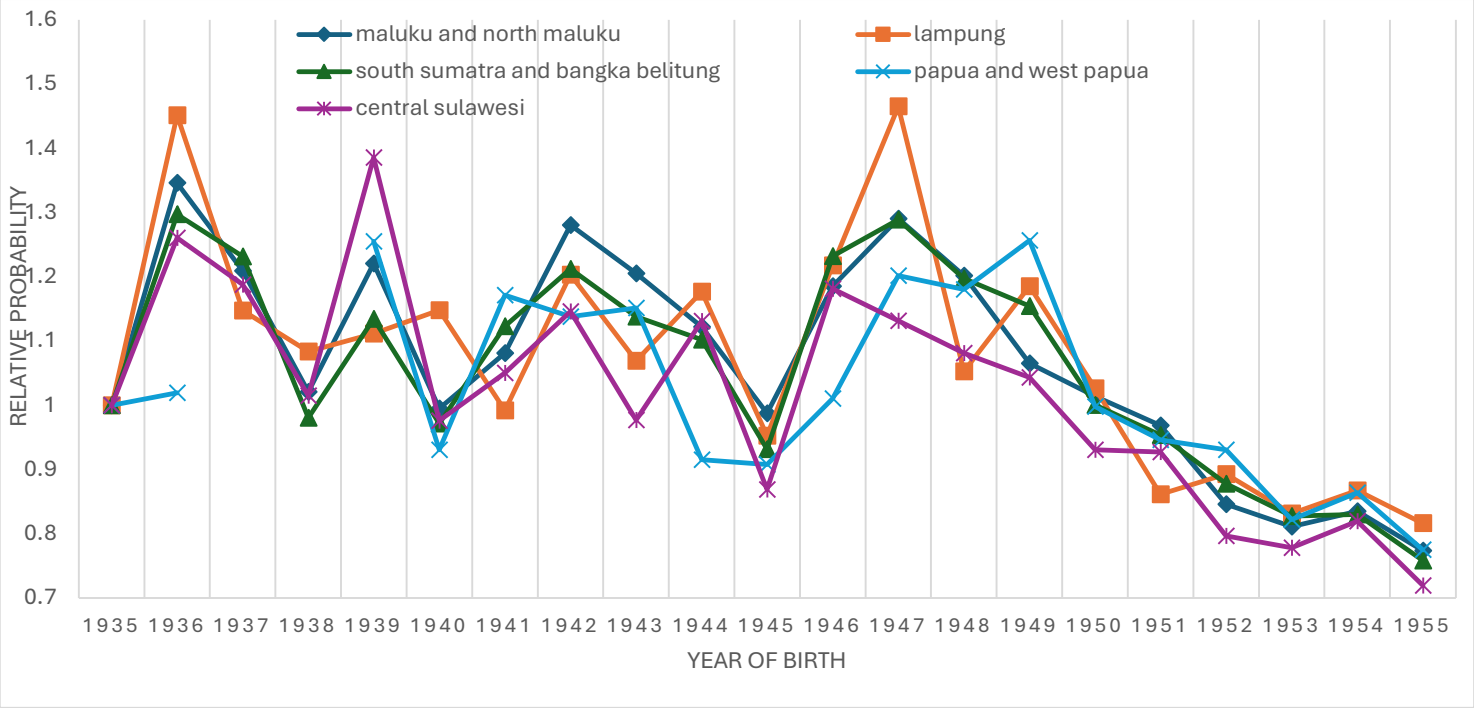
Figure 4.11 Provinces with the Highest-mid Relative Probability of Last Child Death by Birth Year (1935-1955)



Several patterns emerged across different historical periods among the high to mid-ranked provinces. Figure 4.11 shows that, during pre-war times, most provinces experienced an initial shock in child mortality risk around 1936-1937, with 30-40% higher risks than in 1935. The Special Capital Region of Jakarta stood out with a particularly severe spike in 1937 (49.4% higher than in 1935). West Kalimantan showed unique volatility with a sharp 56% increase in 1936, followed by a steeper decline than other regions. During the Japanese occupation (1942-1945), the patterns diverged notably: East Java and Central Java maintained consistently higher mortality risks (20-28% above 1935 levels). The independence war period (1945-1949) marked the most severe phase, with all provinces

showing their highest mortality risks in 1946-1947, particularly Central Java and East Java, where children faced nearly 50% higher mortality risks than in 1935. The Special Region of Yogyakarta showed a unique pattern during this period, with slightly lower peaks than its neighbours. By the early 1950s, all provinces began showing improved child survival compared to 1935. However, the rate of improvement varied, with Jakarta and Yogyakarta achieving faster reductions in mortality risk than other regions.

Figure 4.12 Provinces with the Lowest Relative Probability of Last Child Death by Birth Year (1935-1955)



The provinces with the lowest wartime relative probabilities (Figure 4.12), including Central Sulawesi (1.070), Papua and West Papua (1.095), South Sumatra and Bangka Belitung (1.157), Lampung (1.165), and Maluku and North Maluku (1.167), experienced relatively modest increases in child mortality risk compared to 1935. Their peak values during 1946-1947 remained relatively low, with Central Sulawesi reaching only 1.181(18%) in 1946 and Papua and West Papua reaching 1.256 in 1949. In contrast to areas with higher rankings, these regions showed more moderate fluctuations across all periods, with pre-war spikes generally not exceeding 30% above 1935 levels. By the early 1950s, these

provinces had all returned to levels below the 1935 reference point, with Central Sulawesi showing the lowest relative probability at 0.720 by 1955.

The relative probability analysis presents a distinct pattern from the regression results using Papua and West Papua as the baseline. Although the regression indicates West Sumatra with the highest mortality risk (0.594 higher than Papua), the relative probability analysis during the wartime period identifies Bengkulu (1.468), Central Kalimantan (1.389), and Southeast Sulawesi (1.352) as the provinces with the highest relative child mortality risks compared to their own 1935 levels. Despite the regression showing that the Special Region of Yogyakarta has a significantly lower mortality risk than Papua (-0.578), the relative probability analysis reveals that Yogyakarta maintains relatively high wartime averages (1.251) compared to its 1935 baseline. In a similar pattern, even though Java regions display generally negative coefficients in the regression, suggesting lower mortality risks than Papua, the relative probability analysis demonstrates that Central Java (1.276), East Java (1.272), and West Java (1.235) all experienced substantial increases in mortality risk during the wartime period compared to their pre-war levels. This contrast indicates that despite some regions having lower absolute mortality risks compared to Papua, they experienced more dramatic increases in mortality risk relative to their pre-war conditions.

The control variables (family size, age at marriage, and literacy,) are included in the analysis to account for variations in socioeconomic status and family structure across regions and over time. By controlling for these factors, we isolate the effects of region and year of birth on child mortality, ensuring that observed regional and temporal differences are not confounded by variations in these background factors. The control variables demonstrate statistically significant negative associations with last-child mortality. Family size exhibits the strongest protective effect (-0.083, $p<0.01$), indicating that the probability of last-child death decreases by 0.083 in log odds for each additional family member. The age at marriage coefficient (-0.020, $p<0.01$) suggests that the probability of last-child death decreases by 0.020 in log odds for each additional year of age at marriage. Literacy status shows a substantial protective effect (-0.122, $p<0.01$), indicating that being literate decreases the probability of last-child death by 0.122 in log odds compared to being illiterate. All these relationships are highly significant at the 1% level, with narrow

confidence intervals: family size [-0.090, -0.076], age at marriage [-0.026, -0.015], and literacy [-0.173, -0.072].

The model's overall fit statistics demonstrate the statistical significance of the identified relationships (Chi-square = 1949.577, p<0.000). The pseudo-R-squared value of 0.022 indicates that the model explains only 2.2% of the variation in last-child mortality. This low explanatory power suggests that year effects, regional differences, and sociodemographic factors significantly predict child mortality. However, other crucial determinants remain uncaptured in the model, such as specific health interventions, environmental factors, or economic conditions. The large sample size (121,275 observations) provides confidence in the statistical significance of these relationships despite the modest overall explanatory power. The model's AIC (87995.279) and BIC (88470.864) values are benchmarks for comparing alternative model specifications that might better explain variations in child mortality.

CHAPTER V

Discussion

This chapter delves into interpreting the results, focusing on the relationship between child mortality and famine during the 1940s in Indonesia. The analysis utilizes findings from the birth cohort study and logistic regression models to explore child mortality as an indicator of famine severity during wartime. By exploring changes over time, this chapter seeks to uncover how the war and famine impacted mortality rates among children and whether the patterns observed can be directly attributed to these harsh conditions. The findings are discussed in the broader context of famine studies, emphasizing where the results align with or diverge from existing literature. It also critically addresses the study's limitations, discussing factors such as data constraints, methodological challenges, and potential confounding variables that may have influenced the findings. These limitations are considered carefully to provide a comprehensive and precise understanding of the results and their implications.

5.1 The Impact of wartime famine on child mortality

This section examines potential shocks to child mortality rates in Indonesia during the 1940s, marked by war-related disruptions and severe famine conditions. Drawing on birth cohort analysis and logistic regression models, we investigate whether and how the famine manifested in observable disruptions to child survival patterns. By analysing mortality trends across different birth cohorts, we seek to identify possible deviations from the long-term demographic transition that might signal acute famine effects. The temporal analysis in this section allows us to assess if specific cohorts experienced elevated mortality risks that diverged from the secular trend of improving child survival, thereby providing insights into the demographic footprint of the 1940s crisis. A spatial analysis in the subsequent section will complement this temporal investigation.

In examining the variation of child mortality rates across birth cohorts in Indonesia during the 1940s wartime period, our results align with broader historical patterns of demographic transition. The data shows a consistent declining trend in child mortality rates across successive birth cohorts, ranging from 27.6% for the oldest cohort (1895-1904) to 18.4% for the youngest cohort (1935-1944). Although this secular decline in child mortality follows expected modernisation patterns, our analysis specifically sought to identify potential disruptions to this trend during the 1940s crisis. Cohorts in their reproductive years during the crisis period (1905-1924) showed intermediate mortality rates (26.8% and 25.5%), and the youngest cohorts demonstrated the lowest rates (22.6% and 18.4%). These findings, accompanied by similar standard deviations across cohorts (ranging from 0.225 to 0.279), suggest that generational improvements in healthcare, nutrition, and living conditions may have had a more substantial impact on child mortality than the acute effects of the 1940s wartime crisis (Baten et al., 2013; van der Eng & Sohn, 2019). However, it is essential to note that these results represent overall cohort mortality rates and do not isolate mortality specifically during wartime, limiting our ability to directly attribute variations to crisis exposure versus general historical trends in development and healthcare improvements.

In addition, we can look at the coefficients from the logistic regression analysis and probability prediction to learn more about how child mortality rates (CMR) as an indicator of famine during the 1940s. The logistic regression results indicate a significant increase in CMR from 1942 to 1944, with positive and significant coefficients, suggesting higher odds of child mortality during these years. These findings are consistent with historical accounts of worsening conditions under Japanese occupation, particularly the strict controls over rice supplies imposed in 1943 (Huff, 2020a; Van Der Eng, 2008, 2024).

However, the results present some unexpected patterns that warrant further discussion. First, the coefficient for 1943 is higher than that of 1944, a pattern that aligns with documented evidence of initial food supply disruptions and widespread malnutrition emerging in 1943 (Kurasawa, 1983), though it appears to diverge from other accounts suggesting a progressive worsening of conditions as the occupation continued (Nitisastro, 1970; Van Der Eng, 2024). Moreover, the results show a sharp drop in the coefficient for 1945, which becomes non-significant. These finding contrasts historical accounts that describe 1945 as the peak of the famine, with mortality expected to reach its highest levels (Huff, 2020b, 2020a; Nitisastro, 1970; Van Der Eng, 2002, 2024). The predicted probability of the last child dead also shows a similar pattern. These anomalies in the findings raise important questions about data reliability and interpretation. One plausible explanation for these unexpected patterns could be the issue of data heaping and recall bias in the IPUMS data collected in the 1980s. As noted by recent studies (Colvin et al., 2024; Schmertmann et al., 2024), there can be significant inaccuracies in reporting or recording birth and death dates, especially for events that occurred 35-40 years before data collection. This potential limitation in data sources may be obscuring the true impact of the famine during the critical later years of the occupation.

The artifactual nature of this decline becomes more apparent when we consider the sharp increase in child mortality immediately following 1945. The regression analysis reveals that significantly elevated child mortality rates marked the War of Independence period in Indonesia (1945-1949) compared to the baseline year of 1935. This period, except 1945, showed consistently high and statistically significant coefficients, indicating a substantial increase in the odds of child mortality. This resurgence in mortality rates

suggests that the conditions contributing to high child mortality during the occupation period did not suddenly improve in 1945 but rather continued and potentially worsened during the struggle for independence.

The regression results for 1946-1949 reveal a complex pattern of child mortality during Indonesia's War of Independence. Child mortality saw a sharp increase in 1946, likely reflecting the immediate aftermath of the Japanese occupation and the beginning of Indonesia's struggle for independence. This period, marked by political instability, economic hardship, and violent conflicts, significantly negatively impacted child survival rates (Cribb, 2008, 2015; Pham, 2019; Van Der Eng, 2008). The peak in child mortality occurred in 1947, a year of intensified conflict, including the first Dutch military action in July 1947, which disrupted healthcare, food distribution, and displaced populations, exacerbating mortality rates (Cribb, 2015; Van Der Eng, 2008; Vu, 2003). Although child mortality slightly decreased in 1948 and 1949, it remained significantly higher than pre-war levels, likely due to continued conflict, including the second Dutch "police action," in December 1948 and the lasting effects of years of instability on public health and food security (Cribb, 2008; Van Der Eng, 2008).

The estimation of population loss due to famine during the Indonesian War of Independence remains limited in scholarly literature. Recent research, including Van der Eng's (2024) study and the current analysis, offers complementary perspectives on mortality patterns during this period. Our regression analysis reveals a sharp increase in child mortality in 1946, reaching its peak in 1947, followed by a slight decline in 1948-1949, yet remaining above pre-war levels. Van der Eng's study of Java shows a different pattern (see Figure 2.1): a sharp recovery in 1946-1947, followed by a mortality spike in 1948, and a dramatic drop in 1949 (Van Der Eng, 2024). Rather than contradicting each other, these distinct patterns illuminate different aspects of the crisis. As our analysis captures the specific impact on child mortality across Indonesia, Van der Eng's work focuses on overall mortality in Java, where unique factors - including severe drought affecting harvests, political instability, and the Republican government's economic policies that discouraged surplus food production - may have created a distinct mortality pattern (Van Der Eng, 2008, 2024; Vu, 2003). The geographic and demographic differences between the studies provide

valuable insights into how the crisis manifested differently across regions and population groups. Both analyses strengthen our understanding of how conflict, famine, and food shortages affected population health during this critical period in Indonesian history, even as they highlight the complex regional and demographic variations in the impact of political instability and nutritional crises.

By the early 1950s, the coefficients begin to stabilize, indicating a gradual recovery from the wartime shocks as the effects of improved healthcare and nutrition started to take hold. In the post-war years, Indonesia, experienced a notable recovery in population health and living conditions (Baten et al., 2013; Van Der Eng & Sohn, 2019). Despite the severe disruptions caused by the Japanese occupation (1942-1945) and the War of Independence (1945-1949), the 1950s marked a period of stabilization and improvement. Nitisastro (1970) underscores that the improvement in vital rates, including the decline in mortality and stabilization of fertility, was a key indicator of Indonesia's broader demographic recovery during this period (Nitisastro, 1970). Van der Eng (2002) notes that this era saw better access to food and significant public health efforts, reducing mortality rates and increasing life expectancy (Van Der Eng, 2002).

In conclusion, the analysis reveals a long-term trend of declining child mortality rates across birth cohorts, indicating generational improvements in child survival. Nevertheless, the consequences of the 1940s famine are more complex. Logistic regression analysis shows increased child mortality from 1942 to 1944, aligning with historical accounts of worsening conditions under Japanese occupation. Unexpectedly, the data suggests a drop in mortality for 1945, contrary to historical evidence of peak famine conditions. This anomaly may be due to data limitations such as recall bias and data heaping. The period of 1946-1949, during the War of Independence, saw consistently elevated child mortality rates, peaking in 1947. These findings highlight the complex interplay between conflict, famine, and demographic patterns while also underscoring the challenges of accurately quantifying famine impacts due to data constraints and the multifaceted nature of historical events.

5.2 Regional Variations of famine

The impact of famine during the Japanese occupation (1942-1945) showed variation across Java's provinces, as evidenced by birth cohort analysis, regression results, and relative probability of the last child dead. Birth cohort analysis revealed distinct mortality patterns across Java's regions. The Special Region of Yogyakarta emerged as a notable outlier, consistently maintaining the lowest child mortality rates (CMR) throughout all studied cohorts. Meanwhile, Central Java and East Java exhibited moderate and relatively stable patterns without significant extremes in their mortality rates. Central Java demonstrated steady progress, with CMRs declining from 0.255 in the earliest cohort (1895-1904) to 0.177 by the fifth cohort (1935-1944). East Java's trajectory closely mirrored this pattern of gradual improvement, reflecting broader regional trends in child survival rates.

The regression analysis provided further insights: Central Java, East Java, and West Java (including Banten) did not show statistically significant differences in child mortality rates compared to the baseline. Interestingly, the Special Region of Yogyakarta stood out with a significantly lower child mortality rate, indicating better outcomes in this area during the occupation period. The Special Capital Region of Jakarta also showed no significant variation in child mortality. It is crucial to note that these findings are based on the IPUMS 1980 census data, which reflects demographic improvements during the 1970s, a period marked by declining mortality and falling fertility rates, especially in Java (Hartanto, 1998; McNicoll, 1982). This data source likely contributes to the apparent better child mortality outcomes in Java, as it captures the effects of later development rather than solely reflecting conditions during the occupation period.

In contrast, During the Japanese occupation period (1942-1945), despite Java regions showing lower absolute mortality risks in the regression analysis, the relative probability analysis reveals significant increases in child mortality compared to their 1935 levels - East Java and Central Java maintained consistently higher mortality risks (27-28% in 1943). With these trends, West Java and Banten showed similar elevated risks (around 23.5%). Despite having the lowest absolute mortality risk in the regression analysis, the Special Region of Yogyakarta maintained relatively high wartime averages (25.1% above its 1935 baseline),

indicating that even areas with better overall survival outcomes experienced substantial deterioration during the occupation period. These findings suggest that while Java's provinces may have had lower absolute mortality risks than other regions, as evidenced by the cohort analysis and regression results, they still experienced substantial increases in mortality risk relative to their pre-war conditions.

The overall picture suggests that while Java was undoubtedly affected by the occupation and likely experienced food shortages, the impact on child mortality is difficult to isolate due to the nature of the data source. The seemingly less severe or non-uniform impact of famine in Java, particularly the better outcomes in areas like Yogyakarta, might be partially attributed to the retrospective nature of the 1980 census data and the subsequent demographic improvements in Java during the 1970s (McNicoll, 1982). Additionally, as previously discussed, the sharp decline in mortality probabilities across all provinces in 1945 is likely due to age heaping. These factors underscore the importance of cautious interpretation when assessing the full extent of the famine's impact on Java during the Japanese occupation, recognizing the limitations of using later census data to infer historical demographic patterns.

On the contrary, the birth cohort analysis reveals significant regional variations in child mortality rates (CMR) across Indonesia's outer islands during the Japanese occupation period. Regions and birth cohorts that experienced either sharp increases or unexpectedly slow decreases in child mortality rates (CMR) provide the most apparent evidence of famine's impact. These trends are especially pronounced in birth cohorts 2 and 3, representing women at or approaching their peak reproductive years during the 1940s, in contrast to the cohorts before and after them. Notably, several regions, including West Nusa Tenggara, Central Sulawesi, South Kalimantan, and Riau and Kepulauan Riau, experienced notable CMR increases during Cohort 2. At the same time, Bengkulu uniquely peaked in Cohort 3, directly corresponding to women in their prime childbearing years during the famine. This pattern is visually represented in GIS maps, where cohorts 2 and 3(for Bengkulu) display darker colours, indicating increased mortality rates. These findings suggest that certain outer island areas may have been particularly vulnerable to the effects

of the occupation and potential famine conditions, highlighting the uneven distribution of hardship during this period.

Regions such as West Sumatra, Southeast Sulawesi, and Jambi exhibited consistently high child mortality rates (CMR) across multiple cohorts, suggesting systemic challenges in child survival that persisted over time. If these challenges intensified specifically during the occupation period, we would expect to see distinct data patterns, such as an unexpected rise in mortality rates or a marked slowing of the anticipated decline in cohorts spanning the occupation years. These indicators could point toward conditions typically associated with famine, such as increased food scarcity or deteriorating health environments, which may have compounded hardships in these regions. This approach highlights the diverse trends across different outer island areas, where some regions may reflect acute, occupation-linked increases in mortality rates. In contrast, others exhibit sustained high rates over an extended period.

The regression analysis reinforces the regional disparities observed in the birth cohort's analysis, highlighting several outer island regions that experienced significantly higher child mortality rates than the baseline. Areas in eastern Indonesia, particularly parts of Nusa Tenggara, Maluku, and Sulawesi, showed elevated mortality rates. Certain regions in Sumatra, notably West Sumatra and Lampung, also exhibited higher child mortality than other regions. These findings indicate that outer island regions may have faced severe challenges in child survival during the occupation period. However, this general observation requires further examination of specific child mortality patterns to identify potential signs of famine-like conditions. Analysing these patterns more closely could help to pinpoint variations in the timing and severity of these hardships, providing a more nuanced understanding of their impact across different regions and periods.

The Japanese occupation period (1942–1945) markedly influenced regional variations in child mortality across Indonesia's outer islands, with findings suggesting substantial differences in relative child mortality risks among provinces. The relative probability of child death increased in most provinces, peaking in 1943. The data reveal that relative probabilities of child death increased notably in certain regions, peaking in 1943. Provinces like Bengkulu, Central Kalimantan, and Southeast Sulawesi exhibited the highest relative

probabilities of child mortality, indicating pre-existing vulnerabilities that were likely intensified during this period. This rise aligns with the onset of food crises in several regions in 1943. On Sumatra Island and in East Indonesia, declines in food supply, compounded by transportation issues and trade restrictions, exacerbated these shortages (Huff, 2020a; Van Der Eng, 2008).

However, biases and anomalies in the data unexpectedly revealed a sharp decline in child mortality across all provinces in 1945, potentially obscuring the true impact of the 1944–1945 famine in the outer islands. Before this decline, the results indicated that Jambi, West Sumatra, Jambi, South Sulawesi, and West Sulawesi exhibited maintained consistently high relative probabilities of child mortality, signalling persistent challenges in child survival through the occupation years. Because throughout 1944 and 1945, the situation remained critical, with food scarcity persisting as a significant problem until the war's end (Huff, 2020a; Van Der Eng, 2008). These findings suggest that famine severity varied across Indonesia's outer island regions, underscoring the complex nature of food shortages and their impact on different provinces beyond Java.

Although limited literature specifically addresses the regional variations of famine in Indonesia's outer islands during this Japanese Occupation Period (1942-1945), the available evidence points to food shortages that likely contributed to these disparities in child mortality (Huff, 2020a; Nitisastro, 1970; Van Der Eng, 2008). Both birth cohorts' analysis and regression results highlight significant regional variations in child mortality rates across the outer islands. The analysis reveals that while Java faced severe challenges, many outer island regions experienced equally dire, if not worse, conditions. Areas such as West Sumatra, Lampung, Bengkulu, West Nusa Tenggara, Kalimantan and Sulawesi showed exceptionally high child mortality rates and relative probability of child mortality risk, suggesting these regions were profoundly affected by food scarcity and wartime disruptions. These findings underscore the importance of expanding research beyond Java to fully comprehend the nationwide impact of the 1940s famine in Indonesia.

The analysis of regional variation in child mortality during Indonesia's 1945-1949 War of Independence period also reveals significant disparities across provinces, providing insights into the geographic patterns of hardship and potential famine conditions. The data,

drawn from both birth cohort analysis and predicted probability models, paints a complex picture of the impact of this tumultuous period on child survival rates.

The birth cohort analysis focuses on women born between 1915 and 1934 (Cohorts 3 and 4) who were in their prime childbearing years or entering them during the War of Independence. West Nusa Tenggara, Jambi, Bengkulu and West Sumatra emerged as particularly affected regions, with high child mortality rates (CMR) that only modestly decreased in Cohort 4 (1925-1934). The widespread impact of this period was further evidenced by significant CMR increases across diverse regions, including Central Sulawesi, South Kalimantan, and Riau and Kepulauan Riau. These findings suggest that the socio-political upheaval during the War of Independence had far-reaching effects on child mortality.

Indonesia's War of Independence period (1945-1949) witnessed significant regional variations in child mortality probabilities across the archipelago. Analysis of relative probabilities and regression results reveals a complex pattern of child survival rates during this tumultuous time. Overall, most provinces experienced an increase in child mortality risk from 1945 to 1949, reflecting the widespread impact of the conflict. However, the severity of this increase varied considerably by region. Outer island provinces, particularly in western Indonesia, showed the highest child mortality probabilities. The regression results confirm these observations, indicating significantly higher odds of child mortality in West Nusa Tenggara, West Sumatra, Lampung, and Jambi consistently showed the highest probabilities of child mortality than in the baseline (Papua and West Papua) and the absolute predicted mortality. Based on the relative probabilities Bengkulu experienced the most severe impact in 1946-1947, followed by Central Kalimantan, Bali and Jambi. Java, particularly its central and eastern regions, maintained relatively lower absolute child mortality rates throughout the 1945-1949. In contrast, among provinces with high to mid-ranked relative probabilities, Java's regions showed significant increases during 1946-1947, with Central Java and East Java experiencing nearly 50% higher mortality risk than 1935. Despite showing lower absolute mortality in the regression analysis, the Special Region of Yogyakarta maintained relatively high wartime averages (1.251) compared to its 1935 baseline.

Despite that, considering the historical context and potential data biases, these findings must be interpreted cautiously. Historical records indicate that Java experienced significant food shortages, potential famine conditions, and frequent changes in political control during this period, which likely negatively impacted child survival rates (Van Der Eng, 2002, 2008, 2024). Data anomalies, similar to those observed during the Japanese occupation, may explain the discrepancy between the historical context and the study's findings. This is particularly evident in the case of the Special Region of Yogyakarta, which the study suggests had significantly lower child mortality odds and 25% relative high probabilities in wartime average. Nevertheless, the historical research indicates that Yogyakarta was one of the most severely affected provinces during the Japanese occupation and Indonesia's War of Independence (Van Der Eng, 2008; van der Eng, 2024).

In 1946, the new Republican government struggled with food policies while Dutch-controlled areas faced blockades. Food shortages worsened throughout 1946-1947 due to arbitrary rice requisitioning, inflation, crop failures, and disrupted inter-regional trade (Van Der Eng, 2008; Vu, 2003). Dutch military actions in 1947-1948 further destroyed rice infrastructure and displaced populations (Van Der Eng, 2008, 2024), aligning with findings in most Sumatran and eastern Indonesian provinces. During this period, both Republican and Dutch-controlled areas, including parts of Sumatra, Central Java, eastern Indonesia, and major cities, reported food shortages (Van Der Eng, 2008). The pattern of increased child mortality continued until around 1949, with fluctuations across regions but generally higher probabilities compared to 1945.

This study both extends and challenges Van der Eng's (2024) analysis of the 1945-1949 period's demographic impact (Van Der Eng, 2024). While existing literature focuses heavily on Java's food shortages and mortality patterns (Van Der Eng, 2008, 2024; Vu, 2003), our findings reveal a more complex geographic pattern. Outer islands in western Indonesia showed the highest absolute child mortality rates, challenging the Java-centric focus of previous research. However, when examining relative increases from pre-war baselines, Java’s regions also experienced significant relative increase in mortality risk from prewar levels and after Japanese Occupation. This suggests that although Java may have maintained relatively better absolute survival conditions, it still experienced severe

deterioration from its pre-war state. These findings add important nuance to previous research by demonstrating both the wider geographic scope of the demographic crisis and the importance of considering both absolute and relative changes in mortality patterns when assessing the revolution's impact.

In summary, this analysis of regional variations in famine during the 1940s in Indonesia reveals a more complex pattern of mortality than previously documented in the literature. Most existing research focused on Java; however, this study demonstrates significant regional disparities in absolute and relative terms. Outer island regions, particularly West Sumatra, Lampung, and parts of Nusa Tenggara, Maluku, and Sulawesi, exhibited higher absolute child mortality rates compared to Java's provinces. However, when examining relative increases from pre-war baselines, both Java and outer islands showed substantial deterioration - Central and East Java experienced higher mortality risk, and Bengkulu, Central Kalimantan, and Southeast Sulawesi showed the highest relative probabilities of child mortality during the Japanese occupation. Despite the limitations of the data, including potential biases from the 1980 census and age-heaping issues, these findings significantly expand our understanding of the famine's geographic scope. By highlighting absolute and relative mortality patterns across the archipelago, this study demonstrates the importance of examining Indonesia's 1940s famine nationwide rather than focusing solely on Java. This broader perspective enhances our comprehension of this crucial period and suggests the need for further research to fully understand the varying impact of famine conditions across Indonesia's diverse regions.

5.3 Limitation of the results

This study faces several important limitations that must be considered when interpreting its findings on child mortality and famine in 1940s Indonesia. The primary challenge stems from the retrospective nature of the data source, which impacts the ability to establish causal relationships and introduces potential biases. The retrospective nature of the data introduces potential recall bias, as the IPUMS data was collected in the 1980s, requiring women to recollect births and deaths from 30-40 years prior. This extended time gap increases the likelihood of imperfect or inaccurate memories, particularly regarding

precise dates of births and deaths. There is also a risk of systematic under-reporting of children who died very young, as these brief lives may be more easily forgotten or omitted in retrospective reporting. This potential under-reporting could lead to an underestimation of true child mortality rates, especially for the earlier periods of the study.

Several limitations constrain the interpretation of birth cohort analysis results. The primary limitation lies in temporal ambiguity, as the data does not directly specify when child deaths occurred, making it impossible to isolate mortality during the 1942-1949 crisis period precisely. Survival bias presents another significant challenge, as the data only includes women who survived and those able to conceive/bear children during the war to be included in the sample, potentially underestimating accurate mortality rates, particularly for earlier cohorts. Reporting issues, including recall bias and possible underreporting of deaths in earlier periods, may affect data accuracy. Additionally, contextual limitations, such as the lack of information about specific causes of death and the inability to control for regional variations in crisis impact, restrict our ability to draw more detailed conclusions about the relationship between the crisis and observed mortality patterns.

The data heaping observed in birth year reporting is particularly problematic for our analysis of child mortality trends. Our regression results in 1945 show an unexpected decline in child mortality, which contradicts historical evidence of peak mortality during the severe famine (Van Der Eng, 2024). This inconsistency likely stems from the artificial clustering of reported births around 1945 (9.15% of responses, see Table 3.6), which may have distorted the actual temporal pattern of births and associated mortality risks. The heaping effect could have led to misclassification of actual birth years, potentially masking the proper relationship between the famine period and child mortality outcomes. This limitation suggests that our mortality estimates around these heaped years, particularly 1945, should be interpreted cautiously.

Thus, rather than reflecting a natural decline in mortality during the famine, the data for 1945 may be more indicative of reporting bias, which compromises the analysis of child mortality patterns. Future studies should account for this limitation and consider applying statistical techniques to correct for data-heaping errors, allowing for more accurate

interpretation of mortality trends during historically significant periods, mainly when wartime disruptions affected precise record-keeping

The apparent better conditions in Java observed in the study present a significant limitation attributable to data bias from the 1980 census. This presumption possibly indicates the demographic advancements in Java during the 1970s rather than properly portraying the situations of the 1940s. This study reveals a complex pattern: Java showed lower absolute child mortality rates than many outer islands, and the relative probability analysis suggests a different picture. When examined against their pre-war baselines, Java's regions experienced substantial deterioration, with some areas showing up to 30% increases in mortality risk from their 1935 levels during the crisis periods. This nuanced finding helps reconcile the seemingly contradictory results with historical evidence of severe food shortages and high mortality rates in Java during the Japanese occupation and the War of Independence (Huff, 2019, 2020a, 2020b; Van Der Eng, 2008, 2024). The retrospective nature of the data source and its temporal distance from the events studied creates this discrepancy. During the 1970s, Java experienced significant demographic changes, including declining mortality and fertility rates, due to focused development efforts and better access to healthcare and family planning services (M. B. I. B. Utomo, 1986; McNicoll, 1982).

The consistently high child mortality rates observed in West Nusa Tenggara reflect broader patterns seen in 1970s Indonesia, where provinces like East and West Nusa Tenggara faced significant healthcare challenges. These regions were marked by limited healthcare infrastructure and high poverty levels, leading to inadequate maternal and child health services (I. M. B. Utomo, 1989; Ve. et al., 1978). The lack of access to essential care, such as prenatal and postnatal services, severely impacted child survival. Moreover, the rural province, including many in Indonesia, experienced higher child mortality due to the prevalence of infectious diseases and malnutrition (I. M. B. Utomo, 1989; Ve. et al., 1978).

In contrast, provinces like Jakarta and Yogyakarta reported lower child mortality rates during this period. These areas benefited from better healthcare infrastructure and more effective public health initiatives, which were less accessible in rural areas. Urban centers had greater access to hospitals and trained healthcare professionals, contributing to

improved child health outcomes (I. M. B. Utomo, 1989; M. B. I. B. Utomo, 1986). This urban-rural divide in healthcare access and quality created significant disparities, with rural provinces often lagging their urban counterparts (M. B. I. B. Utomo, 1986; Sm & Gl, 1986)

Additionally, the lower child mortality rates observed in Papua and other eastern regions may not necessarily indicate better conditions but could reflect under-reporting. Research shows that birth registration in Indonesia is affected by geographical and socio-economic factors, with regions in eastern Indonesia, such as Papua and East Nusa Tenggara, showing lower birth registration rates than western regions (Pont et al., 2023). This under-reporting could result from limited access to healthcare and administrative services, suggesting that lower mortality rates in these areas may mask significant healthcare challenges (Pont et al., 2023; Soleman, 2020).

Furthermore, although the study offers significant insights into regional disparities, the spatial resolution may remain constrained. Smaller-scale variations within provinces or between urban and rural areas may be missed, and changes in administrative boundaries between the 1940s and 1980 could affect the accuracy of regional comparisons. This limitation highlights the need for more granular data to fully understand the local impacts of famine and war on child mortality.

The regression analysis presents several methodological challenges that warrant careful interpretation. First, the low pseudo-R-squared value of 0.022 suggests that the model captures only a tiny portion of the factors influencing child mortality, pointing to significant unexplained variation. While the large sample size (121,275 observations) provides statistical power, this limited explanatory power raises concerns about the model's completeness. Second, the analysis faces potential endogeneity issues, particularly with control variables like family size and literacy. These variables might be both determinants and consequences of child mortality - for instance; families might have more children in response to high mortality risks, or literacy rates might be lower in regions with poor child survival outcomes. Finally, the model assumes constant effects of control variables across periods and regions, potentially masking essential variations in how these factors influenced child survival during different phases of the crisis years.

Additionally, the absence of interaction effects between variables and limited inclusion of broader contextual factors such as healthcare access, environmental conditions, or cultural practices further constrains the model's comprehensive understanding of child mortality determinants. Potential multicollinearity among control variables and possible sample selection bias complicates the interpretation of results. Given these limitations, although the model offers some insights into factors associated with child mortality, its overall fit suggests that it captures only a fraction of the intricate determinants of child survival in this historical context. Future research could benefit from addressing these limitations by incorporating additional variables, such as educational attainment, income inequality, and family structure, considering non-linear relationships, and employing more sophisticated econometric techniques to mitigate potential biases and provide a more robust analysis of child mortality factors in 1940s Indonesia.

Several strategies could be employed to address these limitations in future research. Combining IPUMS data with other historical sources, such as local records and qualitative accounts, could help cross-validate findings and fill gaps. Statistical techniques, such as inverse probability weighting, could be used to adjust for potential survival bias. Conducting sensitivity analyses would assess the potential impact of missing data on results. Linking IPUMS data with other Indonesian census datasets (such as the 1961 Population Census or the 1963 Agricultural Census) and the Indonesian Family Life Survey (IFLS) could provide additional control variables and more precise timing information. Furthermore, more advanced demographic techniques, such as multi-state life tables or agent-based models, could better account for complex population dynamics during famine periods. By acknowledging these limitations and suggesting ways to address them, the study can provide a more nuanced interpretation of its findings and pave the way for more robust future research on historical demographic patterns in Indonesia.

CHAPTER VI

Conclusion

This study investigated how child mortality patterns provide insights into the incidence and regional variation of famine impact in Indonesia during the 1940s. The analysis of birth cohorts from 1895-1944 revealed a consistent decline in child mortality rates over time, from 27.6% for the 1895-1904 cohort to 18.4% for the 1935-1944 cohort, indicating long-term improvements in child survival. The logistic regression analysis revealed significant increases in child mortality from 1942 to 1944, aligning with historical accounts of deteriorating conditions under Japanese occupation. However, the data shows an unexpectedly sharp decline in mortality for 1945. The analysis also identified a sustained period of elevated child mortality during the War of Independence (1945-1949), with peaks in 1947 coinciding with intensified conflict and widespread food shortages.

Regional analysis revealed that while Java has traditionally been the focus of famine studies, many outer island regions experienced more severe conditions during this period. An analysis of birth cohorts indicates that child mortality rates (CMR) rose significantly in areas such as West Nusa Tenggara, Bengkulu, Central Sulawesi, and Riau during the wartime period. Regions like West Sumatra, West Nusa Tenggara, and Lampung displayed notably higher absolute odds of child mortality than the baseline (Papua) in regression analyses. Moreover, when examining relative changes from pre-war conditions, provinces like Bengkulu, Central Kalimantan, and Southeast Sulawesi experienced increases of up to 53.5% in child mortality risk compared to their 1935 levels. Despite showing lower absolute mortality rates in the regression analysis, even Java saw substantial deterioration during the crisis periods. Central and East Java experienced nearly 50% higher mortality risk on its peak.

However, the study faced several methodological challenges that require careful consideration when interpreting the results. The reliance on 1980 census data introduced significant limitations, including recall bias and data heaping, particularly evident in the anomalous decline in reported mortality for 1945. The apparent better conditions in Java likely reflect the demographic improvements of the 1970s rather than accurately

portraying 1940s conditions. Additionally, the lower mortality rates observed in some eastern regions, such as Papua, may indicate under-reporting due to limited access to healthcare and administrative services rather than genuinely better survival conditions.

Despite these limitations, this research has contributed to the literature by expanding our understanding of famine impact beyond Java and highlighting the complex interplay between conflict, food shortages, and child mortality across Indonesia's diverse regions. It emphasizes the need for a more comprehensive approach to studying historical demographic patterns in Indonesia, considering regional variations in food production, infrastructure, and wartime disruptions. Future research could benefit from integrating multiple data sources, employing advanced statistical techniques to address data limitations, and incorporating broader contextual factors to provide a more robust analysis of famine impact during this critical period in Indonesian history.

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The Appendix

Appendix 1: Child born, survive, and dead by mother born from 1895-1944

1895

	mean	sum	sd
chborn str	4.568	9117	3.582
chdead str	1.525	3044	2.067
chsurv str	3.04	6068	2.462

1896

chborn str	5.113	1856	3.590
chdead str	1.871	679	2.327
chsurv str	3.242	1177	2.409

1897

chborn str	4.53	2206	3.927
chdead str	1.499	730	2.047
chsurv str	3.072	1496	3.004

1898

chborn str	4.625	3783	3.723
chdead str	1.534	1255	2.158
chsurv str	3.115	2548	2.739

1899

chborn str	4.675	3366	3.654
chdead str	1.471	1059	2.136
chsurv str	3.204	2307	2.616

1900

chborn str	4.462	48933	3.562
chdead str	1.512	16581	2.093
chsurv str	2.952	32379	2.483

1901

chborn str	4.602	7727	3.752
chdead str	1.569	2635	2.243
chsurv str	3.041	5105	2.606

1902

chborn str	4.692	8586	3.546
chdead str	1.507	2758	2.023
chsurv str	3.185	5829	2.523

1903

chborn str	4.764	5212	3.645
chdead str	1.553	1699	2.171
chsurv str	3.214	3516	2.571

1904

chborn str	4.664	9697	3.755
chdead str	1.586	3297	2.227
chsurv str	3.075	6392	2.541

1905

chborn str	4.53	43641	3.591
chdead str	1.506	14507	2.122
chsurv str	3.026	29154	2.505

1906

chborn str	4.746	8438	3.857
chdead str	1.54	2739	2.241
chsurv str	3.215	5716	2.784

1907

chborn str	4.654	10063	3.735
chdead str	1.522	3291	2.128
chsurv str	3.144	6797	2.736

1908

chborn str	4.555	18827	3.543
chdead str	1.485	6138	2.039
chsurv str	3.067	12677	2.495

1909

chborn str	4.579	14983	3.609
chdead str	1.393	4557	1.979
chsurv str	3.186	10425	2.626

1910

chborn str	4.452	121254	3.570
chdead str	1.475	40176	2.077

chsurv str	2.974	81009	2.500
1911			
chborn str	4.86	15002	3.713
chdead str	1.536	4743	2.128
chsurv str	3.329	10276	2.694
1912			
chborn str	4.681	22118	3.679
chdead str	1.487	7025	2.053
chsurv str	3.192	15081	2.627
1913			
chborn str	4.726	21913	3.624
chdead str	1.471	6821	2.009
chsurv str	3.259	15112	2.680
1914			
chborn str	4.774	16746	3.767
chdead str	1.45	5087	2.115
chsurv str	3.323	11657	2.714
1915			
chborn str	4.528	114675	3.518
chdead str	1.437	36382	2.012
chsurv str	3.089	78217	2.483
1916			
chborn str	4.89	21871	3.614
chdead str	1.468	6567	1.984
chsurv str	3.417	15286	2.651
1917			
chborn str	4.767	27808	3.736
chdead str	1.446	8434	2.014
chsurv str	3.321	19377	2.779
1918			
chborn str	4.773	40056	3.675
chdead str	1.46	12256	2.031
chsurv str	3.31	27777	2.672
1919			
chborn str	4.661	30809	3.571
chdead str	1.352	8939	1.936
chsurv str	3.308	21864	2.656
1920			
chborn str	4.547	232618	3.548
chdead str	1.437	73505	2.020
chsurv str	3.11	159110	2.512
1921			
chborn str	4.896	32259	3.597

chdead str	1.441	9494	1.981
chsurv str	3.452	22747	2.655

1922

chborn str	5.073	50315	3.785
chdead str	1.471	14591	2.034
chsurv str	3.599	35696	2.791

1923

chborn str	5.03	48121	3.742
chdead str	1.434	13717	2.004
chsurv str	3.593	34377	2.770

1924

chborn str	5.114	56299	3.706
chdead str	1.438	15826	2.027
chsurv str	3.673	40436	2.756

1925

chborn str	4.913	193097	3.626
chdead str	1.428	56136	2.002
chsurv str	3.483	136902	2.653

1926

chborn str	5.271	57053	3.723
chdead str	1.423	15405	1.994
chsurv str	3.851	41679	2.857

1927

chborn str	5.279	62366	3.718
chdead str	1.434	16942	1.986
chsurv str	3.842	45387	2.773

1928

chborn str	5.279	88193	3.607
chdead str	1.428	23861	1.916
chsurv str	3.85	64320	2.737

1929

chborn str	5.157	71126	3.601
chdead str	1.324	18262	1.912
chsurv str	3.83	52819	2.752

1930

chborn str	4.998	345924	3.600
chdead str	1.412	97751	1.989
chsurv str	3.584	248029	2.647

1931

chborn str	5.448	75665	3.548
chdead str	1.31	18197	1.823
chsurv str	4.138	57477	2.778

1932

chborn str	5.529	117476	3.505
chdead str	1.326	28176	1.833
chsurv str	4.202	89277	2.735

1933

chborn str	5.544	100262	3.516
chdead str	1.32	23875	1.833
chsurv str	4.222	76359	2.740

1934

chborn str	5.547	95381	3.437
chdead str	1.271	21847	1.805
chsurv str	4.275	73509	2.688

1935

chborn str	5.276	378662	3.407
chdead str	1.307	93787	1.827
chsurv str	3.968	284808	2.608

1936

chborn str	5.656	79916	3.358
chdead str	1.22	17244	1.733
chsurv str	4.435	62667	2.673

1937

chborn str	5.505	103913	3.291
chdead str	1.202	22685	1.684
chsurv str	4.303	81225	2.632

1938

chborn str	5.432	144948	3.270
chdead str	1.185	31614	1.675
chsurv str	4.247	113328	2.602

1939

chborn str	5.392	99595	3.208
chdead str	1.112	20539	1.651
chsurv str	4.28	79056	2.584

1940

chborn str	5.07	463129	3.193
chdead str	1.153	105317	1.677
chsurv str	3.917	357809	2.487

1941

chborn str	5.257	107912	3.026
chdead str	1.012	20766	1.504
chsurv str	4.245	87142	2.468

1942

chborn str	5.174	175167	2.949
chdead str	.997	33742	1.494
chsurv str	4.177	141424	2.392

1943			
chborn str	4.99	138935	2.899
chdead str	.966	26890	1.477
chsurv str	4.024	112046	2.330
1944			
chborn str	4.818	122700	2.747
chdead str	.868	22105	1.378
chsurv str	3.95	100598	2.237

Appendix 2: Child Mortality Rate all birth cohorts (1895-1944)

birthyr_new	mean	sd
1895	.276	.272
1896	.303	.278
1897	.276	.277
1898	.276	.282
1899	.267	.283
1900	.276	.281
1901	.286	.283
1902	.267	.271
1903	.264	.275
1904	.284	.278
1905	.274	.28
1906	.274	.274
1907	.27	.274
1908	.268	.274
1909	.255	.269
1910	.271	.279
1911	.263	.272
1912	.267	.275
1913	.265	.275
1914	.252	.268
1915	.261	.273
1916	.256	.263
1917	.256	.264
1918	.259	.271
1919	.247	.265
1920	.259	.273
1921	.251	.27
1922	.248	.258
1923	.244	.262
1924	.24	.259
1925	.244	.261
1926	.233	.256
1927	.233	.251
1928	.233	.251
1929	.218	.247
1930	.236	.257
1931	.208	.237
1932	.205	.234

1933	.205	.234
1934	.198	.23
1935	.21	.239
1936	.185	.22
1937	.189	.224
1938	.187	.222
1939	.176	.219
1940	.192	.231
1941	.165	.21
1942	.164	.211
1943	.163	.212
1944	.152	.208

Appendix 3: CMR Birth cohort 1 (1895-1904)

Provinces	mean	sd
bali	.253	.285
bengkulu	.269	.272
central java	.255	.27
central kalimantan	.26	.246
central sulawesi	.301	.285
east java	.258	.281
east kalimantan	.252	.297
east nusa tenggara	.287	.27
jambi	.382	.325
lampung	.308	.292
maluku and north maluku	.313	.284
north sulawesi and gorontalo	.292	.263
north sumatra	.259	.268
papua and west papua	.245	.268
riau and kepulauan riau	.307	.275
south kalimantan	.315	.294
south sulawesi and west sulawesi	.32	.271
south sumatra and bangka belitung	.345	.287
southeast sulawesi	.365	.297
special capital region of jakarta	.256	.279
special region of aceh	.281	.28
special region of jogyakarta	.205	.253
west java and banten	.292	.28
west kalimantan	.264	.249
west nusa tenggara	.36	.276
west sumatra	.392	.29

Appendix 4: CMR birth cohorts 2 (1905-1914)

bplid_str	mean	sd
bali	.225	.267
bengkulu	.28	.262
central java	.248	.275
central kalimantan	.247	.237
central sulawesi	.328	.276
east java	.246	.279
east kalimantan	.259	.279

east nusa tenggara	.293	.263
jambi	.349	.281
lampung	.314	.288
maluku and north maluku	.292	.278
north sulawesi and gorontalo	.278	.26
north sumatra	.258	.259
papua and west papua	.238	.259
riau and kepulauan riau	.331	.277
south kalimantan	.339	.295
south sulawesi and west sulawesi	.298	.261
south sumatra and bangka belitung	.317	.278
southeast sulawesi	.348	.276
special capital region of jakarta	.259	.272
special region of aceh	.258	.266
special region of jogyakarta	.198	.247
west java and banten	.293	.278
west kalimantan	.243	.257
west nusa tenggara	.378	.282
west sumatra	.37	.285

Appendix 5: CMR birth cohorts 3 1915-1924

bplid_str	mean	sd
bali	.204	.249
bengkulu	.304	.26
central java	.243	.272
central kalimantan	.252	.248
central sulawesi	.297	.258
east java	.231	.273
east kalimantan	.23	.253
east nusa tenggara	.271	.253
jambi	.339	.279
lampung	.262	.262
maluku and north maluku	.274	.265
north sulawesi and gorontalo	.232	.227
north sumatra	.229	.239
papua and west papua	.189	.243
riau and kepulauan riau	.297	.264
south kalimantan	.297	.282
south sulawesi and west sulawesi	.278	.255
south sumatra and bangka belitung	.302	.262
southeast sulawesi	.288	.245
special capital region of jakarta	.232	.267
special region of aceh	.231	.257
special region of jogyakarta	.191	.249
west java and banten	.283	.271
west kalimantan	.22	.239
west nusa tenggara	.359	.265
west sumatra	.348	.271

Appendix 6: CMR birth cohorts 4 1925-1934

bplid_str	mean	sd
bali	.187	.233
bengkulu	.267	.245
central java	.216	.254
central kalimantan	.209	.223
central sulawesi	.273	.239
east java	.202	.252
east kalimantan	.188	.227
east nusa tenggara	.238	.236
jambi	.294	.26
lampung	.258	.248
maluku and north maluku	.236	.238
north sulawesi and gorontalo	.186	.194
north sumatra	.181	.207
papua and west papua	.162	.224
riau and kepulauan riau	.233	.233
south kalimantan	.269	.268
south sulawesi and west sulawesi	.251	.241
south sumatra and bangka belitung	.247	.244
southeast sulawesi	.271	.246
special capital region of jakarta	.217	.249
special region of aceh	.19	.236
special region of jogyakarta	.154	.214
west java and banten	.264	.257
west kalimantan	.207	.225
west nusa tenggara	.344	.26
west sumatra	.285	.248

Appendix 7: CMR birth cohorts 5 1935-1944

bplid_str	mean	sd
bali	.152	.203
bengkulu	.205	.215
central java	.177	.227
central kalimantan	.16	.2
central sulawesi	.208	.218
east java	.162	.226
east kalimantan	.165	.213
east nusa tenggara	.202	.219
jambi	.219	.23
lampung	.184	.212
maluku and north maluku	.195	.207
north sulawesi and gorontalo	.15	.183
north sumatra	.141	.181
papua and west papua	.137	.206
riau and kepulauan riau	.198	.213
south kalimantan	.214	.238
south sulawesi and west sulawesi	.197	.221
south sumatra and bangka belitung	.192	.211

southeast sulawesi	.221	.225
special capital region of jakarta	.162	.211
special region of aceh	.143	.2
special region of jogyakarta	.122	.195
west java and banten	.222	.235
west kalimantan	.192	.219
west nusa tenggara	.3	.245
west sumatra	.213	.22

Appendix 8: Child Mortality Rates (CMR) by Province and Birth Cohort (1895-1944)

Province	**Cohort 1 (1895-1904)**	**Cohort 2 (1905-1914)**	**Cohort 3 (1915-1924)**	**Cohort 4 (1925-1934)**	**Cohort 5 (1935-1944)**
Bali	0.253	0.225	0.204	0.187	0.152
Bengkulu**	0.269	0.280	0.304	0.267	0.205
Central Java	0.255	0.248	0.243	0.216	0.177
Central Kalimantan	0.26	0.247	0.252	0.209	0.16
Central Sulawesi**	0.301	0.328	0.297	0.273	0.208
East Java	0.258	0.246	0.231	0.202	0.162
East Kalimantan**	0.252	0.259	0.230	0.188	0.165
East Nusa Tenggara**	0.287	0.293	0.271	0.238	0.202
Jambi*	0.382	0.349	0.339	0.294	0.219
Lampung**	0.308	0.314	0.262	0.258	0.184
Maluku and North Maluku*	0.313	0.292	0.274	0.236	0.195
North Sulawesi and Gorontalo	0.292	0.278	0.232	0.186	0.15
North Sumatra	0.259	0.258	0.229	0.181	0.141
Papua and West Papua	0.245	0.238	0.189	0.162	0.137
Riau and Kepulauan Riau**	0.307	0.331	0.297	0.233	0.198
South Kalimantan**	0.315	0.339	0.297	0.269	0.214
South Sulawesi and West Sulawesi*	0.320	0.298	0.278	0.251	0.197
South Sumatra and Bangka Belitung*	0.345	0.317	0.302	0.247	0.192
Southeast Sulawesi*	0.365	0.348	0.288	0.271	0.221
Special Capital Region of Jakarta	0.256	0.259	0.232	0.217	0.162
Special Region of Aceh	0.281	0.258	0.231	0.19	0.143
Special Region of Yogyakarta	0.205	0.198	0.191	0.154	0.122
West Java and Banten**	0.292	0.293	0.283	0.264	0.222
West Kalimantan	0.264	0.243	0.22	0.207	0.192

West Nusa Tenggara**	0.360	0.378	0.359	0.344	0.300
West Sumatra*	0.392	0.370	0.348	0.285	0.213

Note: *Indicates slower-than-expected decline in child mortality rates
**Indicates increase in child mortality rates in cohort 2 or 3
no symbol indicates gradual decline and lower CMR

Appendix 9: The Predicted Probability of Last Child Death for Children Born Between 1935-1955

lastbyr	mean
1935	.1143719
1936	.1649215
1937	.147973
1938	.1253575
1939	.1523864
1940	.1247517
1941	.1428571
1942	.1467113
1943	.1467474
1944	.1435721
1945	.1181294
1946	.1579442
1947	.1666667
1948	.1430992
1949	.1455696
1950	.1250158
1951	.1139139
1952	.1086635
1953	.1002778
1954	.1048562
1955	.093313
Total	.1217646

Appendix 10: The Predicted Probability of Last Child Death for Children Born Between 1935-1955 across provinces

geolev1_cat	Last Childbirth Year																					Mean Probability per Provinces
	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	
West Sumatra	0.22	0.31	0.26	0.24	0.28	0.23	0.26	0.27	0.25	0.26	0.21	0.27	0.29	0.25	0.25	0.22	0.21	0.19	0.18	0.19	0.17	0.24
West Nusa Tenggara	0.20	0.25	0.24	0.20	0.25	0.20	0.23	0.23	0.23	0.24	0.19	0.25	0.25	0.22	0.24	0.20	0.18	0.17	0.16	0.17	0.15	0.21
South Kalimantan	0.17	0.22	0.21	0.18	0.24	0.18	0.21	0.20	0.21	0.20	0.17	0.22	0.23	0.20	0.21	0.18	0.17	0.16	0.14	0.15	0.13	0.19
Lampung	0.17	0.25	0.20	0.19	0.19	0.20	0.17	0.21	0.18	0.20	0.16	0.21	0.25	0.18	0.20	0.18	0.15	0.15	0.14	0.15	0.14	0.18
East Nusa Tenggara	0.17	0.23	0.19	0.17	0.20	0.16	0.21	0.20	0.20	0.20	0.16	0.20	0.23	0.19	0.19	0.17	0.16	0.15	0.14	0.14	0.13	0.18
Jambi	0.15	0.23	0.18	0.16	0.20	0.18	0.20	0.21	0.20	0.21	0.16	0.20	0.22	0.18	0.21	0.17	0.16	0.15	0.14	0.14	0.13	0.18
South Sulawesi and West Sulawesi	0.16	0.22	0.20	0.17	0.20	0.17	0.19	0.19	0.21	0.20	0.16	0.21	0.21	0.19	0.19	0.17	0.16	0.15	0.14	0.14	0.13	0.18
Riau And Kepulauan Riau	0.16	0.20	0.18	0.19	0.19	0.17	0.17	0.20	0.20	0.19	0.16	0.21	0.23	0.21	0.20	0.17	0.16	0.15	0.14	0.14	0.13	0.18
Special Region of Aceh	0.16	0.22	0.18	0.17	0.22	0.17	0.20	0.20	0.18	0.18	0.16	0.21	0.22	0.19	0.19	0.17	0.16	0.14	0.14	0.14	0.12	0.18
Bengkulu	0.13	0.18	0.20	0.18	0.20	0.16	0.21	0.19	0.20	0.16	0.17	0.19	0.21	0.20	0.19	0.16	0.17	0.14	0.14	0.14	0.13	0.17
North Sulawesi and Gorontalo	0.15	0.21	0.19	0.16	0.19	0.16	0.18	0.18	0.19	0.18	0.15	0.20	0.21	0.19	0.18	0.16	0.15	0.14	0.13	0.14	0.12	0.17
Maluku And North Maluku	0.16	0.21	0.19	0.16	0.19	0.16	0.17	0.20	0.19	0.18	0.16	0.19	0.20	0.19	0.17	0.16	0.15	0.13	0.13	0.13	0.12	0.17
Southeast Sulawesi	0.14		0.20	0.17	0.19	0.15	0.19	0.18	0.19	0.19	0.15	0.20	0.21	0.18	0.19	0.16	0.15	0.14	0.14	0.13	0.12	0.17
Central Sulawesi	0.16	0.20	0.19	0.16	0.22	0.16	0.17	0.18	0.16	0.18	0.14	0.19	0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.12	0.16
South Sumatra and Bangka Belitung	0.15	0.19	0.18	0.15	0.17	0.14	0.17	0.18	0.17	0.16	0.14	0.18	0.19	0.18	0.17	0.15	0.14	0.13	0.12	0.12	0.11	0.16
East Kalimantan	0.13	0.20	0.13	0.15	0.14	0.14	0.14	0.19	0.15	0.16	0.12	0.16	0.17	0.15	0.14	0.13	0.12	0.12	0.11	0.11	0.09	0.14
Central Kalimantan	0.11		0.14	0.12	0.12	0.13	0.15	0.15	0.15	0.14	0.13	0.17	0.17	0.16	0.14	0.14	0.12	0.11	0.11	0.11	0.11	0.13
West Java and Banten	0.12	0.16	0.15	0.12	0.15	0.13	0.14	0.14	0.14	0.14	0.12	0.16	0.16	0.14	0.14	0.12	0.11	0.10	0.10	0.10	0.09	0.13
North Sumatra	0.11	0.16	0.13	0.12	0.15	0.12	0.14	0.14	0.14	0.14	0.12	0.15	0.16	0.14	0.14	0.13	0.11	0.11	0.10	0.10	0.09	0.13
Special Capital Region Of Jakarta	0.11	0.15	0.16	0.12	0.14	0.12	0.14	0.13	0.13	0.13	0.11	0.14	0.16	0.14	0.14	0.12	0.11	0.10	0.09	0.09	0.09	0.13
Papua And West Papua	0.12	0.12			0.15	0.11	0.14	0.14	0.14	0.11	0.11	0.12	0.14	0.14	0.15	0.12	0.11	0.11	0.10	0.10	0.09	0.12
West Kalimantan	0.10	0.16	0.14	0.12	0.14	0.12	0.12	0.13	0.12	0.13	0.11	0.13	0.15	0.13	0.13	0.12	0.11	0.10	0.10	0.10	0.09	0.12
East Java	0.10	0.15	0.13	0.11	0.14	0.11	0.13	0.13	0.13	0.13	0.10	0.14	0.15	0.13	0.13	0.11	0.10	0.09	0.09	0.09	0.08	0.12
Central Java	0.10	0.14	0.13	0.11	0.13	0.11	0.12	0.13	0.13	0.13	0.10	0.14	0.15	0.13	0.13	0.11	0.10	0.09	0.09	0.09	0.08	0.12
Bali	0.08	0.13	0.11	0.10	0.11	0.09	0.11	0.12	0.11	0.11	0.09	0.12	0.13	0.10	0.11	0.09	0.09	0.08	0.08	0.08	0.07	0.10
Special Region Of Jogyakarta	0.08	0.11	0.10	0.08	0.11	0.09	0.10	0.10	0.10	0.10	0.08	0.11	0.12	0.10	0.10	0.08	0.08	0.07	0.07	0.07	0.06	0.09
Mean Probability	0.14	0.19	0.17	0.15	0.18	0.15	0.17	0.17	0.17	0.17	0.14	0.18	0.19	0.17	0.17	0.15	0.14	0.13	0.12	0.12	0.11	

Appendix 11: The estimates Annual Population Growth in the Outer Islands (Van der Eng, 2000)

Table 8: *Estimated Annual Population Growth in the Outer Islands by Daerah/Province (per cent)*

	1930–40	1940–41	1941–42	1942–43	1943–44	1944–45	1945–46	1946–47	1947–48	1948–49	1949–50	1950–61
Aceh	1.59	1.60	1.60	1.50	1.25	1.25	1.50	1.50	1.50	1.60	1.60	1.63
North Sumatra	1.73	2.00	2.00	1.50	0.50	0.50	0.50	1.50	1.50	2.00	2.50	2.56
West Sumatra	0.55	0.75	0.75	0.50	0.25	0.25	0.40	0.50	0.75	0.75	0.75	0.76
Riau	5.23	5.00	5.00	3.00	1.25	1.25	2.00	3.00	3.50	5.00	5.00	5.26
Jambi	3.92	4.00	3.75	3.00	1.25	1.25	1.25	2.00	3.25	3.50	4.00	4.17
South Sumatra	2.27	2.25	2.25	2.25	1.25	1.25	1.25	2.00	2.25	2.25	2.50	2.56
Bengkulu	0.71	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.76
Lampung	7.02	7.00	5.00	1.75	1.00	1.00	1.25	1.75	1.75	2.50	5.00	5.26
Bali	1.47	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.65	1.68
West Nusateggara	1.79	2.00	1.75	1.75	1.50	1.50	1.75	1.75	1.75	1.75	2.00	2.04
East Nusateggara	1.23	1.50	1.25	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.25	1.27
West Kalimantan	2.31	2.50	2.25	2.00	1.50	1.50	1.75	2.00	2.00	2.00	2.25	2.30
Central Kalimantan	1.12	1.25	1.25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.01
South Kalimantan	3.00	3.00	2.75	2.40	1.50	1.50	1.75	2.00	2.25	2.25	2.50	2.56
East Kalimantan	1.61	1.60	1.60	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.50	1.52
North Sulawesi	1.92	1.90	1.90	1.70	1.50	1.50	1.50	1.70	1.70	1.70	1.80	1.83
Central Sulawesi	2.08	2.00	2.00	1.75	1.50	1.50	1.50	1.75	1.75	1.75	1.75	1.78
South Sulawesi	1.71	1.75	1.75	1.50	1.25	1.25	1.25	1.50	1.50	1.75	1.75	1.78
Southeast Sulawesi	1.21	1.25	1.10	1.00	0.50	0.75	1.00	0.75	0.75	1.00	1.10	1.11
Maluku	1.30	1.25	1.10	1.00	0.50	0.75	1.00	0.75	0.75	1.00	1.10	1.11
Irian Jaya	0.76	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.76
Outer Islands, total	1.83	2.05	1.93	1.56	1.06	1.08	1.18	1.50	1.59	1.79	2.05	2.12
Indonesia, total	1.56	1.64	1.60	1.08	−0.00	−0.18	0.63	1.06	1.24	1.59	1.84	1.89

Appendix 12: The Relative Probability of Last Child Death for Children Born Between 1935-1955 across provinces

Provinces	Year of last childbirth																					Average relative probabilities wartime 1942-1949
	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	
Bengkulu	1	1.437	1.529	1.425	1.555	1.273	1.596	1.465	1.535	1.279	1.287	1.454	1.670	1.548	1.505	1.237	1.347	1.083	1.051	1.100	1.013	1.468
Central kalimantan	1		1.323	1.061	1.136	1.168	1.381	1.374	1.349	1.300	1.172	1.597	1.582	1.428	1.309	1.265	1.084	1.041	1.046	0.987	0.970	1.389
Southeast sulawesi	1		1.450	1.245	1.378	1.074	1.385	1.338	1.349	1.377	1.095	1.457	1.515	1.307	1.378	1.180	1.090	1.006	1.012	0.965	0.879	1.352
Bali	1	1.517	1.309	1.151	1.259	1.108	1.322	1.380	1.339	1.281	1.040	1.466	1.522	1.229	1.308	1.126	1.056	0.981	0.918	0.956	0.831	1.321
Jambi	1	1.525	1.176	1.059	1.318	1.162	1.338	1.391	1.325	1.398	1.065	1.356	1.453	1.214	1.358	1.108	1.064	0.975	0.917	0.933	0.841	1.320
Central java	1	1.389	1.324	1.098	1.308	1.078	1.232	1.281	1.276	1.266	1.031	1.372	1.463	1.260	1.259	1.089	1.005	0.930	0.882	0.896	0.813	1.276
North sulawesi and gorontalo	1	1.424	1.293	1.072	1.316	1.109	1.260	1.238	1.311	1.227	1.047	1.387	1.438	1.282	1.255	1.071	1.009	0.935	0.899	0.963	0.849	1.273
East java	1	1.426	1.310	1.099	1.325	1.080	1.235	1.264	1.283	1.262	1.019	1.392	1.445	1.251	1.261	1.081	0.990	0.924	0.865	0.893	0.798	1.272
West kalimantan	1	1.560	1.365	1.117	1.316	1.127	1.178	1.294	1.192	1.266	1.071	1.308	1.501	1.296	1.219	1.143	1.069	0.985	0.926	0.938	0.867	1.268
Special region of jogyakarta	1	1.421	1.290	0.989	1.309	1.057	1.209	1.250	1.228	1.211	0.991	1.405	1.445	1.233	1.248	1.041	0.968	0.881	0.850	0.873	0.767	1.251
Special capital region of jakarta	1	1.394	1.494	1.127	1.330	1.119	1.302	1.240	1.207	1.233	1.013	1.320	1.432	1.271	1.249	1.133	0.974	0.917	0.871	0.863	0.815	1.246
South sulawesi and west sulawesi	1	1.390	1.244	1.090	1.294	1.072	1.201	1.225	1.331	1.273	1.006	1.344	1.356	1.211	1.208	1.050	0.998	0.934	0.859	0.910	0.816	1.244
West java and banten	1	1.405	1.268	1.070	1.287	1.082	1.231	1.244	1.250	1.203	1.013	1.341	1.407	1.205	1.217	1.064	0.958	0.902	0.845	0.861	0.785	1.235
North sumatra	1	1.434	1.136	1.074	1.314	1.058	1.252	1.246	1.223	1.197	1.017	1.301	1.375	1.265	1.239	1.100	1.005	0.936	0.879	0.909	0.810	1.233
Special region of aceh	1	1.430	1.145	1.068	1.427	1.073	1.292	1.257	1.179	1.162	1.021	1.333	1.425	1.219	1.240	1.059	1.018	0.903	0.871	0.883	0.790	1.229
Riau and kepulauan riau	1	1.202	1.107	1.171	1.171	1.062	1.075	1.223	1.248	1.155	0.994	1.296	1.395	1.268	1.209	1.046	0.970	0.921	0.844	0.848	0.794	1.224
South kalimantan	1	1.296	1.258	1.066	1.414	1.093	1.229	1.180	1.280	1.197	1.018	1.299	1.369	1.206	1.238	1.081	0.998	0.951	0.859	0.903	0.789	1.223
East kalimantan	1	1.523	1.012	1.166	1.108	1.050	1.093	1.464	1.179	1.210	0.928	1.264	1.324	1.170	1.092	1.009	0.925	0.929	0.858	0.834	0.732	1.204
West sumatra	1	1.424	1.182	1.081	1.270	1.076	1.176	1.223	1.155	1.174	0.978	1.249	1.313	1.142	1.169	1.025	0.943	0.891	0.823	0.867	0.778	1.175
West nusa tenggara	1	1.274	1.202	1.017	1.278	1.022	1.162	1.155	1.168	1.204	0.945	1.293	1.294	1.100	1.217	1.018	0.943	0.887	0.823	0.867	0.775	1.172
East nusa tenggara	1	1.369	1.128	0.997	1.209	0.977	1.246	1.177	1.202	1.172	0.959	1.189	1.354	1.140	1.153	1.012	0.921	0.897	0.819	0.832	0.766	1.168
Maluku and north maluku	1	1.346	1.209	1.021	1.221	0.995	1.081	1.281	1.205	1.122	0.987	1.185	1.290	1.202	1.065	1.014	0.969	0.846	0.811	0.835	0.774	1.167
Lampung	1	1.451	1.147	1.084	1.111	1.148	0.992	1.203	1.069	1.177	0.953	1.218	1.465	1.053	1.185	1.026	0.861	0.893	0.832	0.867	0.816	1.165
South sumatra and bangka belitung	1	1.297	1.232	0.981	1.134	0.972	1.123	1.212	1.138	1.102	0.931	1.232	1.289	1.197	1.154	1.000	0.953	0.878	0.827	0.830	0.758	1.157
Papua and west papua	1	1.019			1.255	0.931	1.171	1.138	1.151	0.915	0.908	1.010	1.202	1.180	1.256	0.998	0.946	0.931	0.822	0.864	0.775	1.095
Central sulawesi	1	1.261	1.188	1.015	1.386	0.976	1.050	1.146	0.977	1.131	0.869	1.181	1.131	1.081	1.043	0.931	0.927	0.797	0.778	0.820	0.720	1.070

Appendix 13: Use of Artificial Intelligence

During developing this thesis, I utilized ChatGPT (GPT-4) as a supplementary tool to enhance my writing process. This appendix outlines how AI was employed and its impact on the final draft.

1. Grammar and Spell checker:

   Example prompt:

   a. Can you check this paragraph for grammatical and Spell errors while maintaining my original ideas?"
   b. Are there any instances of passive voice in this text that would be stronger in active voice?
   c. Does my use of academic language feel consistent throughout this section?

2. STATA Code and statistical Interpretation:

   Example prompt:

   a. What might be causing this error message in my STATA output: [error message/invalid syntax/too many variables]?
   b. How to export the result/table into document and excel file?
   c. Give me an example of code, how to create line graph in Stata?
   d. How to interpret the logistic regression output, please provide the simulation?

Due to using a shared account, ChatGPT conversation links are not available for reference because other users deleted my history. Moreover, ChatGPT supported this thesis but did not replace my original research and analysis. All final decisions, interpretations, and conclusions represent my critical thinking and academic judgment. The AI served as a supplementary tool to enhance the quality and rigor of my work while maintaining academic integrity.