Essays on physical and human capital in developing economies

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ABSTRACT

The international community has been engaging in economic development after World War II. The development is still the most important issue in the 21st century, however, there are still lots of poverty problems in the world. Toward the challenges, the United Nations showed a direction as Sustainable Development Goals (SDGs) which consists of seventeen goals and 169 targets. Likewise, development economics has presented the importance of investments in physical capital and human capital. The SDGs are also designed based on this problem consciousness.

This dissertation investigates physical capital and human capital following these issues. The first study shows the influences of the railroads' construction on the price convergence. Infrastructure development is the basic strategy as the investment in the physical capital. This paper adopts the Japanese railroads in the Meiji era utilizing historical statistics for six commodities. Authors digitize paper records and construct an unbalanced panel dataset. The paper finds that the railroads played an important role in the price convergence. In addition, the relationship between railroads and traditional transports is discussed.

The second study evaluates the effects of conflicts on child health. Early life health is critically important for human capital since it affects educational attainment and wage. The civil conflicts, however, break out in most regions and damage child health in developing countries. This paper the effects of conflicts on child health in northern Mali, and finds the exposure to the conflict when the child is in utero reduces his/her height significantly. The paper also discusses the effects of using the intensity variables that are constructed by the number of deaths of conflicts.

The third study shows the correlation between experience that the inclusive environment and the discrimination. This paper focuses on the case of people with disabilities (PwDs) since there are few studies on the discrimination against disabilities

although most of the PwDs are extremely poor. The paper demonstrates students' teacher preference decision utilizing the unique dataset of teachers with or without visual impairments in Nepal's mainstream schools. Results show the significant difference in visually impaired teachers based on whether students have the opportunity to interact with PwDs at schools or communities. These findings suggested that policies promoting the inclusive participation of PwDs were likely to be instrumental to increase positive attitude towards disability on the part of non disabled people.

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Chapter 1

Introduction

Economic development is set as the most important issue in international cooperation. Its realization is a global concern, and each country attempts this great project with a huge budget. At the beginning of this stream, interests of the international community gathered for economic development following the wretched World War II (WWII). In 1945, the United Nations (UN), the World Bank Group and International Monetary Fund (IMF) were established one after another, with the object of peace in the international community and reconstruction after the WWII. The international organizations have made huge investments such as Official Development Assistance (ODA) for half a century, however, many problems still exist strictly as various disparities such as lack of human rights, too low wages, labour supply, opportunity of education, and high infant mortality rate. As many human beings already understand, the development has various aspects and a complex theme that any problems cannot be ignored.

Toward the difficult problem, modern society presented comprehensive direction in the form of Millennium Development Goals (MDGs) which has the eight goals to reach by 2015. Since the ODA of each country has not proceeded the results, aid effectiveness has been drawing attention in the 1990s (OECD 2012). As focusing on effectiveness worked, the UN adopted the MDGs based on the International Millennium Declaration in September 2000.

While several developments are realized in the 15 years, lots of problems that could not be achieved remained. The UN summarized the problems as follows: Gender inequality persists; Big gaps exist between the poorest and richest households, and between rural and urban areas; Climate change and environmental degradation undermine progress achieved, and poor people suffer the most; Conflicts remain the biggest threat to

human development; Millions of poor people still live in poverty and hunger, without access to basic services (UN 2015).

Following the problems highlighted in MDGs, the UN adopted Sustainable Development Goals (SDGs) in 2015. A lot of new goals are added to the SDGs, which consists of totally 17 goals and 169 targets. Many targets are contents conscious of the issues of MDGs, and more concrete directions are set. These goals are urgent international issues that are required to achieve by the year 2030 and are highly afflicted.

Toward these challenges, development economics has presented clear problem awareness and methodology. After WWII, initially, macroeconomic suggestions were actively discussed, such as Big Push advanced by Paul Rosenstein-Rodan (Roland 2013, Rosenzweig 2012). Most of the research focused on which resources to invest. At that time, theories including the Solow model emphasized the accumulation of physical capital, namely neoclassical theory. Therefore, governments set infrastructure development at the core of growth strategies (Meier 2000).

Even now, infrastructure development is still the basic strategy of economic growth (Esfahani and Ramirez 2003). The SDGs emphasized infrastructure development as Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation. In fact, the World Bank has allocated the most budget for infrastructure development. Investment in transportation in Africa, East Asia, and Pacific where have serious poverty problem was in the range of 18-20% of the budget (World Bank 2017). Demonstration of the pathway from the investment in infrastructure to economic growth is in various ways (Donaldoson 2018, Duflo and Pande 2007, Frankel and Romer 1999, Robinson and Torvik 2005). Especially physical investment such as transportation tends to be influenced by geographical factors. However, once the facilities are controlled for, the geographical characters do not affect the wage disparity directly (Rodrik et al. 2004).

After the investment in physical capital, the accumulation of human capital got a lot of attention (Romer 1986). The reason was that the poverty population continued to increase and the doubts were directed to the theories despite intensive investment in physical capital (Meier 2000). Likewise, the neoclassical theory was given technical innovation as exogenous, however, the technological progress was reviewed as endogenous, namely the endogenous growth model (Lucas 1988). Technological progress depends on individual labour productivity endogenously. Therefore, labour productivity aroused the discussion of human capital, and thus the importance of investment in education and health began to be recognized. G. Becker described the influence of education in individual on his/her productivity theoretically and empirically (Becker 1994). Likewise, the effects of child health on earnings and educational attainment was recognized widely (Glewwe and Miguel 2007, Strauss and Thomas 1998).

Human capital is hence one of the most important investment targets in the 21st century. In fact, the SDGs introduces the investment in human capital as Goal 3: Ensure healthy lives and promote well-being for all at all ages, Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all, and Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

These goals have the words “for all” which means inclusion (Jāhāna 2016). Since the investment targets focused on human capital, personal differences based on the characteristics of several backgrounds such as gender need to be considered. As the MDGs have already listed as their own tasks, gender gaps were recognized as a problem on the basis of development strategies. Following the awareness of the issues, the SDGs emphasizes the reduction of any discrimination regardless of gender in all goals.

The outcome of discrimination appears in employment opportunity (Becker 1971, Phelps 1972). Likewise, it has been theoretically suggested that the reduction of gaps induces economic growth (Galor and Weil 1996). Many kinds of research on

discrimination are conducted in various contexts: Blau and Kahn (2017), Croson and Gneezy (2009) for Gender; Yinger (1998) for Ethnicity; Iyer (2016) for Religion; Darity and Mason (1998) for Race. The disappearance of discrimination brings about the inclusion, however, the exclusion still exists in the world.

This dissertation discusses comprehensively investment in physical capital and human capital. The poverty reduction is not implemented although the international communities have struggled to develop. As mentioned above, the history of development economics has presented the importance of several problems. Infrastructure development was remarked initially, and the function of human capital was recognized secondly. Furthermore, the resolution of discrimination is emphasized in recent development strategies based on the failure of the MDGs.

Therefore, this dissertation first verifies the effect of investment in physical capital. It is the development of transportation which is the most basic strategy to promote economic integration. It is important to verify the effect of policies that require the most budget among the development policies of each country. Subsequently, following criticism of the internal growth theory, this dissertation discusses the importance of human capital. Even if we invest in the physical capital in huge amounts, it is difficult to connect with economic development if the human capital is neglected. In other words, it is the first step toward economic development to emphasize both physical capital and human capital (Démurger 2001). In addition to the issue of conventional development, I would also like to discuss discrimination that is emphasized newly in SDGs. This is because the case of Nepal discussed in this study is special and hopeful. In Nepal, it was permanently to hire people with visual impairments as teachers from early on. People with disabilities are in extreme poverty worldwide. Although discrimination against them can be confirmed in various aspects, it is possible to discuss the possibility of the inclusive society by focusing on the case.

Chapter 2 in the dissertation investigates the market development through the investment in physical capital, especially infrastructure development. The chapter verifies the relationship between railroad construction and market integration. Investment in transportation construction is the basis of development strategies and allocated the most budget (World Bank 2017). The market integration is often measured using the price convergence rationalized by the Law of One Price (LOP). In the case of the Japanese railroads installation, the existing of rich and unique dataset allows discussing the market investment.

This study estimates the impact of Japanese railroads established in the Meiji era (the late 19th and early 20th centuries) on price convergence focusing on six commodities: rice, barley, alcohol, soy sauce, charcoal, and firewood. Authors digitize records in physical books published by the administration in those days and construct panel data during the periods 1879 to 1912. This paper adopts the Difference in Differences (DID) as a methodology and shows two findings. First, the railroads played an important role in price convergence. The effects of the railroads are observed in all six goods and depend on commodities. Second, existing harbors – thus traditional water transport - affect the convergence caused by the railroads. In particular, it can be interpreted that the harbors act strongly on high-priced goods such as alcohol. This paper contributes to the policy-making of infrastructure development in developing countries since the economic status of the Meiji era in Japan is similar to the one of the modern developing counties. In addition, this paper is the first investigation of empirical studies covering the whole county since there are few kinds of research on Japanese railroads in the Meiji era.

Chapter 3 focuses on human capital, especially child health. The LOP has presented that investment in physical capital induces the reduction of differentials in commodity prices. However, the real world did not show the expected results, which is explained by the disparity of human capital. Although the health and education are often

focused on as factors constructing the human capital, the chapter investigates child health since health hazards at childhood play a critical role in socioeconomic status and educational attainment (Currie and Almond 2011, Strauss and Thomas 1998). In other hands, conflicts in developing countries are regarded as a problem as well as the investment in health. Seventy-five percent of regions in Sub-Saharan Africa have experienced civil conflicts since World War II (Gleditsch et al. 2002). Likewise, Malian child has serious health conditions that the infant mortality rate is one of the worst in the world (World Development Data Indicators 2014), and the human capital such as early-life health has significantly deteriorated.

This study evaluates the impact of the 1990-94 conflict in northern Mali on child health at different timings of exposure (in utero and after birth) using the Malian Demographic and Health Surveys conducted in 1995-1996 and 2001. An anthropometric variable (Height-for-age Z-scores) is used as an indicator of child health. The empirical strategy relies on the difference-in-differences approach based on birth cohorts, GIS for residence information and the intensity of the conflict. The intensity of conflict exposure is measured by the total number of deaths resulting from a conflict that broke out within a 10-km radius of each community, utilizing the Uppsala Conflict Data Program database providing the GIS information for each battle. Previous studies adopted the intensity using several indicators (e.g. distance or period of exposure); however, this paper is the first to estimate the total deaths. The estimation results show that the more severe the exposure to children and their mothers, the greater the negative impact on the height of the children. Additionally, the timing of conflict exposure plays a critical role in the outcome of a child's health: the exposure to conflict in utero, not after birth, negatively impacts child health. Testing the robustness of these findings in three ways, this paper concludes that the HAZ in utero conflict exposure has serious negative impacts on health in early life.

Chapter 4 discusses the reduction of discrimination for people (PwDs) with disabilities. Eighty percent of PwDs in the world live in developing countries and are one of the extremely poor populations (WDI 2014). The current society excluding PwDs has complexed problems such as human rights, access to education and employment opportunity. Since several discrimination strictly exists regardless of PwDs, the SDGs emphasizes the inclusion more than the MDGs. Rapidly growing studies accumulate research on several discrimination such as gender, ethnicity, religion, and race. However, the number of papers investigating PwDs is less than other backgrounds. In order to achieve the inclusion society declared in SDGs, PwDs cannot be ignored. Towards the reduction of discrimination for PwDs, the chapter focuses on inclusive education in Nepal. Nepal is one of the poorest countries in Asia, however, it is a rare example of inclusive education being implemented early. Efforts to inclusion in Nepal appear as inclusive education and employing people with visual impairments as teachers in mainstream schools.

This study estimates the students"s teacher preference decision utilizing the unique dataset of teachers with or without visual impairments and students in Nepal's mainstream schools. Results show the significant difference in visually impaired teachers based on whether students have the opportunity to interact with PwDs at schools or communities. Our findings suggest that inclusion and visibility of disability in communities help reduce discrimination and increase positive attitude on disability.

Although the international community towards economic development is continuing various efforts, and the development economics has also demonstrated some problem consciousness, however, both are still under discussion. Chapter 2 contributes to the knowledge of the investment in infrastructure. The infrastructure development may introduce the price convergence theoretically, however, there are few papers focusing on the domestic market integration. The study demonstrates the topics evidenced by Japanese railroads for the first time. In addition, the chapter tries to discuss the

relationships between the traditional and the new transport means. Chapter 3 uses the new indicator of the intensity of conflicts. Recent papers have started to show the effects of conflicts on child health, however, their discussion is based on dummy variables mainly. In order to clarify how do the conflicts damage child health, the discussion based on the intensity of conflict is needed. Chapter 4 focuses on a new perspective on discrimination. The study draws an important potentiality that the discrimination consciousness against PwDs can be reduced utilizing PwDs society in Nepal.

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Chapter 2

Railroads and price convergence: Evidence from Japan in the Meiji era[1]

2.1 Introduction

Transportation development has been adopted as a fundamental policy to grow the economy in developing countries. Infrastructure for transportation may induce economic integration, enabling people to move, trade, and access economic opportunities. Economic theory suggests that economic integration reduces trading costs and produces economic development. In line with this, the World Bank has allocated the highest budget to infrastructure development (World Bank 2017).

To make effective investments in infrastructure, it is important to clarify the path from economic integration to development in a detailed manner. Previous studies have found that transportation brings about variations in income across countries (Frankel and Romer 1999) and within countries (Donaldson 2018) since changes in income is one of the most obvious indicators of economic growth. However, there is limited literature that provides comprehensive research on how infrastructure leads to economic growth.

This study estimates the effects of the establishment of infrastructure on price convergence as the initial step for economic integration. One of the phenomena that results from infrastructure development is price convergence as explained by the Law of One Price (LOP). Most studies have focused on the conclusive outcomes that indicate

[1] This paper is co-authored by Koichi Ushijima and Yuki Kaneko (Graduate School of Systems and Information Engineering, University of Tsukuba, Japan). This research was presented at the 2018 Japanese Economic Association Spring Meeting and Seminar at Kwansei University. We thank the people who commented at the conference and the seminar.

economic development; however, these outcomes were results induced by the price convergence. Price convergence is the primary step that is observed toward integration.

Previous studies have shown the effects of railroad construction in India around the 1900s. The construction activities during those days existed in abundance and information on these activities as well as the economic conditions are available for modern economic analysis since India has long been a British colony and thus, had practiced keeping statistical records. Andrabi and Kuehlwein (2010) estimated the impact of railroads on the price convergence in rice and wheat in India. They focused on the average effects of railroad construction from 1860 to 1920 on price convergence. The results showed that the effects were about a 20 percent decline in price dispersion.

Most literature discusses the relationship between international trade and economic indicators; there are few studies focusing on internal network. To fill this gap, this study investigates the establishment of Japanese railroads in the Meiji era (the late 19th and early 20th centuries). The administration in the Meiji era implemented railroad construction as the most important modernization policy. The railroad network, which incorporated Western technologies, expanded rapidly around the 1900s. The development policies at that time have been referred to by developing countries in their path to economic development (Robinson and Acemoglu 2012).

In order to perform the estimation on the relationship between railroad construction and price convergence, we used records from books published by the administration in those days and constructed an unbalanced panel data during the period from 1879 to 1912. One of the modernization policies at that time was the establishment of a statistical office and thus, the government of each prefecture had started to archive their economic status and census. This allowed us to observe economic activities from 100 years ago in Japan.

We also considered the existing water transport. As in other countries, water transport had traditionally been the main transportation in Japan before railroad installation. However, although organizations invest in new transportation networks in developing countries, the relationship between traditional and new infrastructure is unclear. In this study we discuss whether water transportation has any influence on the interaction between price convergence and railroads.

There are two contributions of this study. First, we demonstrate the Law of One Price (LOP) by clarifying the relationship between price convergence and Japanese railroad construction. When considering economic development and investigating infrastructures, it is important to recognize the role of infrastructure in economic integration. Second, our study discusses whether the existing water transportation at that time (the period from 1879 to 1912) affected the relationship between price convergence and railroad expansion. Since it is still unclear how price dispersion declines, we begin by examining the interactions between traditional transport, commodity price changes, and railroad transportation. There have been a few studies that observed whether there is a synergistic relationship or a competitive interaction between them.

2.2 Background

2.2.1 Railroad expansion and price convergence

The establishment of the Meiji government in 1868 had a crucial role in Japan's economic development. The era of the samurai that lasted nearly 700 years ended at that time, and the new government started to import western technology and culture to realize wealth and military strength in Japan. This rapid change is called the *Meiji Ishin* (Meiji Restoration). The government speedily pushed some policies that directly affected the Japanese markets. For example, *Shoho taii* (law amendment in the commercial code)

resolved commercial privileges that had continued since the Edo period. People had been guided by a regulation of occupation selection by caste before the Meiji restoration; *Shoho taii* relaxed the regulation of occupation selection in 1872. Likewise, laws on telegraphy and mail were maintained in 1885 and 1871 respectively. This liberalization reduced gaps in the communication of price information that was forbidden before the restoration.

There were two major policies that physically aggregated markets. The first one is *Haihan chiken* (abolition of feudal domains and establishment of prefectures) in 1871. It promoted domestic unification by permitting all people to move and migrate over administrative boundaries. Second is the railroad construction, which accelerated market integration. The Japanese railroad began with connecting Shinbashi and Yokohama in 1872, opened to Osaka and Kobe in 1874, and extended to Kyoto in 1877. The railway was maintained in various places afterwards (see Figure 2-1). It is theoretically expected that market integration produces comparative advantages, division of labor in a wider range, and economies of scale.

The fundamental cause of economic integration is the loss of transaction costs. Anderson and Wincoop (2004) summarized literature on transaction costs, but the fundamental factors are transportation means and tariffs. During the Meiji era, small tariffs on transactions were charged, and liberalization of movement was fulfilled by the *Haihan chiken*. Therefore, this study focuses on transportation, which is the second factor that achieves economic integration.

A typical indicator to measure economic integration is price convergence. Many empirical studies have been conducted on the price convergence of international transactions because it can be interpreted as equilibrium between production input and purchasing power levels. We also know that price convergence will be the same as the convergence of income (Glushenkova et al. 2016).

Price convergence can be interpreted as a result of the LOP. The LOP states that identical goods sold in any location must sell for one price assuming complete information and the absence of trade frictions. When homogeneous goods are traded at different prices in different markets, price differences of goods converge due to arbitrage. Arbitrage is the act of generating profit utilizing the price differences. There are several formulas of the LOP[2]; here we describe the "iceberg form" since it is the simplest and most suitable to estimate.

Let P_i be the price of a commodity in market *I* and P_j be the price in market *J*. Assuming a fraction (such as transport costs) *f* of the commodity melts in transport, the arbitrage that transports the commodity from market *I* to market *J* occurs if

$$(1-f)P_j > P_i \rightarrow 1-f > P_i/P_j.$$

Likewise, reverse transportation would come about if

$$(1-f)P_i > P_j \rightarrow 1-f > P_j/P_i.$$

Therefore, a bandwidth of the commodity price is given by

$$(1-f) < P_i/P_j < 1/(1-f),$$

which means that the price fluctuates depending on the fraction rate *f*. When any cost of transportation *f* disappears, P_i/P_j converges in the value of one:

$$\lim_{f\to 0}(1-f) < P_i/P_j < \lim_{f\to 0} 1/(1-f) \rightarrow P_i/P_j = 1\ .$$

However, the LOP may not hold in the real world since transportation costs, incomplete information, and other barriers exist. In terms of the Japanese market, the restoration reduced some factors of friction *f* such as the telegraphy and mail network, which cut the information gaps among regions legally and technologically before the

[2] Anderson and Wincoop (2004) presented five types of LOP outcomes. It should be noted that the representation of convergence differs depending on the indicator; however, there is no difference in the trend looking at the results of their simulation. Likewise, since many studies use the iceberg type of LOP it is easy to compare with our interpretation.

railroad construction. *Haihan chiken* allowed the movement and migration of people, and *Shoho taii* relaxed the choice of occupation regardless of caste.

This study investigates the effects of railroad construction on price convergence. In other words, this study estimates how railroad expansion reduces the friction f. In economics, abundant studies focused on the effects of international transportation[3]; however, there are not many that discussed internal transportation (e.g., Crucini and Smith (2016) for Sweden, Andrabi and Kuehlwein (2010) for India, Dobado and Marrero (2005) for Mexico, and Slaughter (2001) for the United States).

We adopted Andrabi and Kuehlwein (2010) as a benchmark research since the conditions in their research are similar to ours. They discussed India's internal railroad construction in the 19th and 20th centuries using historical dataset. India had been a British colony since 1858, and its independence was recognized in 1947. In 1853, detailed schema and parliamentary law about national railroad expansion were established, and construction was started. The railroad was basically laid from the main port going inland. There were various purposes for the expansion related to the military and measures against hunger caused by the poor harvest. They found that the price convergence on wheat and rice resulting from the railroad was about 20 percent.

Similar to the case of India, the Japanese railroad was constructed in the 19th and 20th centuries and certain frictional factors f (costs of information and legislation on movements) have been relaxed before the construction. There is no prior research on the causalities between railroads and price convergence on a national level in Japan; however, there were some studies written in Japanese on specific areas (detailed in the next section). We were able to search some literature about railroads and prices; however, these studies

[3] For discussions on price convergence in international trade, see O'Rourke and Williams (2002), Jacks et al. (2011), Arribas et al. (2009), who have demonstrated price convergence using historical data. Likewise, Chilosi and Federico (2015) targeted Asian internationalization in the 19th and 20th centuries, and Hynes et al. (2012) studied the European region.

investigated only local cases as stated above. To the best of our knowledge, this study is the first to perform estimations on national-level data.

2.2.2. Railroad and Commodities

In the Meiji Era Japan was a developing country and the main industry was primarily agricultural products (Robinson and Acemoglu 2012, Fukao and Settsu 2017). This study investigates six commodities: rice, barley, alcohol, soy sauce, charcoal, and firewood since these were the major products at the time. Furthermore, statistics in the Meiji era mainly concerned agricultural products (details are described in the data section).

The structure of the logistics at that time was different according to the type of goods. It was rice that realized systematic nationwide circulation. The distribution of brewed items such as alcohol and soy sauce were carried out by leading manufacturers. Likewise, the tendency to distribute locally produced items was high in the case of high-bulk products such as charcoal and firewood. These features are further discussed as follows.

Rice and grain were the major products in the Meiji era. The government encouraged rice production and actively implemented breed and technology improvements since more than half of the government's revenue source was land tax. Government policies encouraged the increase in production; however, the production volume and prices were unstable on a yearly basis. To stabilize the prices, the government issued a regulation on savings (*Chochiku bei jorei*). During the period of expanding the railroads, there were no policies to control the prices (Isayama 1961). There are few studies that investigated price differences between regions nationwide; for example, Koiwa (2003) described the regional variation of rice prices in the Meiji era using prefecture-level variation coefficients. His research revealed the reduction of regional

price differences, and the trend was noticeable in the difference between local markets and the central markets (e.g., Tokyo, Okasa, and Kobe).

Likewise, there are few papers that quantitatively discussed the relationship between price changes and the railroads. At a local level, Omameuda (2003) described the case of Tohoku region and the Tokyo markets. Tohoku is a rural region consisting of six prefectures located in northern Japan. His study revealed that most of the rice in the Tohoku region had been exported to the Tokyo market (consisting majority of the rice imported into the Tokyo market). Furthermore, the means of transport had shifted from water transport to the railroads, and traditional wholesalers were out of business. Similar movements were observed in other local studies[4]. However, there were cases that reported railways were not used for neighboring prefectures. Koiwa (2003) focused on the markets in Aomori prefecture[5]. His research stated that the rice exports to neighboring areas rarely used the railroads and relied on shipping even when the railroads were constructed. Moreover, the distribution system in neighboring prefectures still made use of horses. It is expected that Transportation within the neighbourhood was not done using the railroad since this cost more than other alternative modes of transportation.

Alcohol and soy sauce were also important products, and these were the major sources of government revenues as rice and grains (Yunoki 1998). This tendency was particularly noticeable in alcohol, and the same vendor often produced alcohol and soy sauce. Since the restriction on brewing alcohol was relaxed in the early Meiji era, the number of alcohol brewers increased. However, the government levied heavy taxes in

[4] Kimura (2005) compared water transports and railroads in the case of Tokyo markets. Nihiso and Yuzawa (2008) investigated the topic in Gunma prefecture and revealed the transition from water transport to railroads throughout the Meiji era. Kato (2003) revealed similar findings for Yamanashi prefecture. Nakamura (2003) discussed the distribution volume's increase in the railroads' transport in northern Kyusyu region. Moreover, the volume in shipping did not increase as much as that of the railroads'.

[5] Aomori is a rural region located at the northernmost tip of the main island of Japan. Rice was about 70% of the products in Aomori (Koiwa 2003).

anticipation of an increase in tax revenues and thus, the number of breweries declined. Only breweries that can withstand taxation continued to operate; nationwide production volume nearly doubled. Oshima (2007) discussed changes in the distribution of alcohol in the cases of Hyogo and Aichi prefectures[6]. In the early Meiji period, the major trading partner of brewers was the Tokyo market. However, because of changes in the distribution associated with railways, the transaction volume in Tokyo declined, and business partners increased all over the country.

As for soy sauce, this was customarily manufactured in each household and was not regulated before the Meiji period. However, after the Meiji restoration, the population concentration in urban areas progressed. As a result, lesser households manufactured soy sauce (as the people diversification their lifestyles), and the soy sauce industry developed (Yoshida and Sugino 2011). Ioku (2003) described the differences in sales routes before and after the railroad construction in the case of the Boso region[7]. Before the railroad was constructed, the main wholesaler of the Boso region was Tokyo. Afterwards, there were customers spread throughout the country as a result of the railway being laid. Moreover, the fare was cheaper as compared with the existing distribution system (water transport), and the manufacturers who were far from the railways did not expand their sales channels.

Charcoal and firewood were the main fuel of Japan until the use of gas spread. Firewood and charcoal were used as fuel at home, and charcoal was mainly used in industries. Forestry was one of the main industries at the time since more than half of the country's land consisted of forests. The amount of charcoal produced in forestry in the Meiji Era was about 15%, and firewood was almost the same although there were regional differences (Akaha and Shioya 1963). Before the railroad construction, wood had been distributed only to neighboring prefectures since wood was bulky and the forests were

[6] Hyogo and Aichi prefectures, located in the west and central regions of Japan's main island, respectively, were the leading manufacturers that continued from the Edo period.

[7] The Boso region is located in the southwest part of Japan's main island and is a neighboring region of Tokyo. It was a famous place for soy sauce since the Edo period.

spread out all over Japan (Japan Charcoal and Fuel Association 1960, Ringyohattasushi-chosakai 1960, Takahashi and Nakagawa 2014). Likewise, water and land transports were the main means of transportation. As railroads expanded, wood started to be transported from all over the country to large cities such as Tokyo and Osaka. However, with wood's low unit price against volume, there were many areas that had been reliant on water transport. As an example of a regional research, in the document and data of Iwate prefecture[8], water and land transportation were mainly used before the railroads were constructed as described above. However, after the railroad was laid, transport by rail increased but mostly in big distant cities such as Tokyo (Iwate-ken 1982).

As mentioned above, many studies showed that a major change in the distribution route of daily necessities was caused by the construction of railroads in Japan. However, many previous studies are regional studies and performed only at the level of descriptive statistics. Our study is the first to cover the whole country and performs strict estimation over existing research.

2.3 Data

The data for this study came from two surveys. First, prices of commodities came from *Huken tokeisho* (prefectural statistics) as surveyed by the local administrations in the Meiji era. These statistics are public and preserved in the National Diet Library in Japan. Authors digitized the prices of rice, barley, alcohol, soy sauce, charcoal, and firewood in 651 markets and thus, constructed an unbalanced panel data from 1879 to 1912[9]. Most statistical data had the prices recorded in terms of annual average, and some

[8] Iwate prefecture is located in the north part of the main island, and its forestry was the largest production volume in Japan (Japan Charcoal and Fuel Association 1960, Akaha and Shioya 1963).

[9] A large-scale survey of wholesale and retail merchants in Japan began after the Meiji era. Ishii (2005) collected and presented unusual data from 1883. The number of merchants such as

monthly average records were converted to annual terms. Likewise, these statistics allowed us to unify moderate quality of commodities since the prices have been recorded for each quality. The second survey is the National Land Numerical Information download service provided by the Ministry of Land, Infrastructure, Transport, and Tourism in Japan. This survey included the geographical information and service period of infrastructures in Japan. We used information on the station, railroad, and harbor and thus, constructed the geographical dataset.

To facilitate our estimation, we merged these datasets with reference to geographical information system (GIS). GIS requires latitude and longitude of the markets and stations. This information on the station, railroad, and harbor was already provided in the second dataset; however, the information on the markets in the Meiji era was not prepared. In addition, even though the prefectural statistics included addresses of markets, they were difficult to geocode since the addresses in the Meiji era differ from modern addresses. Accordingly, this study substituted the administrative facilities of municipalities in modern day for the addresses of markets in the Meiji era following Andrabi and Kuehlwein (2010). We mapped the addresses of all objects using ArcGIS software and measured distances to the nearest station for each market (see Figure 2-1 and 2-2). Conclusively, we constructed an unbalanced panel dataset from 1879 to 1911 containing the prices of six commodities, with distance from 525 markets to stations and harbors.

We were able to directly observe differences of raw prices instead of price indexes since the prefectural statistics gave us annual prices in each market. Therefore, this study adopted the log price difference (LPD) as an indicator of the LOP following Andrabi and Kuelwein (2010), Chilosi and Federico (2015), and Slaughter (2001). When P_i/P_j from

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retailers and wholesalers was 1.17 million, accounting for 15.3% of the total number of units; 90% of which were retail merchants. Likewise, the number of cereals handled was about 100,000. Alcohol and soy sauce were 86,000 and 50,000 respectively. Fuel retail merchants were not recorded.

the iceberg type LOP is transformed to the logarithm, LPD is the absolute value of the log price difference between markets:

$$LPD := \left| ln\, P_{it}/P_{jt} \right| = \left| lnP_{it} - lnP_{jt} \right|$$

where subscripts $i, j,$ and t indicate market *i* and *j*, and year, respectively. P_{it} is the price of commodity in market *i* at year *t*. LPD is, in brief, rationalized by the LPD, and is a simple outcome for the difference of price. This study made combinations of markets at each year and thus, sample sizes for each commodity are shown in Table 2-1. Sample sizes are 456,663 for rice, 338,736 for barley, 391,125 for alcohol, 459,262 for soy sauce, 414,142 for charcoal, and 371,969 for firewood.

Table 2-1 describes the statistics for the LPDs of each commodity. Mean values for the primary products rice and barley are 1.102 and 1.332, respectively; these are low compared to other goods. The values for alcohol and soy sauce are 3.382 and 1.734; and for fuels and charcoal and firewood are 2.086 and 3.032, respectively. More details of the descriptions are shown in Table 2-2. In the table, the average price of each commodity for each year and the number of their markets are stated. The number of markets dealt with for each product was about 40 in 1879, and the highest number was about 300 in 1883. This decreased to around 22 in 1912. The average price tended to increase, and we consequently found that the prices continued to rise through the Meiji era. In fact, the prices in 1911 were about doubled since 1879.

An overview of the relationship between the railroad expansion and price dispersion of the price of barley is shown in Figure 2-3[10]. We measured the dispersion using the annual coefficient of variation: $\mathrm{CV} = \mathrm{Standard\ Deviation}_t/\mathrm{Mean}_t$, where *t* indicates the year. These indexes demonstrate the degree of standardized variation in prices across the country and are shown on the left axis. Likewise, the figure also displays the number of markets where railroad was constructed at year t on the right axis. We can

[10] The indexes for other goods are shown in Appendix figure 1. For soy sauce and alcohol, we can observe similar results as those for rice and barley. However, the behavior in the CV of fuels differ from table 2-1 and thus, we should carefully compare these goods.

see a decline of almost 70 percent in the CV of both goods from 1879 through 1911. The CV of rice in the 1880s is about 0.25 to 0.30, while the CV in the 1900s fell to 0.10. The same behavior can be observed with barley. Meanwhile, the number of markets connected to railroads has increased to more than 200 through the sample period. Figure 2-3 suggests that an introduction of railroads may have affected the price variation because as the number of markets with railroad increases, the CV appears to decrease. However, this simple correlation is insufficient to discuss causal relationships since it cannot control various factors such as inflation as shown in table 2-2.

2.4 Estimation Model and Results

2.4.1 Baseline model

Investigating the causal relationship between railroad construction and price convergence requires careful consideration since the estimation includes several concerns.

First, there is a selection bias problem related to the railroad construction areas. The selection of areas where the railroad is to be installed may be biased towards a market where economic development is expected, not at random. Therefore we have to distinguish between changes in the prices due to the installation of railroads and changes that would have occurred even if railroads were not constructed.

Second is the existence of macro trends such as the inflation observed in Table 2-2, and economic growth. It is assumed that the macro trends greatly affected the market price since Japan in the Meiji era had undergone a historically intensive transition period.

Third, alternative (traditional) means of transport were available. Andrabi and Kuehlwein (2010) argued that it is necessary to pay attention to the influence of the transport network existing before the railroads were constructed. Before the railroads, the water transport and manpower cars were the leading modes of transportation. However,

our analysis can be interpreted as a measurement of the effect of shortening transportation cost and time since the railroad network was often laid along the existing land route. Therefore, we carefully evaluated the effects of railroads construction near water transport.

Fourth, historical datasets: *Huken tokeisho* (the prefectural statistics) require proper handling. It is expected that necessary information were not completely recorded in the statistics since these are very old statistics compared with the modern dataset. The sample based on prefectural statistics has the following concerns: (1) overestimation due to outliers and (2) underestimation due to the inclusion of integrated markets before railroad construction. We dealt with the sample that caused these problems[11].

Our identification strategy relied on the Difference-in-Differences (DID) approach by utilizing the variation of timing and location of railroad construction. We estimated the effects of railroad construction on the price convergence using ordinary least squares as follows:

$$LPD_{ijt} = \alpha + \beta_1 Railroad_{ijt} + d_{ij} + d_t + \varepsilon_{ijt} \quad (1)$$

$$LPD_{ijt} = \alpha + \beta_2 Railroad_{ijt} + \beta_3 Harbour_{ij} \times Railroad_{ijt} + d_{ij} + d_t + \varepsilon_{ijt} \quad (2)$$

where subscripts $i, j,$ and t indicate market i and j, and year, respectively. LPD_{ijt} is the log of price difference that is described above in chapter 2.3. $Railroad_{ijt}$ is a dummy variable equal to one if railroads were constructed *near* both market *i* and *j* at year *t*, and zero otherwise. We defined *near* when the distance between the station and the market is

[11] For the first concern, it is expected that the administrators in Meiji recorded erroneous inputs such as the comma position, which gives us measurement error. As for the second concern, the sample contains a market that had been integrated with neighboring markets thus the price difference had already been zero before the railroad construction. Regarding the concerns above, we tried to remove bias by performing the following. For the first concern, we regarded the sample that test statistics ($\tau_{ijt} = (x_{ijt} - \mu_{ij})/\sigma_{ijt}$) is more than three as outlier. Likewise, for the second concern, we removed combinations of the same market price in the same prefecture before the railroad was constructed. We also estimated that these outliers and combinations were included, and the results did not differ significantly from the main results.

10 km or less. In other words, $Railroad_{ijt}$ takes the value of one if both market *i* and *j* are 10 km or less away from the nearest stations. When one or both are more than 10 km from any stations, $Railroad_{ijt}$ takes zero[12]. We also tested other definitions of the distance (i.e., 20km, 30km, and 40 km).

To determine the interaction between railroads and traditional water transport, we estimated the effects on markets that connected to both railroads and harbors using equation (2). As with the key variable for railroads, we constructed $Harbour_{ij}$ which equals one if harbors were located *near* both the market *i* and *j* . We set two types of the variable in which the distances between the market and the nearest harbor are 0 to 10 km, and 10 to 20 km. The harbors were basically constructed before the railroad installation and thus, the variable does not vary through the sample period. $Harbour_{ij} \times Railroad_{ijt}$ focuses on the effects of railroad construction on the markets that were already connected to harbors.

d_{ij} is a fixed effect variable for the combination of market *i* and *j* , and controls time-invariant individual characteristics of the combination such as distance between market *i* and *j*. Likewise, d_t is a fixed effect variable for year *t* , and controls time-series-specific events such as inflation and nationwide policy implementations. β_1, $\beta_{2,}$ and β_3 are parameters to be estimated. ε_i is an error term. It is expected that the gap of prices between market *i* and *j* related to the railroads are likely to decrease ($\beta_1, \beta_2 < 0$).

We addressed above problems of estimation as follows. First, we adopted the DID approach to resolve the selection bias of railroad construction areas. Particularly, the variation of timing and location of railroad installation allows us to identify the effects of

[12] There is no common definition for the connection between market and station. Andrabi and Kuehlwein (2010) considered 20 miles (32 km) as the distance that indicated their key variable has a connection. If the construction of railroads affects a wider area than 10 km, the markets which are more than 10 km from the stations are included in the control group in this study. Therefore, our results may be underestimated and report lower limit of the effects of railroad construction.

railroads. Second, we introduced fixed effects in our estimation models to control macro trends and thus, these reduced confounders caused by macro trends from the parameters of key variables. Third, we determined the relationship between railroads and water transports using equation (2), especially the comparison between β_2 and β_3. Fourth, we removed in advance problematic data that may cause under/over-estimation.

The estimated results for equation (1) are provided in Table 2-3. Panel A shows the results for β_1 when $Railroad_{ijt}$ equals one if the distance between markets and the nearest station is within 10 km. Likewise, the results for other definitions of distance (20km, 30km, and 40 km) are in Panels B, C, and D, respectively. These results show that the effects of railroad construction reduce the price dispersion in each commodity. When the markets connect to the stations within 10 km as in Panel A, results show that the LPDs decrease by 3.0% for rice, 4.5% for barley, 3.5% for alcohol, 2.2% for soy sauce, 12.0% for charcoal, and 12.2% for firewood. These coefficients tend to shrink as the distance increases from 10 km to 30 km. For example, in the case of rice in Column (1), the coefficient is 3.0% in Panel A when the definition of the connection is within 10 km, and are 2.1% and 0.6% in Panel B (within 20 km) and Panel C (within 30 km), respectively. Meanwhile, the coefficients in Panel D (within 40 km) are larger than the ones in Panel C. This suggests that the effects of railroad installation is not linear with the distance to the market.

The estimation results for equation (2) are shown in Table 2-4. The equation includes the variables indicating the connection to harbors: Harbour (0 to 10km) takes the value of one if both of markets *i* and *j* are within 10 km from harbors, and zero otherwise; and Harbour (10-20km) equals one if the distances between both markets and the nearest harbors are 10 km to 20 km, and zero otherwise. Compared with the results from equation (1) in Table 2-3, there is a slight change in the coefficients for $Railroad_{ijt}$. For the prices of rice and barley (Columns (1) and (2)), the markets connected to the station and in the range of 10 km to 20 km from the harbors have tendencies where the price dispersion

decreases even more; the coefficients of $Railroad_{ijt}$ and $Railroad_{ijt} \times Harbour(10-20km)_{ij}$ are statistically negative. Moreover, the coefficients of $Railroad_{ijt} \times Harbour(10-20km)_{ij}$ are larger than those of $Railroad_{ijt}$. For example, in Panel A and Column (1), the effects of railroad construction on the price dispersion is -2.8%, and the effect of the existence of both railroads and harbor within the range of 10 km to 20 km is -7.2%. When the markets have both stations and harbors within 10 km, only railroads affect the price convergence since the coefficient of $Railroad_{ijt} \times Harbour(0-10km)_{ij}$ is not significant. This suggests that the market may have prioritized the use of railroad in the case of markets where stations and harbors are within the same 10 km distance. Additionally, from the Panels B, C, and D, the proximity of the harbor may not influence the price convergence even if the distance between the stations and the markets goes further (20 km to 40 km). These tendencies were observed in the cases of rice and barley.

In the case of alcohol (Column (3)), the relationship between railroads and harbors is different from those in the case of rice and barley. The price of alcohol converges as the stations and harbors become closer, with the coefficients of $Railroad_{ijt}$ and $Railroad_{ijt} \times Harbour(0-10km)_{ij}$ at -3.1% and -11.0% respectively in Panel A. Regardless of the distance between the markets and stations in any panel, the prices in markets where harbors and railroads are both available are more convergent than those that are connected only by railroads. Hence, this suggests that the harbors continued as a means of transporting alcohol after the railroads were constructed. Alcohol is different in character from other goods and has high unit price per kilogram. Since alcohol tends to be popular in big markets, the closer the station and harbor are to the market, the more the price difference is observed to be convergent.

On fuels and soy sauce, the interactions between the railroads and harbors are not unlike other commodities. In Panel A, when the markets connect to both of the stations and harbors within 10 km, the coefficients are positive significantly. As for charcoal,

shown in Column (5), the coefficients of $Railroad_{ijt} \times Harbour(0-10km)_{ij}$ is 16.9%. The markets with only stations show the same trend as other commodities: the one of $Railroad_{ijt}$ for charcoal (Column (5)) is -12.7% in Panel A. When the distances between the markets and the nearest station are 20 km, 30 km, and 40 km in Panels B, C, and D, respectively, the coefficients of $Railroad_{ijt} \times Harbour(10-20km)_{ij}$ are negatively significant, same as the trends in rice and barley. These results suggest three points. First, the markets that only have stations show convergence in the prices. Second, when the markets connect to both the railroads and harbors within 10 km, both of these transports offset the convergence. Third, for the markets with both stations and harbors within 10 km to 20 km radius price convergence is further promoted.

In the case of the markets connected to harbors before the railroad construction, there is a possibility that the market integration and expansion had already proceeded (before railroad construction) since the friction *f* (shown in Ch. 2) had been reduced by the water transport. In brief, the water transport had established routes to connect the markets with harbors from before the Meiji era, and the communication infrastructure had been easily maintained in these central markets (Ishii 2005). These advance maintenances had already reduced the friction *f* , and changed the relationships between the railroad construction and harbors.

2.4.2 Common trend checks

The base model in this study relies on the DID approach, which needs to validate a common trend assumption. The DID approach utilizes the difference between the markets where railroads were constructed (hereafter referred to as railroad-constructed market) and the markets where no railroads were constructed (hereafter referred to as non-constructed market) in the difference between the railroad installation and before the installation. Here, the approach assumes that the trends of the treatment group and the

control group are identical before and after the railroad expansion. If the assumption is violated, the main results shown in Ch.4.1 are biased and may not identify the effects of railroads.

In order to verify the assumption, we estimated the following model:

$$LPD_{ijt} = \alpha + \beta_4 Railroad_{ijt} \times d_t + d_{ij} + d_t + \varepsilon_{ijt} \qquad (3)$$

$$LPD_{ijt} = \alpha + \sum_{k=-15}^{15} \gamma_k Years_{k,ijt} + d_{ij} + d_t + \varepsilon_{ijt} \qquad (4)$$

where the subscripts are the same as those for equations (1) and (2). β_4 in equation (3) means the effects of railroads' installation for each year. Thus, the deviations between β_4 and d_t are the differences from the coefficients of the non-constructed market pair *ij* in year *t*. $Years_{k,ijt}$ in equation (4) is a dummy variable that equals one if both markets *i* and *j* that are to be connected with the railroads are *k* years away from the railroads' introduction in year *t* , and zero otherwise. The period away from the introduction is defined as 15 years[13]. The coefficients γ_k for the value of *k* which takes minus allow us to observe the trend of the periods before the railroad installation. It is expected that the trends are different before and after the introduction of railroads if the common trend assumption holds and the introduction is an exogenous shock. When the trends behave in a similar manner before and after the introduction, the assumption does not hold, which means our identification strategy is not robust and thus, the main results may include other effects.

Moreover, equation (4) shows the dynamic character of the railroad effects. The price convergence may fluctuate at the time that markets foresee the railroad installation. Likewise, the markets gradually learn the effectiveness and utilization of the new technology and thus, the degree of convergence consequently varies depending on the number of years since the introduction of railroads. It is expected that the effects of the

[13] All years that the market pair *i* and *j* are 15 years and more earlier than the railroads' introduction are defined as $k = -15$, and years over 15 years after the railroads' introduction are included in the $k = 15$.

railroads are small at the beginning of its installation and become larger as the use period becomes longer for each market.

Figure 2-4 shows the estimation results for β_4 and d_t using equation (3) for each commodity included in this study. The vertical axis represents the coefficients (β_4 and d_t), and the horizontal axis represents the time series (year t). From this trend we find that there are no big differences in the price fluctuation between the constructed market pairs (black lines) and the non-constructed market pairs (grey lines). From this figure, note that the values on the vertical axis in the graphs for fuels (charcoal and firewood) are different from other goods since the magnitude of the coefficients for fuels are bigger than the others.

The results from equation (4) are shown in Figures 2-5-1, 2-5-2, and 2-5-3. We plot the coefficients of dynamics for each year: γ_k, when $-15 \leq k \leq 15$. The coefficients with positive values mean expansion of price disparity, while negative values indicate price convergence. This is summarized in the figure for commodities whose trends are similar. For all commodities, there are two findings. First, when comparing results before and after the railroad installation, there is no consistent trend of decrease/increase in any commodities. In other words, the trends change at the timing of the railroads' introduction and thus, we conclude that the common trend assumption holds and our main results do not show effects that are non-railroad related.

Second, we find an approximate trend that price convergence begins just before the introduction of railroads. Most coefficients before the introduction of railroads indicate positive values or zero, which means that the price difference widens or does not spread. Meanwhile, most of the coefficients after the railroad introduction take negative values, and the impacts increase as time passes by from the introduction of the railroads. This means that the railroad construction gradually prompts the price convergence; the trends are remarkably observed particularly in Figures 2-5-1 and 2-5-2. Likewise, the values three to five years after the railroads' introduction temporarily increase which may

be due to the Sino-Japanese War (1894 to 95) and the Rosso-Japanese War (1904 to 05). As shown on Figure 2-5-3, the values are also different before and after the introduction of the railroads. However, the behavior after zero ($k = 0$) has unique characteristics where the values increase from the seventh year. Whether the railroads caused price convergence for fuels need to be carefully considered.

2.4.3 Market distance

In the previous research and the above estimation, the total average of the impact of railway connection was estimated regardless of the distance between markets. However, transportation costs increase as the distance between markets increases. Therefore, there is a limit to the distance for arbitrage transactions. Here, we estimate the effects of the railroads by the distance between market *i* and *j*.

$$LPD_{ijt} = \alpha + \sum_{l=50}^{3000} \delta_l (Railroad_{ijt} \times distance_{l,ijt}) + d_{ij} + d_t + \varepsilon_{ijt}\,, l = \{50,100,150, \ldots 3000\} \qquad (5)$$

where the subscripts are the same as those for equations (1) and (2). l is a set of integers from 50 to 3,000 increasing by fifty. $distance_{l,ijt}$ is a dummy variable equal to one if the distance (km) between markets i and j is in the range from l-50 km to l km, and zero otherwise. The distance between markets is the maximum value of 3,000 km and thus, l is 50 to 3,000 in order to estimate the influence every 50 km.

Figures 2-6-1, 2-6-2, and 2-6-3 plot the results of δ_l for each commodity. The vertical axis indicates the estimated values of δ_l, and the horizontal axis shows the distance between markets. When the distance between markets is about 150 km, the impact of railroads on price convergence is not clearly seen until a distance of over 200 km when it starts decreasing. In other words, it is understood that if the distance between markets is too close, it is not cost-effective to use railroads. The regional research in

section 2.2.2 showed that when transporting to neighboring prefecture water and land transports were relied upon. Particularly, the fuels, which are bulky and of low unit prices exhibited this remarkable tendency. Moreover, even if the distance between markets is long, the influence of the railroads decreases. In the case of rice and barley there are upward trends at around 1,000 km. For luxury goods like alcohol and soy sauce, the relevant distance is about 1,200 km, whereas for fuels, it is at about 700 km.

2.5 Conclusion

In this study, we estimated the effects of the railroads' construction in the Meiji era using the prefectural statistics published at that time. This study focused on six commodities: rice, barley, alcohol, soy sauce, charcoal, and firewood, and covered the period from 1879 to 1912. The authors digitized the prices of the commodities and constructed the unbalanced panel data. To address the endogeneity issue in our estimation, we relied on the DID approach utilizing the heterogeneity of timing and location of the railroads' installation.

We found that the railroads' construction promoted the price convergence in the Meiji era. The estimation results showed that the price dispersion between markets *i* and *j* connected by the railroads had declined more than those without the railroads. To determine the effects of the distance between stations and markets, we analyzed four distances from 10 km to 40 km (in 10 km increments). Regardless of the distance, the main results indicated price convergence in six commodities. Likewise, the impacts depended on the type of commodities. The effects on rice, barley, alcohol, and soy sauce are in the range from -1.0% to -4.5%, while the effect on fuel is even bigger at about -6.0% to -10.0%.

To check the common trends, we estimated the dynamic nature of the railroad installation. The dynamics showed a common trend in all commodities and validated our

specification. The price convergence of the goods except for fuels proceeded as the railroads became well-known in each market, while there was a lack of consistency in the results for fuels.

Furthermore, this study investigated the relationships between the (traditional) water transport and the railroads' introduction. The existence of the harbors affected the relationship between price convergence and the railroads. The effects of the harbors varied depending on the type of commodities. Both of these modes of transportation resulted in a multiplier effect on the price of alcohol since it had a high unit price per kilogram. However, it was also suggested that water transport was the preferred mode of transportation for fuels. Moreover, this study described the impact of the railroads' construction when considering distances between markets. The results showed that there was no railway influence among closer markets, and this tendency supported the regional research. Likewise, when combined with a market that was too far, the effect was not seen.

This study requires further research in the following areas. First, this study assumed that the markets integrate into one and does not integrate by region. The influence of the railroads may be underestimated since it is not clear whether distant markets are connected. Second, the behavior of the convergence is unclear, lacking the perspective of changes in demand and supply. It is possible that the differences in the impact of commodities are explained by the pathway. Moreover, the pathway from infrastructure development to price convergence may be clarified with more details if we can identify the characteristics of the commodities and the demand-supply relationships.

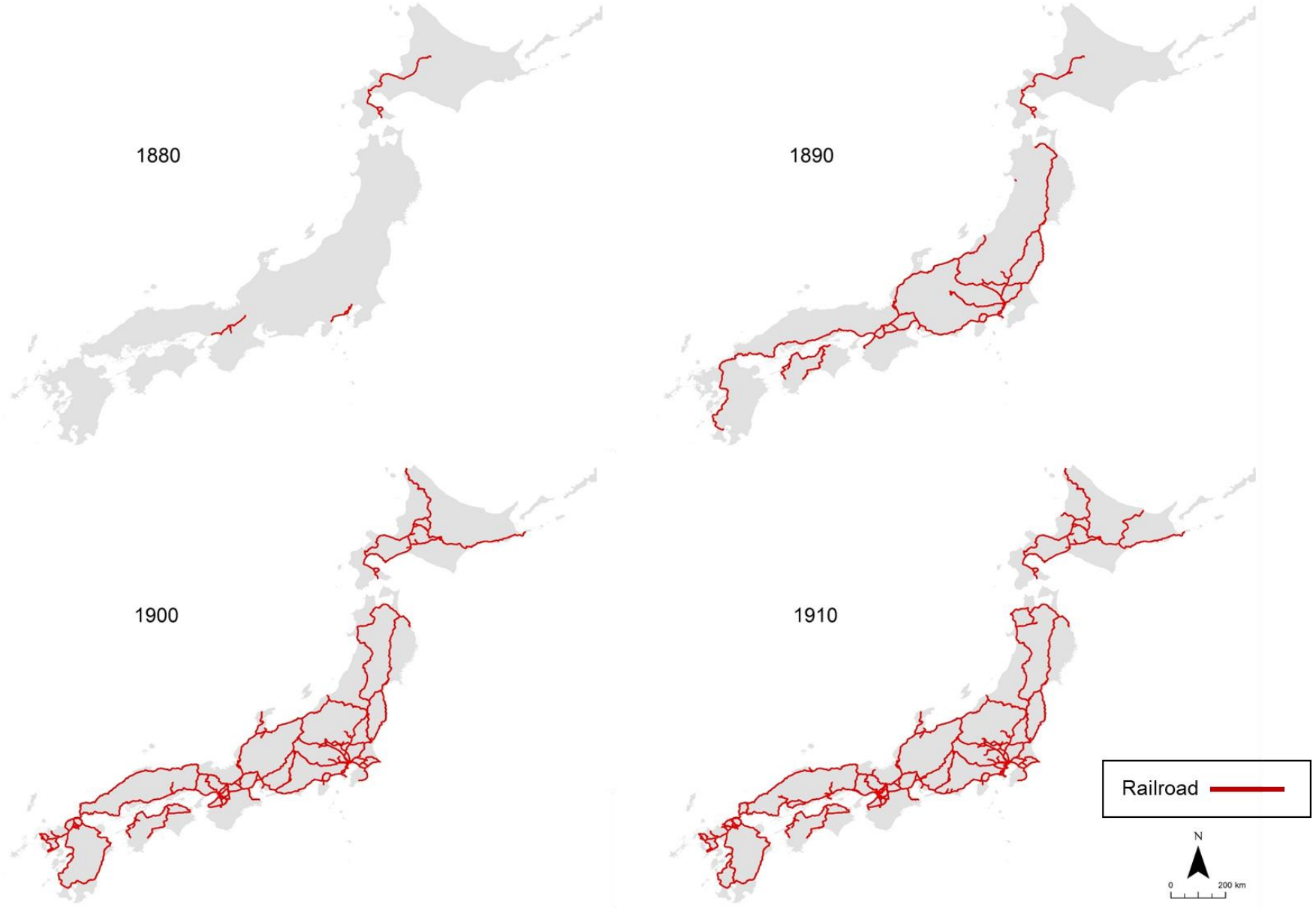


Figure 2-1: Railroad expansion in Meiji era

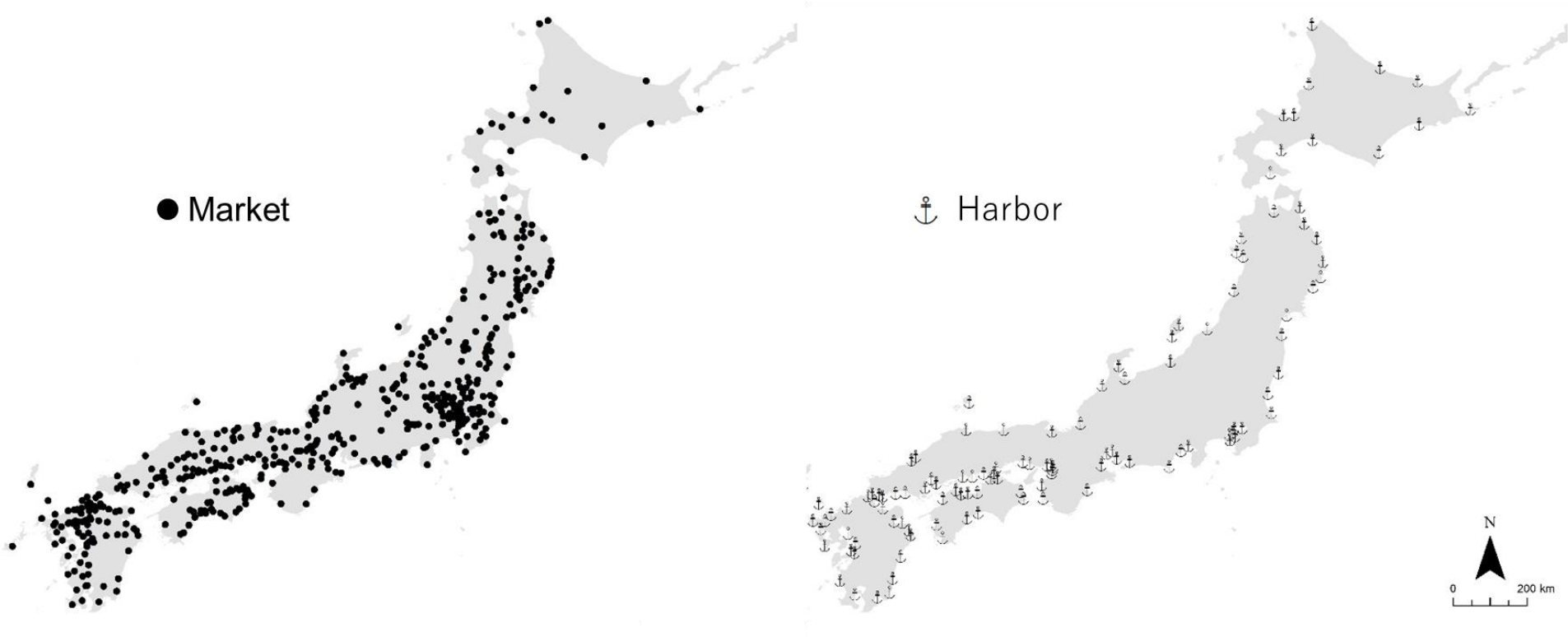


Figure 2-2: Locations of markets and harbors

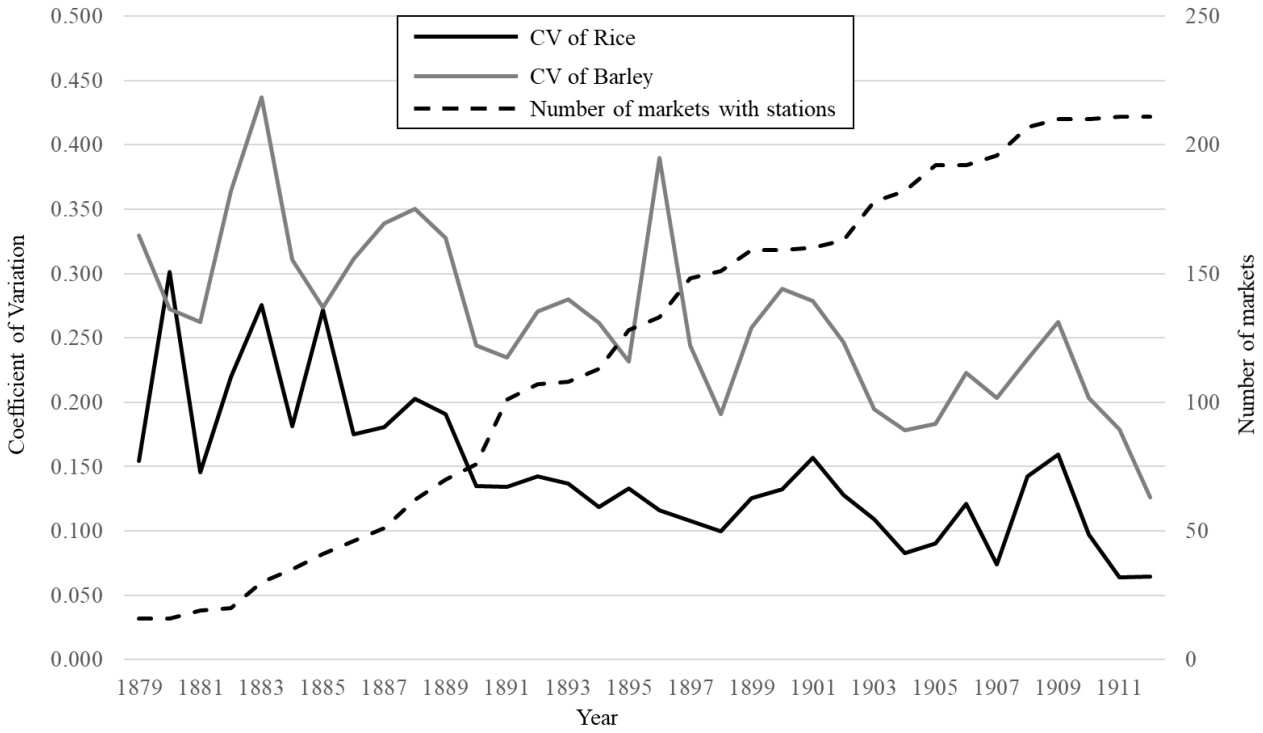


Figure 2-3: Railroad expansion and coefficients of variation (Rice and Barley)
Note: This figure shows shifts in coefficients of variation (left axis) and number of markets with stations (right axis). The coefficient of variation (CV) is obtained by following: $\mathrm{CV} = \mathrm{Standard\ \ Deviation}_t/\mathrm{Mean}_t$, where *t* indicates year. CV of other goods are in Appendix figure 1.

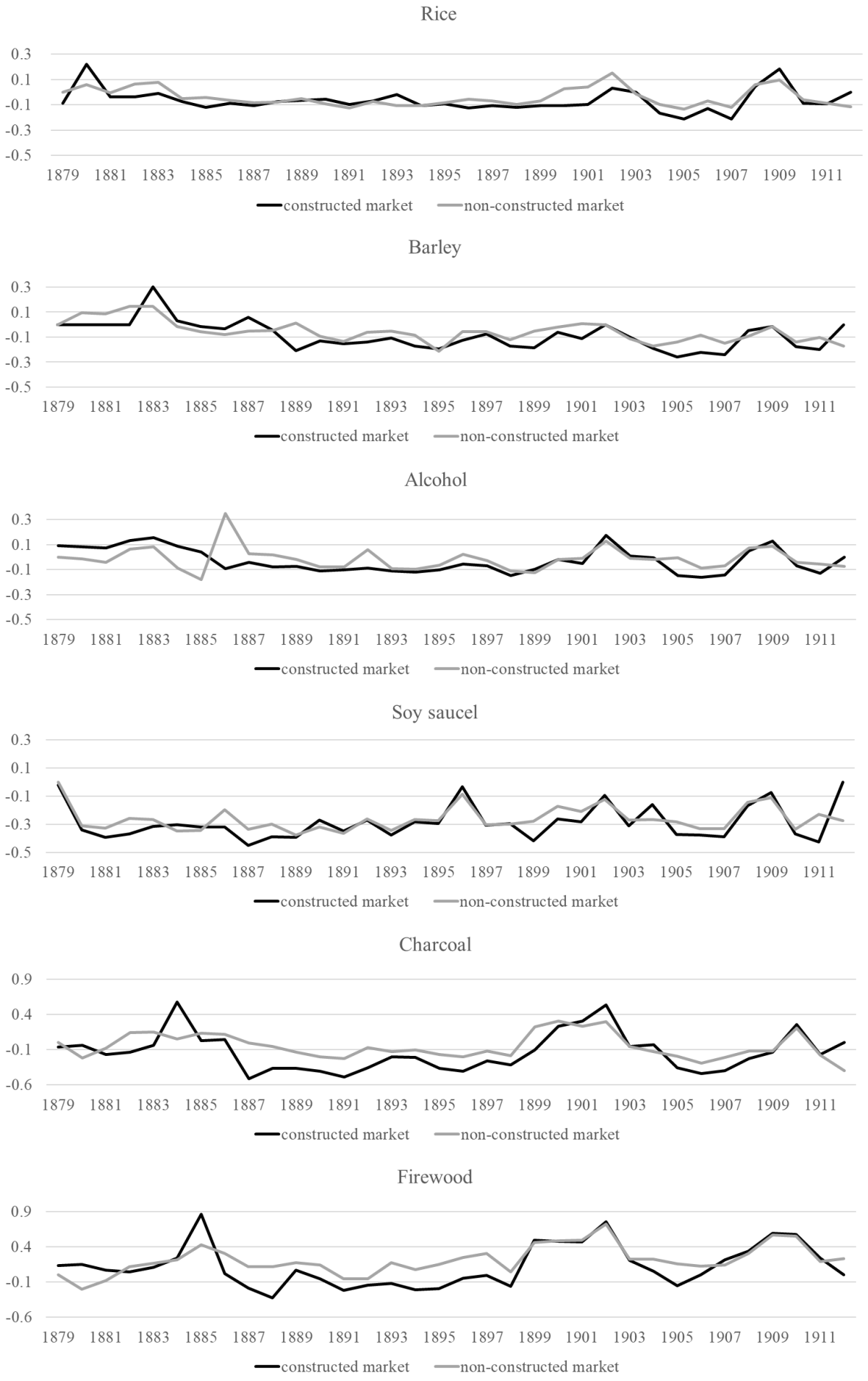


Figure 2-4: Comparison of price differences between railroads constructed area and non-constructed area

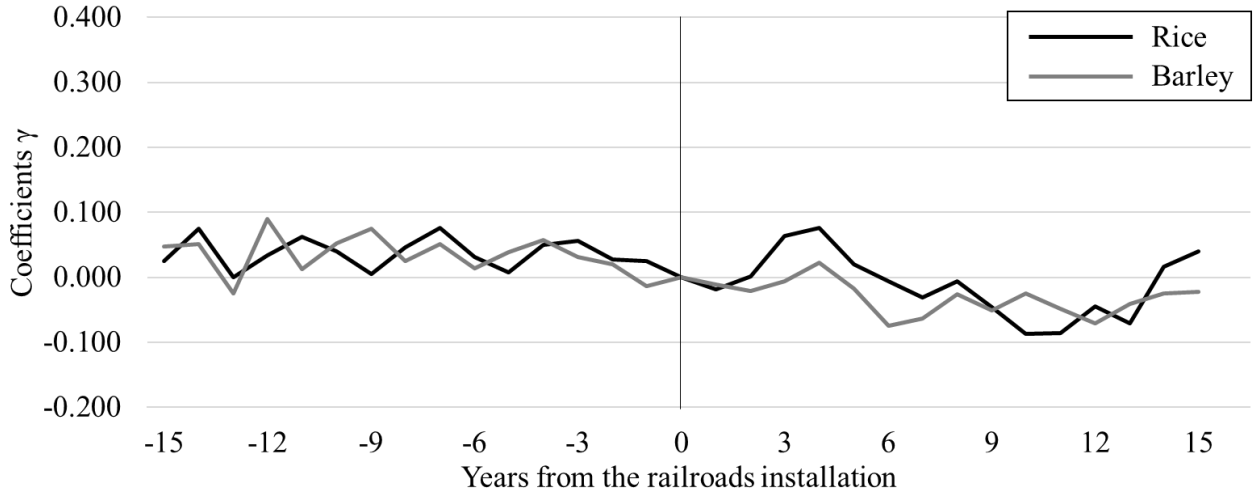


Figure 2-5-1: Changes in the price dispersion of rice and barley

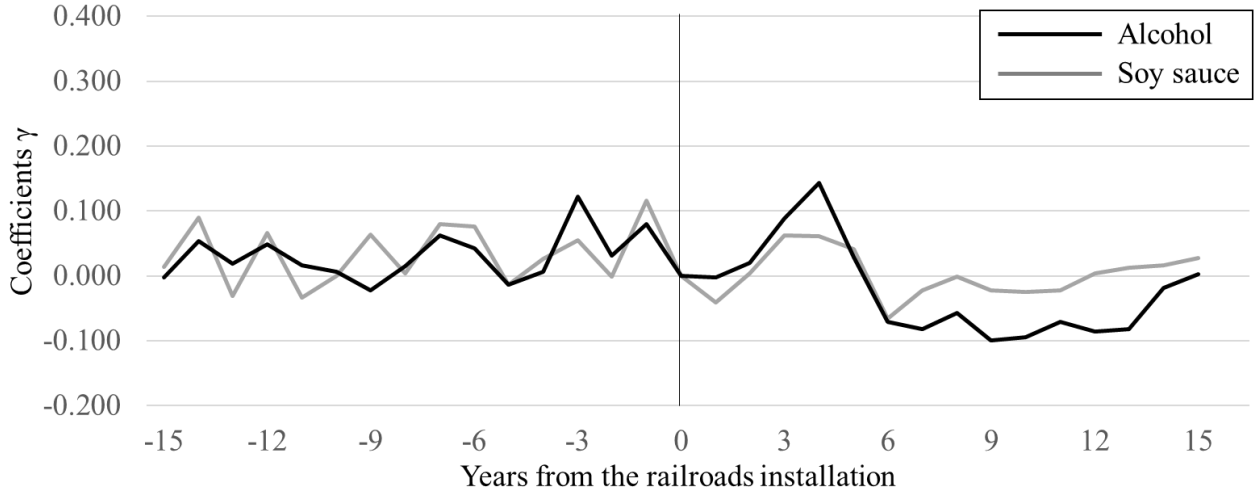


Figure 2-5-2: Changes in the price dispersion of alcohol and soy sauce

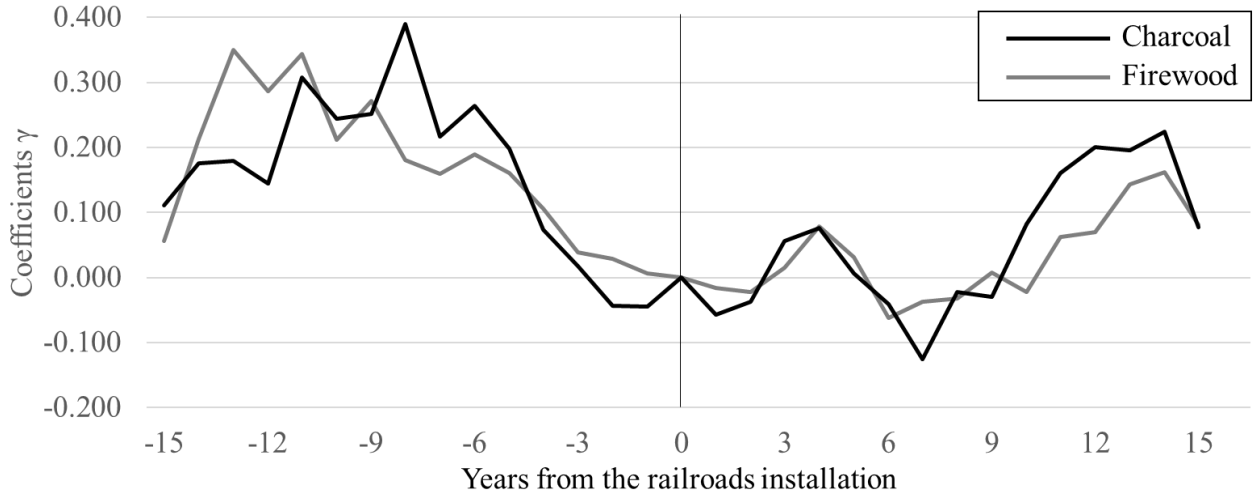


Figure 2-5-3: Changes in the price dispersion of charcoal and firewood
Note: The results for γ_k in equation (4) are plotted. The vertical axis indicates the values of mean of log price difference, and the horizontal shows the years before and after the railroad installation: *k*.

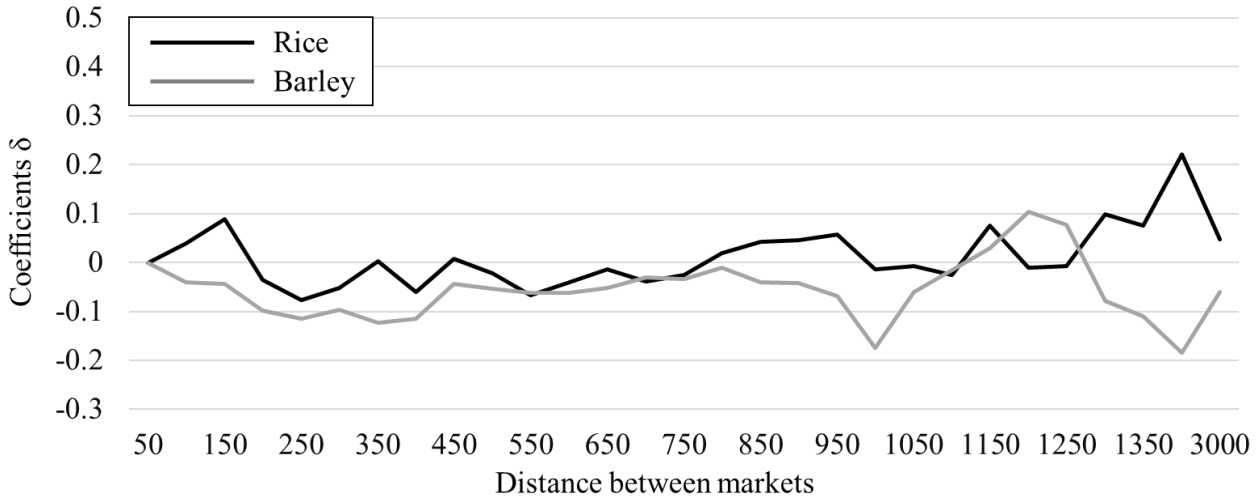


Figure 2-6-1: Impact of railroad construction on distances between markets (Rice and Barley)

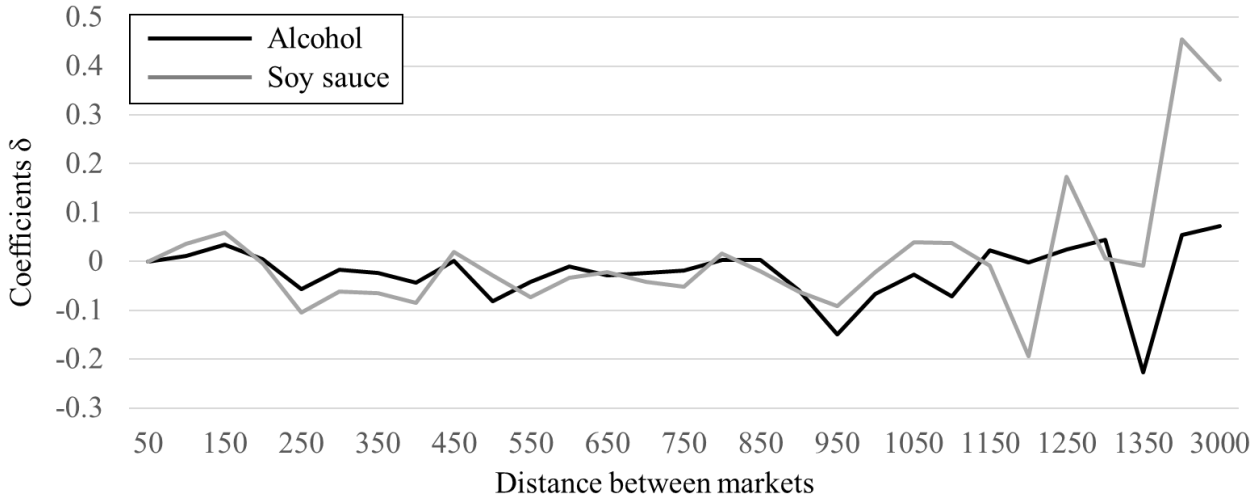


Figure 2-6-2: Impact of railroad construction on distances between markets (Alcohol and Soy sauce)

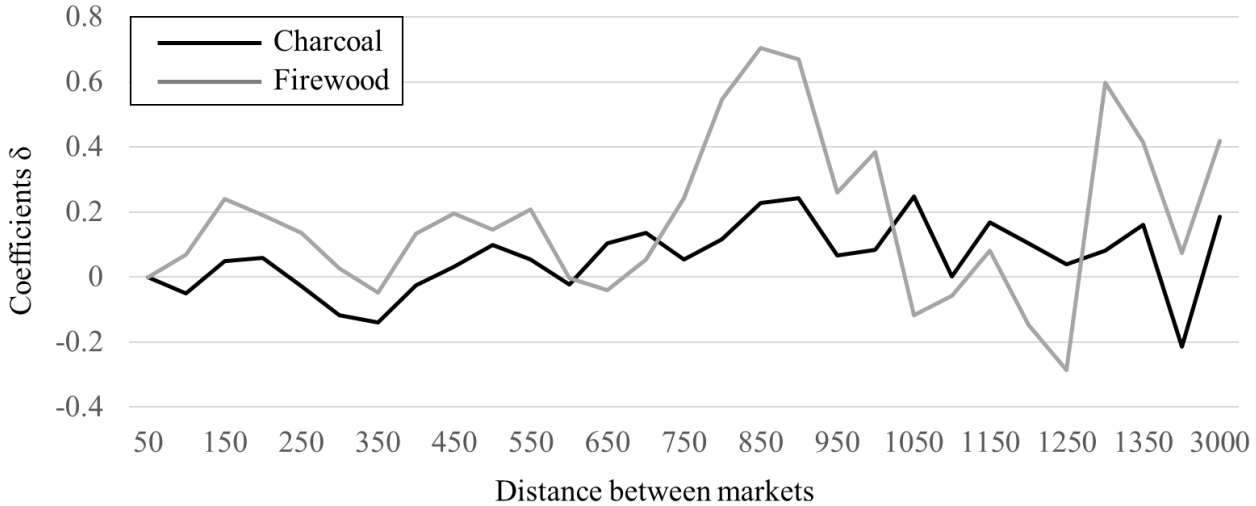


Figure 2-6-3: Impact of railroad construction on distances between markets (Charcoal and Firewood)

Note: The results for δ_l in equation (5) are plotted. The vertical axis indicates the estimated values of δ_l, and the horizontal shows the distance between markets.

Table 2-1: Descrptive statistics of outcomes

Commodity	N	Mean	Std. Dev.	Min	Med	Max
Rice	456663	1.102	1.632	0.001	0.984	109.890
Barley	338736	1.332	159.679	0.000	0.980	1781.343
Alcohol	391125	3.382	2226.862	0.000	1.004	2277.778
Soy sauce	459262	1.734	3090.793	0.000	1.016	19606.740
Charcoal	414142	2.086	504.181	0.000	0.895	3666.667
Firewood	371969	3.032	2122.817	0.000	0.900	6800.000

Table 2-2: Descriptive statistics of each commodity in each year

Year	Rice	Barley	Alcohol	Soy sauce	Charcoal	Firewood
1879	8.303	3.005	16.939	11.200	0.058	0.025
	(1.639)	(0.982)	(3.930)	(4.433)	(0.033)	(0.019)
	{48}	{26}	{42}	{40}	{40}	{40}
1880	10.556	4.844	17.384	148.747	0.798	0.024
	(10.101)	(1.835)	(4.287)	(1387.562)	(6.990)	(0.026)
	{117}	{82}	{80}	{102}	{89}	{89}
1881	9.670	5.005	17.492	12.320	0.743	0.033
	(1.982)	(1.712)	(4.235)	(3.962)	(8.107)	(0.058)
	{196}	{123}	{157}	{175}	{155}	{152}
1882	8.175	4.441	16.223	11.619	0.111	0.090
	(3.158)	(2.594)	(9.326)	(4.593)	(0.185)	(0.764)
	{304}	{180}	{245}	{281}	{249}	{248}
1883	6.301	3.303	13.823	10.227	0.085	0.038
	(2.973)	(2.065)	(4.688)	(4.334)	(0.150)	(0.081)
	{317}	{230}	{289}	{314}	{294}	{293}
1884	5.672	14.412	13.105	8.993	0.240	0.030
	(1.053)	(158.237)	(3.396)	(2.944)	(1.815)	(0.058)
	{245}	{194}	{220}	{242}	{233}	{230}
1885	6.378	18.671	14.222	9.504	0.065	0.042
	(3.039)	(196.481)	(7.518)	(4.217)	(0.094)	(0.091)
	{226}	{173}	{207}	{222}	{219}	{214}
1886	6.034	3.214	12.709	8.519	0.063	0.028
	(3.545)	(1.001)	(4.953)	(3.258)	(0.096)	(0.040)
	{237}	{191}	{196}	{231}	{216}	{179}
1887	5.648	3.063	13.757	9.152	0.053	0.028
	(4.574)	(1.831)	(3.705)	(6.059)	(0.088)	(0.063)
	{238}	{213}	{207}	{231}	{223}	{193}
1888	5.109	2.791	13.211	8.714	0.102	0.021
	(1.075)	(0.954)	(3.712)	(3.476)	(0.833)	(0.028)
	{231}	{201}	{197}	{224}	{225}	{190}
1889	6.236	3.176	13.987	9.163	0.200	0.027
	(1.416)	(1.081)	(10.081)	(2.841)	(2.034)	(0.046)
	{197}	{181}	{174}	{192}	{189}	{184}
1890	8.296	4.166	14.377	55.674	0.062	0.050
	(1.253)	(1.031)	(3.047)	(647.807)	(0.242)	(0.358)
	{204}	{196}	{181}	{198}	{196}	{196}
1891	7.348	5.707	14.644	9.015	0.129	0.022
	(0.972)	(22.363)	(3.094)	(2.758)	(1.138)	(0.030)
	{230}	{221}	{209}	{228}	{225}	{220}
1892	7.319	29.776	14.562	425.111	0.064	0.026
	(1.177)	(370.441)	(3.739)	(6121.918)	(0.090)	(0.035)
	{219}	{211}	{195}	{217}	{214}	{208}
1893	7.773	4.549	14.817	10.214	0.058	1.047
	(1.133)	(5.065)	(3.052)	(2.794)	(0.070)	(5.067)
	{144}	{133}	{132}	{142}	{139}	{133}
1894	8.599	4.566	15.644	10.255	0.067	0.029
	(1.041)	(3.270)	(3.032)	(3.257)	(0.086)	(0.039)
	{111}	{107}	{108}	{111}	{110}	{103}
1895	9.024	3.858	17.291	11.775	0.092	0.155
	(1.441)	(0.800)	(4.614)	(8.551)	(0.115)	(1.113)
	{132}	{130}	{132}	{134}	{134}	{131}
1896	10.077	4.481	19.611	14.442	0.094	0.049
	(1.567)	(3.058)	(5.599)	(9.772)	(0.109)	(0.066)
	{149}	{138}	{149}	{152}	{149}	{140}
1897	13.074	6.020	135.608	15.377	0.158	0.067
	(1.963)	(2.139)	(1459.627)	(5.112)	(0.692)	(0.186)
	{167}	{164}	{172}	{172}	{171}	{168}
1898	14.388	6.375	27.397	15.248	0.117	0.042
	(2.051)	(1.474)	(5.930)	(4.838)	(0.151)	(0.056)

	{126}	{125}	{132}	{132}	{131}	{130}
1899	11.647	5.593	28.920	16.629	0.160	0.089
	(10.740)	(2.079)	(7.119)	(7.101)	(0.224)	(0.114)
	{89}	{89}	{92}	{93}	{89}	{92}
1900	11.532	5.262	29.801	17.203	0.234	0.101
	(2.326)	(2.296)	(8.247)	(6.347)	(0.325)	(0.159)
	{95}	{96}	{100}	{99}	{98}	{88}
1901	11.873	4.713	29.820	16.785	0.223	0.100
	(3.466)	(1.726)	(7.705)	(5.872)	(0.311)	(0.197)
	{91}	{89}	{93}	{94}	{90}	{81}
1902	13.071	4.841	30.534	17.055	0.223	0.113
	(7.934)	(1.425)	(10.995)	(7.058)	(0.326)	(0.178)
	{96}	{94}	{96}	{101}	{81}	{81}
1903	13.753	6.299	32.761	18.545	0.118	0.050
	(2.605)	(1.619)	(7.742)	(6.785)	(0.178)	(0.078)
	{98}	{101}	{112}	{110}	{105}	{95}
1904	13.116	7.060	33.671	18.778	0.076	0.135
	(1.183)	(1.585)	(7.703)	(5.632)	(0.064)	(0.554)
	{119}	{116}	{129}	{131}	{109}	{93}
1905	13.340	6.519	38.526	19.693	0.079	0.054
	(1.443)	(1.428)	(9.219)	(6.566)	(0.077)	(0.198)
	{131}	{128}	{152}	{153}	{139}	{128}
1906	15.444	5.702	38.474	21.108	0.073	0.063
	(5.123)	(2.252)	(6.946)	(6.589)	(0.023)	(0.339)
	{134}	{131}	{152}	{157}	{148}	{133}
1907	16.535	6.300	41.951	172.290	0.091	0.072
	(1.495)	(1.642)	(14.670)	(1871.254)	(0.047)	(0.336)
	{138}	{126}	{148}	{153}	{143}	{136}
1908	14.705	6.743	39.582	20.570	0.094	0.051
	(4.364)	(10.498)	(13.122)	(8.183)	(0.048)	(0.114)
	{149}	{145}	{164}	{169}	{149}	{146}
1909	11.822	6.059	38.463	20.405	0.082	0.055
	(4.169)	(4.900)	(14.273)	(9.071)	(0.038)	(0.127)
	{128}	{127}	{152}	{153}	{138}	{130}
1910	13.675	5.807	43.070	22.280	1.638	0.118
	(1.755)	(1.394)	(9.653)	(5.103)	(7.918)	(0.296)
	{79}	{87}	{104}	{105}	{96}	{90}
1911	17.132	18.039	45.052	25.344	0.115	0.060
	(1.206)	(91.266)	(7.345)	(9.379)	(0.147)	(0.120)
	{48}	{62}	{69}	{69}	{60}	{60}
1912	21.196	8.315	48.581	22.631	0.105	0.050
	(1.715)	(1.179)	(8.116)	(6.588)	(0.023)	(0.060)
	{22}	{23}	{22}	{23}	{23}	{23}

Note: This table shows the mean value estimated from row sample in each year. Standard deviations and sample sizes are in parentheses and curly bracket, respectively.

Table 2-3：The effects of railroads construction on the price convergence

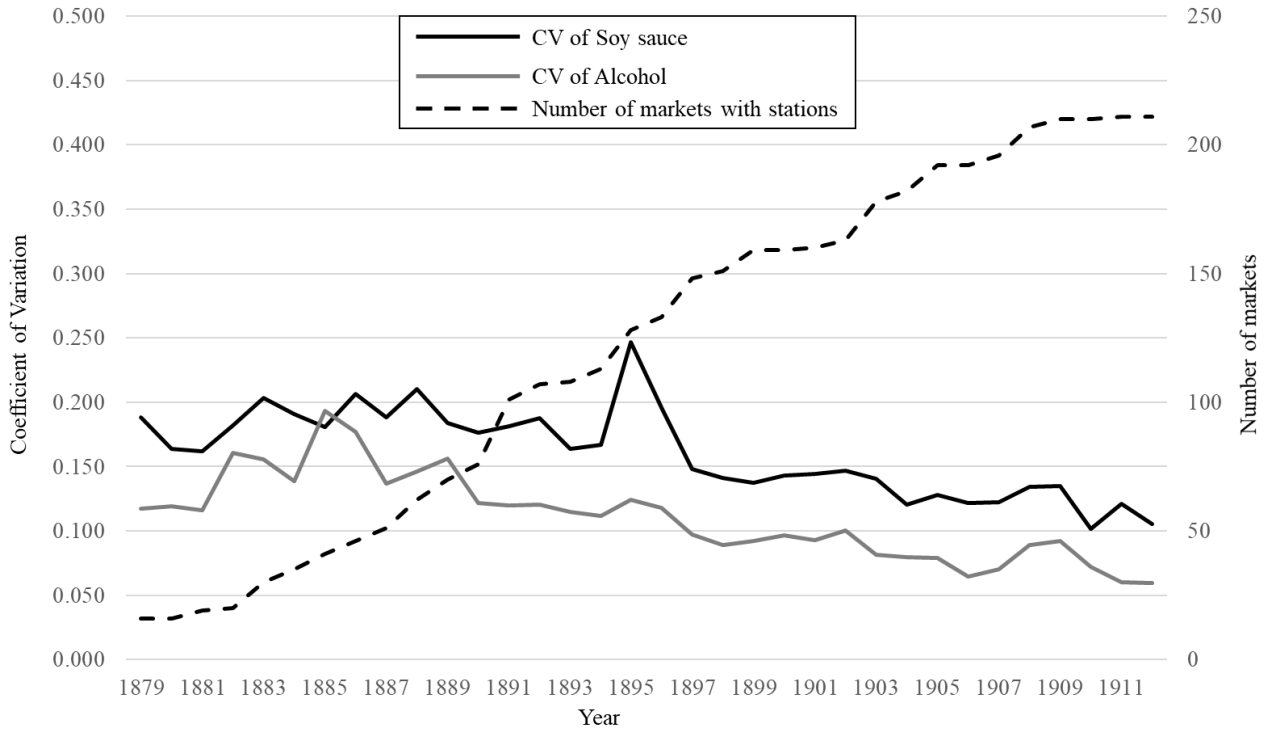
	Commodity					
	Rice	Barley	Alcohol	Soy sauce	Charcoal	Firewood
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Stations are within 10 km from markets (baseline)						
Railroad	-0.030***	-0.045***	-0.035***	-0.022***	-0.120***	-0.122***
	(0.003)	(0.004)	(0.005)	(0.004)	(0.007)	(0.009)
Market FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	455043	337220	385871	452371	407663	363135
R-sq	0.043	0.039	0.053	0.032	0.048	0.041
Panel B: Stations are within 20 km from markets						
Railroad	-0.021***	-0.041***	-0.030***	-0.016***	-0.099***	-0.102***
	(0.003)	(0.004)	(0.005)	(0.004)	(0.007)	(0.008)
Market FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	455077	337241	385997	452501	407792	363334
R-sq	0.043	0.039	0.053	0.032	0.048	0.041
Panel C: Stations are within 30 km from markets						
Railroad	-0.006*	-0.028***	-0.020***	0.016***	-0.057***	-0.068***
	(0.003)	(0.004)	(0.005)	(0.004)	(0.006)	(0.008)
Market FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	455112	337268	386124	452605	407908	363505
R-sq	0.043	0.038	0.053	0.032	0.047	0.041
Panel D: Stations are within 40 km from markets						
Railroad	-0.018***	-0.036***	-0.041***	-0.010**	-0.076***	-0.150***
	(0.003)	(0.004)	(0.005)	(0.004)	(0.006)	(0.008)
Market FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	455144	337304	386256	452799	408035	363736
R-sq	0.043	0.038	0.053	0.032	0.048	0.042

Note: This table shows the results of equation (1) for each commodity. Standard errors in parentheses. ***, **, *, + mean significant level at 0.1%, 1%, 5%, 10%, respectively.

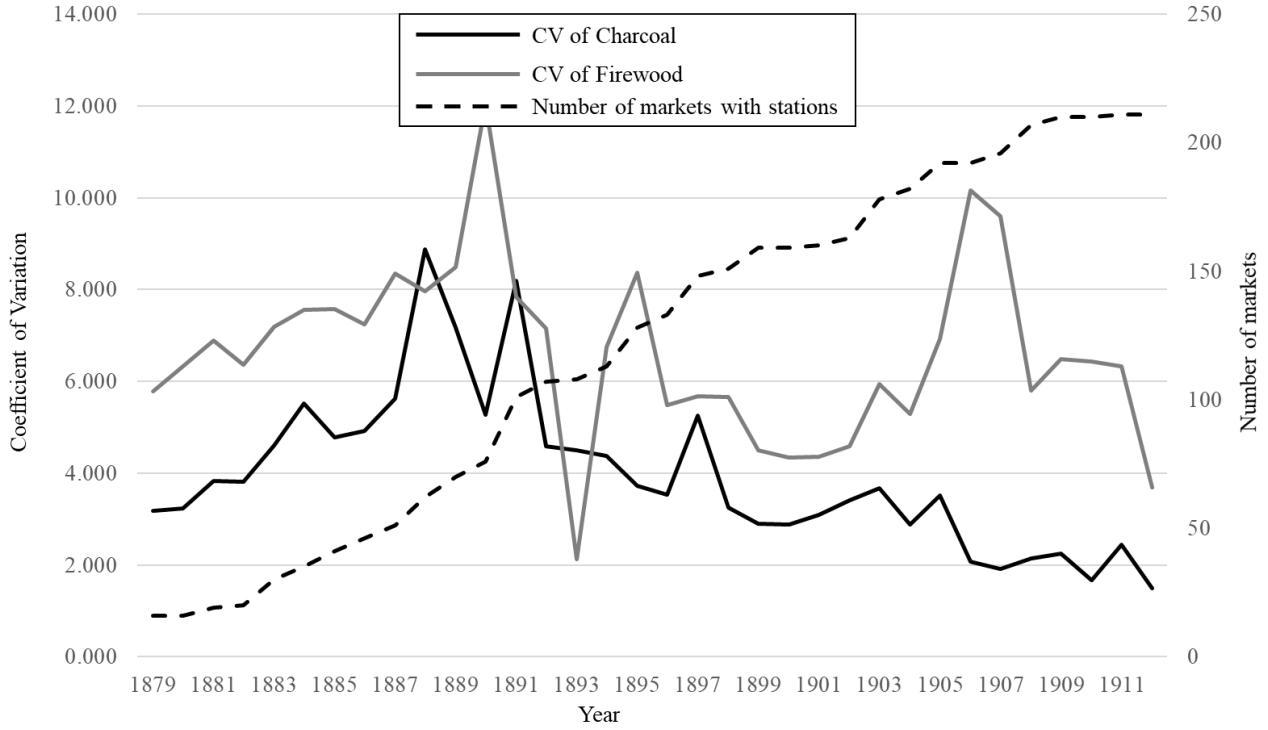
Table 2-4: The effects of railroads construction on the price convergence

	Commodity					
	Rice	Barley	Alcohol	Soy sauce	Charcoal	Firewood
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Stations are within 10 km from markets (baseline)						
Railroad	-0.028***	-0.043***	-0.031***	-0.024***	-0.127***	-0.119***
	(0.003)	(0.004)	(0.005)	(0.004)	(0.007)	(0.009)
Railroad×Harbour (0-10km)	0.012	-0.016	-0.110***	0.078***	0.169***	0.060+
	(0.012)	(0.020)	(0.022)	(0.018)	(0.030)	(0.036)
Railroad×Harbour (10-20km)	-0.072***	-0.065*	0.016	-0.081**	-0.039	-0.235***
	(0.018)	(0.030)	(0.031)	(0.025)	(0.043)	(0.052)
Market FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	455043	337220	385871	452371	407663	363135
R-sq	0.043	0.039	0.053	0.032	0.048	0.041
Panel B: Stations are within 20 km from markets						
Railroad	-0.019***	-0.039***	-0.026***	-0.017***	-0.103***	-0.098***
	(0.003)	(0.004)	(0.005)	(0.004)	(0.007)	(0.009)
Railroad×Harbour (0-10km)	-0.001	-0.019	-0.116***	0.058**	0.137***	0.038
	(0.012)	(0.020)	(0.022)	(0.018)	(0.030)	(0.036)
Railroad×Harbour (10-20km)	-0.096***	-0.072*	0.028	-0.081***	-0.103*	-0.274***
	(0.018)	(0.028)	(0.030)	(0.024)	(0.041)	(0.050)
Market FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	455077	337241	385997	452501	407792	363334
R-sq	0.043	0.039	0.053	0.032	0.048	0.041
Panel C: Stations are within 30 km from markets						
Railroad	-0.003	-0.026***	-0.015**	0.017***	-0.058***	-0.064***
	(0.003)	(0.004)	(0.005)	(0.004)	(0.007)	(0.008)
Railroad×Harbour (0-10km)	-0.005	-0.039*	-0.138***	0.027	0.107***	0.032
	(0.012)	(0.019)	(0.022)	(0.017)	(0.029)	(0.036)
Railroad×Harbour (10-20km)	-0.110***	-0.071**	0.004	-0.107***	-0.136***	-0.243***
	(0.016)	(0.026)	(0.028)	(0.023)	(0.038)	(0.047)
Market FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	455112	337268	386124	452605	407908	363505
R-sq	0.043	0.038	0.053	0.032	0.048	0.041
Panel D: Stations are within 40 km from markets						
Railroad	-0.017***	-0.034***	-0.037***	-0.010**	-0.079***	-0.152***
	(0.003)	(0.004)	(0.005)	(0.004)	(0.006)	(0.008)
Railroad×Harbour (0-10km)	0.005	-0.025	-0.126***	0.036*	0.133***	0.106**
	(0.012)	(0.018)	(0.021)	(0.016)	(0.027)	(0.035)
Railroad×Harbour (10-20km)	-0.096***	-0.066**	0.022	-0.076***	-0.088*	-0.139**
	(0.016)	(0.026)	(0.027)	(0.022)	(0.038)	(0.047)
Market FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	455144	337304	386256	452799	408035	363736
R-sq	0.043	0.039	0.053	0.032	0.048	0.042

Note: This table shows the results of equation (2) for each commodity. Standard errors in parentheses. ***, **, *, + mean significant level at 0.1%, 1%, 5%, 10%, respectively.



Appendix Figure 2-1-1: Railroad expansion and coefficients of variation (soy sauce and alcohol)



Appendix Figure 2-1-2: Railroad expansion and coefficients of variation (charcoal and firewood)

Note: This figure shows shifts in coefficients of variation (right axis) and number of markets with stations (left axis). The coefficient of variation (CV) is obtained by following: $\mathrm{CV} = \mathrm{Standard\ \ Deviation}_t/\mathrm{Mean}_t$, where *t* indicates year.

Chapter 3

Effects of Conflict on Child Health: Evidence from the 1990–1994 Northern Mali Conflict[1]

3.1 Introduction

Many studies have found that early-life health plays a critical role in socioeconomic outcomes in later life (Currie and Almond 2011, Currie and Vogl 2013, Strauss and Thomas 1998, Johnson and Schoeni 2011, Smith 2007). More specifically, the impact of a negative shock during pregnancy tends to be long lasting and those affected in utero are likely to be less educated (Kecmanovic 2012, Lee 2014, Leon 2012, Ouili 2017, Shemyakina 2011, Singh and Syemyakina 2016, Weldeegzie 2017), less healthy (Akresh et al. 2012b, Grimard and Laszlo 2014), and less economically successful (Kecmanovic 2012, Lee 2014). More important are investigations into the impacts of negative shocks on child health in fragile countries that have repeatedly experienced civil conflicts, where the odds of being affected by negative shocks are higher. In Sub-Saharan Africa, 75% countries have experienced civil conflicts since World War II (Gleditsch et al. 2002), and the infant mortality rate is the worst in the world (World Development Indicators (WDI) 2014). In these countries, physical as well as human capital such as early-life health has significantly deteriorated, which can hinder a nation's future development.

This study examines the effects of the 1990–1994 conflict in northern Mali on child health using data from the Malian Demographic and Health Survey (MDHS95/96 and MDHS2001). Since their independence in 1960, there have been several conflicts in northern Mali, where the armed forces of nomadic tribes, namely the Tuareg, have

[1] This paper is co-authored by Yoko Kijima (National Graduate Institute for Policy Studies (GRIPS), Tokyo, Japan). This research has won the Best paper award at the Applied Econometrics conference 2016. Previous version was published as Department of Policy and Planning Sciences Discussion Paper Series, University of Tsukuba, No.1336. The research was presented at the following: 2016 Japanese Economic Association Spring Meeting, Applied Regional Science Conference 2016, Applied econometrics conference 2016, and seminars. We thank the people who commented at the conferences and seminars.

attempted to form an autonomous state. Mali is considered a critical case given its serious child health conditions, where the infant mortality rate is one of the worst in the world (WDI 2014). In addition, the northern area affected by the conflict is poorer and child health conditions are worse than those across the rest of the country (CPS/SSDSPF et al. 2014). It remains unclear whether poorer health conditions among children in the northern region can be solely attributed to their low socioeconomic conditions or whether conflict exposure also plays a role. Thus, there is an urgent need to evaluate the impact of conflicts on child health using proper identification strategy. We utilize more accurate location information based on GPS data to identify areas most affected by the conflict. This allows us to adopt a more reliable identification strategy than those used in previous studies.

Rapidly growing literature shows that there is a negative association between conflict and child health. Earlier studies have examined the impact of violent shocks exposed *in utero* on birth weight (Camacho, 2008; Mansour and Rees, 2012), following the research testing the fetal origin hypothesis (Glynn et al., 2001; Almond and Mazumder, 2008)[2]. In developing countries, however, using birth weight as a measure of a child's health tends to be problematic since delivering at home is common, and thus, the birth weight is less likely to be measured. The dataset generally comprises birth weight information only for children of urban residents and households wealthier than the sample average, which results in selection bias and self-reported bias. Since anthropometric measures such as weight and height can be easily scaled by survey teams, by using measured height and weight in the survey, it is less likely to suffer from such

[2] Effects of conflict on child health was addressed by Akresh et al. (2012a) and Akresh et al. (2014) in Eritrea;, Brown (2014) in Mexico; Bundervoet et al. (2009) and Verwimp (2012) in Brundi; Dagnelie et al. (2018) in Congo; Minoiu and Shemyakina (2014) and Ouili (2017) in Ivory Coast, Shemyakina (2015) in Zimbabwe; Akresh et al. (2012b) in Nigeria.

bias. For these reasons, this study uses height-for-age Z-score (HAZ) to measure child health conditions.[3]

Even though there are numerous children who have been exposed to conflicts, it is unclear whether after-birth exposure to a conflict critically impacts child health since the extant literature focuses on *in-utero* exposure. Another objective of this study is, therefore, to examine whether the timing of exposure matters to child health outcome.[4] We find that the negative impact of conflict on health outcomes can be mainly attributed to in-utero, whereas after-birth exposure does not significantly impact child health.

3.2 Background on Northern Mali Conflicts and Conflict Data

The most recent conflict in northern Mali broke out in January 2012, during which approximately 300,000 people were forced to evacuate their residence to safer places (United Nations High Commissioner for Refugees 2013). This was not the first time that the people of northern Mali were part of a conflict. Some of the previous conflicts broke out during 1962–1964, 1990–1995, and 2007–2009, the causes of which are deep rooted in history. In this study, we examine the effects of the second Tuareg Rebellion on child

[3] HAZ and WHZ are standardized, measured by incorporating children's growth separately according to sex and age group (World Health Organization). They are a number of standard deviations below or above the reference mean, which makes interpreting the results easier. HAZ captures the accumulated nutritious conditions while WHZ reflects the short-term nutritious conditions. Low HAZ indicates chronic undernourishment (stunting) and low WHZ suggests acute undernourishment (wasting). Another commonly used indicator is Weight-for-Age (WAZ), which is computed by using HAZ and WHZ; it is known that interpretation of WAZ is difficult. Although a few studies have examined the impact of conflict on child health using anthropometric measures, they do not include weight indicators (Akresh et al. 2014, Akresh et al 2012a, Minoiu and Shemyakina 2014, Bundervoet et al. 2009). Since the effects of conflicts can last for a long time, HAZ is considered a better measure especially when the long-term impact on health is analyzed. We use WHZ because data were collected immediately after the conflict and WHZ are more appropriate to measure the impact of conflict on child heath. Shemyakina (2015) is an exception in which WHZ are compared with HAZ.

[4] This distinction was examined only by Akresh et al. (2014), who found that in-utero exposure did not worsen children's health in Ethiopia, while after-birth exposure negatively impacted children in Ethiopia and Eretria.

health outcomes. We focus on the second Tuareg Rebellion because the number of casualties during this conflict was estimated to be the highest (Uppsala Conflict Data Program 2014). Child health data on the first and fourth conflicts are unavailable and the main conflict fields during the third rebellion were located in Niger, not Mali.

In northern Mali, the main ethnic groups comprise the pastoral Tuareg and Moors (Arabs) and the sedentary Songhay (Benjaminsen 2008). The Tuareg depend on animals grazing in broad areas covering Mali, Algeria, and Niger for their livelihood. However, the establishment of the Malian border at the time of independence restricted their nomadic ways (Smith 2009, Kisangani 2012). Moreover, the first president, Modibo Keita, considered nomadism an obstacle in the country's modernization and the new Malian administration discriminated against the Tuareg in northern Mali, deeming them unproductive and futile (Benjaminsen 2008). The anti-nomad policy resulted in the marginalization of nomads, which was one of the reasons underlying the first Tuareg Rebellion (Lecocq 2004).[5] The objective of the rebellion was to establish an autonomous state by separating from the southern part of Mali, where the major ethnic group Bambara holds political and economic powers (Krings 1995, Benini 1993, Lecocq 2004).

The loss of cattle due to serious droughts in the late 1980s caused several young Tuaregs to emigrate to Algeria and Libya, where many joined the Tuareg military (Benjaminsen 2008). There was anger among the Tuareg because government officials stole international relief aids for those who were affected by drought. Moreover, more than 300 Tuaregs were killed in Niger and more than 100 Tuaregs were executed by the Malian army in 1990 (Krings 1995). Given the escalating frustrations among Tuaregs toward the government, in June 1990, a small group of Tuareg youth attacked a prison in

[5] It is noteworthy that the Tuareg owned slaves and thus, were further marginalized after the latter's liberalization. After independence, traditional pastoral leaders who dominated land management in wetlands along the Niger River lost power under the modernization policy, which resulted in land use conflicts between the pastoralists and farmers (pasture vs. rice field) and the encroachment of large areas by the latter led to the marginalization of the pastoralists (Benjaminsen and Ba 2009).

Menaka (300 km from Gao city), which was followed by the Tuareg's establishment of armed forces, the Popular Movement for the Liberation of Azawad (MPLA). This came to be known as the Second Tuareg Rebellion (Benjaminsen 2008, Keita 1998).

The rebellions took the form of mobile commandos targeting paramilitary forces (Sidib 2012). In retaliation, the Malian army attacked not only the Tuareg but also the Moors because it was unable to distinguish between the two groups. Many Tuareg people fled to Mauritania (Benini 1993). At the end of 1990, direct talks were held between the Mali government and rebel leaders, resulting in the Tamanrasset Peace Treaty in January 1991, which promised that 47% of the national budget would be allocated to the north (Benjaminsen 2008). However, soon after the Treaty was signed, the government was toppled and the rebel group was separated into opponents (moderate and extreme groups) and proponents of the accord (Kisangani 2012). There was conflict among the rebel groups, reflecting power dynamics in the Tuareg society (Lecocq and Klute 2013)[6]. The army was beyond the control of the transition government, which increased violence against civilians and compelled people to flee to safer places.

In 1991, most of the violence occurred in Goundam (west of Timbuktu), which became a buffer zone between the government and the rebels (Benini 1993).[7] By the end of 1991, the rebels attacked people in villages around Lake Faguibine, located to the northwest of Goundam, which were then abandoned and whose weekly markets were shut down. As a result, many nomads lost access to food, which worsened the violence and led to the stealing of cattle and grains from other families (Benini 1993). In September

[6] Tuareg rebels were split into four factions after the signing of the Tamanrasset Peace Treaty: the Arab-Islamic Front of Azawad (FIAA), the Revolutionary Liberation Army of Azawad (ARLA), the Popular Liberation Front of Azawad (FPLA), and the Popular Movement of Azawad (MPA). The first three groups were established by the dissidents to the Tamanrasset Peace Treaty, which was agreed upon between MPLA and the Malian government. FIAA was formed by the Hassani Arab minority group in northeast Mali. MPA was initially based among Tuareg refugees and exiles in Algeria and Libya. The Tuareg were also divided by the royal family line (Boas 2015).

[7] In May 1991, numerous civilian Tuareg and Moors were massacred in Lere by the Malian army (Randall 2005).

1991, the International Committee of the Red Cross (ICRC) stationed in Goudam to protect civilians and made it possible for weekly markets to be held and for medical staffs to return to their outposts. Although food distribution by ICRC was unreliable due to poor logistics and the dispersed locations of people in need, it helped reduce ethnic tension by decreasing the occurrences of food theft. It is noteworthy that the high mortality rates were mainly ascribed to violence and measles, not famine (Benini 1993).

Attacks were made by both the government army and rebels and continued in a sporadic manner, even after a National Pact was signed in April 1992 (Lecocq and Klute 2013).[8] After more than 100 innocent civilians (Songhai) were killed by one of the Tuareg rebel groups, a self-defense group was formed by the Songhai populations, the Patriotic Movement Ghanda Koy (MPGK), which resulted in a conflict against the Tuareg rebels in 1994 in major northern Mali cities, such as Bourem, Gao, and Ansongo (Lecocq and Klute 2013). In June and July 1994, 500 people were killed and more than 160,000 refugees fled to Algeria and Burkina Faso (Kisangani 2012).

One of the rebel groups (moderate group, namely MPA) defeated other opposition rebel groups (extreme ones) and forced them to sign a peace accord in December 1994 (Kisangani 2012). At the same time, from October 1994, the government took control of the army and peace processes were initiated by civil society (e.g., international NGOs and the Church of Norway) (Benjaminsen 2008). In 1996, a peace ceremony was held in Timbuktu and the second Tuareg rebellion was declared over (Poulton and ag Yousouf 1998).

During this conflict, it is estimated that 250,000 people were temporally displaced and became refugees (Benini 1993). The socioeconomic disruption severely affected not only the rebel groups and the army but also civilians in northern Mali. Those who were displaced had to leave their livestock and farmland behind, which were their main income

[8] MPA, with support from the Malian army, fought against the FPLA and ARL.

sources. Food shortages and unsanitary living conditions in refugee camps affected pregnant women and infants. Those in conflict areas had less access to healthcare facilities and medical attention.[9] We postulate that children exposed to conflicts in utero and after birth have worse health outcome.

3.3 Data and Descriptive Statistics

3.3.1 Data

3.3.1.1 Conflict database

Conflict data used in this study are from the Uppsala Conflict Data Program (UCDP). UCDP comprises information of 103,665 global conflicts that occurred from 1989 till date. The data provide detailed information for each conflict such as belligerents, period of conflict (start and end dates), number of deaths, and location reference using GPS coordinates. This allows us to construct accurate measures of the conflicts in terms of location, timing, and severity.

In the UCDP dataset, 67 conflicts are recorded in Mali for 1990–1994. With the exception of eight cases, all conflicts occurred in Azawad territory, in particular Gao and Timbuktu (Figure 3-1).[10] In these six years, the total number of deaths reached 1,324 and more than half of them were recorded in 1994; seventy-eight percent of the deaths were civilians.

[9] Tuncalp et al. (2015) analyzed data for healthcare facilities collected during the 2012 northern Mali conflict and found that facilities in conflict areas lacked several services such as prenatal care, skilled care during child birth, and post-natal care because of the medical supply chain, and even qualified healthcare workers.

[10] Detailed information on conflicts are provided in Appendix Table 3- 1.

3.3.1.2 Child health data

The data are adopted from the Malian Demographic and Health Survey (MDHS) conducted during 1995–1996 and 2001. The MDHS is a nationally representative household survey and contain household characteristics including geo-referenced locations as well as detailed health measures on mothers and children aged below five years.[11] The MDHS comprises information on women aged 15–49 years, including pregnancies in the last five years, and children aged 0–5 years, which means that the data include children who were born between 1992 and 2001.

3.3.1.3 Construction of conflict exposure variables

As described above, UCDP data comprise information of when each conflict began and ended as well as their location reference using GPS coordinates. UCDP data also contains the number of deaths from each conflict, and we adopt the information as intensity of conflict.[12] For each child in the sample, we create three variables indicating the intensity of conflict exposure as following: $Deaths_i^{in-utero}$, which denotes the total number of deaths from the conflicts within a 100-km radius of the community when he/she was an unborn child; $Deaths_i^{after\ birth}$, which indicates the number of deaths when he/she turned to one year old; $Deaths_i^{total}$, which is the sum of deaths when he/she was an unborn and one year old. We constructed exposure variables with distances other than 100 km (50 km, 150 km, and 200 km) and performed a regression analysis as a robustness check, which is presented in a later section. [13]

[11] MDHS are based on a multiple stratified sampling (Coulibaly et al., 1996; CPS/MS, DNSI and ORC Macro, 2002). It is required to use sample weights for obtaining nationally representative results. Thus, all the analyses in this paper are obtained by using the weights.

[12] The UCDP datasets provide us several information that can be used as index of conflict, and thus we need to be careful to utilize these information. We have examined each index (eg: total days of conflict) as specification variables respectively. However, we found out that these variables are inadequate for identification approach since the common trend assumption was not satisfied. Common trend check is mentioned in section 3.5.1.

[13] The results are shown in the Appendix Table 3- 2.

3.3.2 Descriptive Statistics

Since the Azawad territory stagnated compared with the rest of Mali, and most of the children exposed to conflict were in the Azawad territory, it is possible that the common trend assumption does not hold. Thus, we restrict the sample to households in the Azawad territory.[14] Households are categorized into two groups depending on conflict exposure: "Near to conflict fields" households are located within a 10 km radius of a conflict field while "Not near to conflict fields" households are outside of the radius. We call these groups "conflict area" and "non-conflict area."

Table 3-1 shows descriptive statistics for the variables. Estimated mean of variables for full sample are presented in Column (1), and the ones for conflict and non-conflict area are in Column (2) and (3) respectively. To compare conflict and non-conflict area easily, the table also displays differences in each variable between conflict and non-conflict area in Column (4). The differences are tested by t-test, and results are described as asterisks.

Panel A of Table 3-1 shows the child and household characteristics. The children in the present sample are less likely to be the first-born (birth order is 4.5) and twin siblings are rare (2%). The average age of the children's mothers is about 27 years. The mothers are mostly uneducated and often have not even attended primary school. Almost all the mothers are married (98%). One-fifth of the sampled children reside in urban areas. The difference between mean characteristics in the conflict and non-conflict areas (column 4) indicates that on average, mothers tend to be more educated and healthy, live in urban areas, and be richer than those in non-conflict regions. It is likely that these differences are mainly derived from the locations of conflict fields since most conflicts broke out in towns. When comparing the means of household characteristics in urban

[14] In this paper, households in Mopti, Timbuktu, Kidal, and Gao regions are considered as Azawad territory (Poulton, and Youssouf 1998).

samples in conflict and non-conflict areas, all these differences except mother's HAZ and wealth index disappear (see Appendix Table 3-3).

Panel B in the table shows the main outcome variable (HAZ) for the conflict and non-conflict areas as well as age cohorts for those who were exposed in utero and those who were not.[15] There are differences in HAZ between conflict and non-conflict areas, while in any given area there are no significant differences between exposed and non-exposed cohorts. Panel C shows the identification variables defined in the previous section. In the conflict region, mean value of total of deaths in-utero ($Deaths_i^{in-utero}$) is 22.556. This number means that children exposed in utero in the conflict area were exposed to the conflict that 22.556 people were killed on average. Likewise, mean value of total deaths after birth ($Deaths_i^{after\ birth}$) is 33.827, and the one in-utero and after birth ($Deaths_i^{total}$) is 37.816. [16]

3.4 Estimation Model and Results

Our identification strategy relies on DID approach by utilizing the variations of timing of birth and location. We analyze the effects of exposure to conflict on child health outcomes using ordinary least squares as follows:

$$(1)\quad y_{ijt} = \alpha + \beta E_{ijt} + \gamma X_{ijt} + \delta_1 d_j + \delta_2 d_t + \delta_3 (d_j \times d_t) + \varepsilon_{ijt},$$

where subscripts $i, j,$ and t indicate child, location, and birth cohort (year-month), respectively . y_{ijt} is child's health outcomes (HAZ). X_{ijt} is a vector for the characteristics of a child (birth order, female dummy, multiple birth, and mother's age at his/her birth) and his/her mother (years of education, HAZ, marital status) and a

[15] In this Table 3-, the age cohort "exposed in utero" includes those born before October 1995 and the cohort "not exposed in utero" are those born after October 1995.
[16] The other variables used for the regression analyses are shown in the Appendix Table 3- 4.

household's characteristics (ethnicity and wealth index).[17] E_{ijt} is a set of the conflict exposure variables defined in the previous section ($Deaths_i^{in-utero}$, $Deaths_i^{after\ birth}$, and $Deaths_i^{total}$) and dummy variables. $d_j\ and\ d_t$ are region and birth cohort (year-month) fixed effects, respectively. $\beta,\ \gamma,$ and δ are parameters to be estimated. ε_i is an error term.

It is expected that children with in-utero or after-birth conflict exposure are likely to have worse health conditions ($\beta < 0$). In the first two specifications, we separately estimate the impact of conflict exposure in utero and after birth since the impacts could vary. In the third specification, we estimate the impact of exposure regardless of the timing of the exposure.

To correctly identify the impact of conflict exposure, equation (1) relies on two assumptions. First one is a common trend assumption. To elaborate, in the absence of a conflict, children exposed to a conflict are on the same time trend as those who were not exposed to the conflict.

The second assumption is that once X and other fixed effects are controlled for, the conflict exposure variable does not correlate with the error term in equation (1). However, this assumption can be violated if some households selectively emigrated to mitigate the negative effects from the conflict (selective migration), or if some mothers purposively delayed pregnancy during the conflict to avoid its effects (selective fertility). We acknowledge that our model relies on these assumptions. In section 3.5, we test the robustness of the results using equation (1).

The estimated results are provided in Table 3-2. These results present that the total deaths of conflicts exposure children decreases the height of children. Especially in-utero conflict exposure has a significant negative impacts on the outcomes HAZ in

[17] DHS data contain a wealth index calculated using a principal component analysis on basic household assets such as types of toilet, water sources, electrification, and materials for the floor and roof of a homestead (Gwatkin et al. 2007; Rutstein and Johnson 2004).

Column (1), the coefficient is -0.574 SD. Likewise the coefficients of the intensity are shown in Column (4)-(6), which the significant magnitude is −0.01 SD in Column (4). Since the mean of total deaths in-utero is 22.556 (see Column (3) in Table 3-1), the magnitude of the impact of in-utero exposure is about 0.226 HAZ (= -0.01 × 22.556) on average. Therefore, the timing of exposure had varying effects on child health: in-utero exposure leads to a child being unhealthy, although this does not hold true for after-birth exposure. In terms of magnitude, these results are larger than other studies: Shemyakina (2014) and Akresh et al. (2014) found that increasing the number of months exposed to conflict by one month decreases HAZ from -0.005 to -0.002.

As mentioned in Section 3.3.1.3, whether a child was exposed to conflict or not depends on the defined conflict-affected area. Since there is no clear boundary between conflict and non-conflict areas, we set a 10 km radius of conflict fields as a benchmark case. In Appendix Table 3-2, estimated results with different distances from conflict fields are shown. The effects of conflict exposure in utero on HAZ are significantly negative among those who live in areas up to 10 km away. Additionally the coefficient of dummy variable in utero and after birth is negative significantly in Column (3). In the case of exposure in utero, the magnitudes do not differ from the main result: Table 3-2. It is shown that the estimated impacts of in utero exposure are not sensitive to the distance from conflict fields.

3.5 Robustness Checks

3.5.1 Placebo Tests

In the main analysis, we studied children born during and after the conflict in the Azawad territory as samples to estimate the effect of the conflict. Since the conflict-affected households are richer and more likely to live in urban areas than are non-affected households, there are possibility that children born during the conflict period but living

far from conflict fields. This migration may not satisfy the common trend assumption. If the assumption is violated, the main results shown in Table 3-2 are biased and driven by differentials in health trend in these areas.

To test the assumption, we estimate the model using a placebo treatment with two survey rounds that were conducted after the conflict (MDHS2001 and 2006 where sampled children were born between 1997 and 2006).[18] For this, the placebo treatment (proximity to conflicts) is assigned to each child so that each conflict broke out five years later than the actual conflict timing[19]. Since all the children in these two survey rounds were born after the conflict and were not exposed to the conflict, the DID estimator should be statistically insignificant. The estimation results are shown in Table 3-3. None coefficients of placebo-exposure measures are statistically significant, which means that the results do not capture only differences in health trends between affected and non-affected areas but also those between younger and older cohorts.

3.5.2 Selective Migration

Thus far, we used location information of the respondent's residence to identify whether a household lived in the conflict area during the conflict, assuming a household would not change residence during the conflict. It is possible that some of the respondents lived in the Azawad territory when the conflict broke out and returned to Azawad territory or continued to live outside of the territory once the conflict ended. This potential selective

[18] In general, placebo test targets periods before the conflict started. However, the only available survey conducted before the conflict does not contain GIS information. Thus, it is a limitation to undertake a balance test of pre-conflict characteristics and test time trends before the conflict for affected and non-affected areas.

[19] To test other placebo treatment except for five years (60 months), we examined several definitions shifting 48 to 72 months later than the actual conflict. Appendix Table 3- 4 shows the results that most coefficients are statistically insignificant. In a word, the results of placebo test are not fortuity and the common trend assumption is not violated.

migration could lead to over- (under-) estimation of the conflict' effects if those who migrated were less (more) healthy.

To mitigate the bias from selective migration, we redefine the exposure variable to estimate the impact of the conflict on those who had experienced it for sure. We create a dummy variable (*Li*) indicating whether a household has been in a current residential location for a long enough time to overlap the conflict period.[20] Exposure variables (*Eij*) are interacted with *Li*. The estimation results are provided in Table 3-4. We obtain qualitatively similar results to those in Table 3-2. Thus, we can conclude that the negative effects of the conflict are robust.

3.5.3 Selective Fertility and Mortality

The negative impact of conflict on child health can be attributed to the fact that healthier women in the conflict region possibly had delayed pregnancies until the end of the conflict. To test this, we examine whether women who were pregnant during the conflict living with a 10-km radius of any conflict systematically differ from those who were not. Thus, we run a model similar to equation (1) but with number of births in the past five years, years of education, height, and wealth of household as dependent variables for mothers' characteristics since a mother's human and physical capital as well as her past fertility decision are likely to affect her choice of having a child during a conflict. The estimation results are shown in Table 3-5. The coefficients of the conflict exposure variables do not differ from zero. This result suggests that the estimated impact of exposure to conflict in utero on a child's health is not purely due to selective fertility.

[20] We use responses to the question "For how many years have you been living in this place?" for constructing *Li*.

Furthermore, our results can be biased due to selective mortality since probabilities of child survival may vary between affected and non-affected households. To test this possibility, we use the sample of all the pregnancies five years prior to the survey and investigate whether those who were affected by the conflict are less likely to survive. We use three commonly used mortality indicators: neonatal mortality (child died before turning one month old); infant mortality (child died before turning one year old); and under-five mortality (child died before turning five years old). We use a similar estimation model as equation (1) but use these mortality indicators as dependent variables. Table 3-6 presents the estimation results; the coefficients of the exposure variables do not differ from zero, which means that there is no effect of conflict on mortality. Thus, we can conclude that a possible bias due to selective mortality is not severe.

3.5.4 Mechanism

With this study, we found that in-utero conflict exposure negatively impacts child health. In this section, we investigate the mechanism underlying this effect. A likely reason is that the conflict disrupted access to healthcare services, such as prenatal care and proper attention during delivery. We examine whether access to healthcare services is lower in the conflict area during the conflict by estimating the same models presented in Section 3.4.

As a measure of access to healthcare services, we use four variables: a dummy variable indicating whether the mother of the child received prenatal care (doctor or nurse) during the pregnancy, the number of times a mother visited the clinic for antenatal care, a dummy variable for whether a mother delivered a child at the hospital or in a clinic (using delivery at home as a reference group), and a dummy variable denoting whether a child was delivered with assistance such as from a doctor, nurse, and auxiliary midwife. The estimation results are shown in Table 3-7. The coefficients of the interaction terms

do not differ from zero. In the terms of the case, the mechanisms do not depend on the access to health care.

3.6 Conclusion

In this study, we estimated the impact of the northern Mali conflict on child health using more accurate measures of conflict exposure. We found that children exposed to the conflict had worse health outcomes than those who were not. In addition, the impact was greater when the child was exposed to prolonged and more server conflicts. The impact determined in this study is much larger than that found in existing studies, which suggests that the conflict in poor countries results in greater consequences. The robustness checks confirmed that the estimated impact was not due to selective migration, selective fertility or placebo test.

We also found that the negative impact emanated mainly from in-utero conflict exposure. Although the measure we used is not birth weight, our results confirmed that in-utero exposure to shocks such as conflict negatively affects children's height. Thus, eliminating conflict exposure especially among pregnant women is critical to improve children's health conditions.

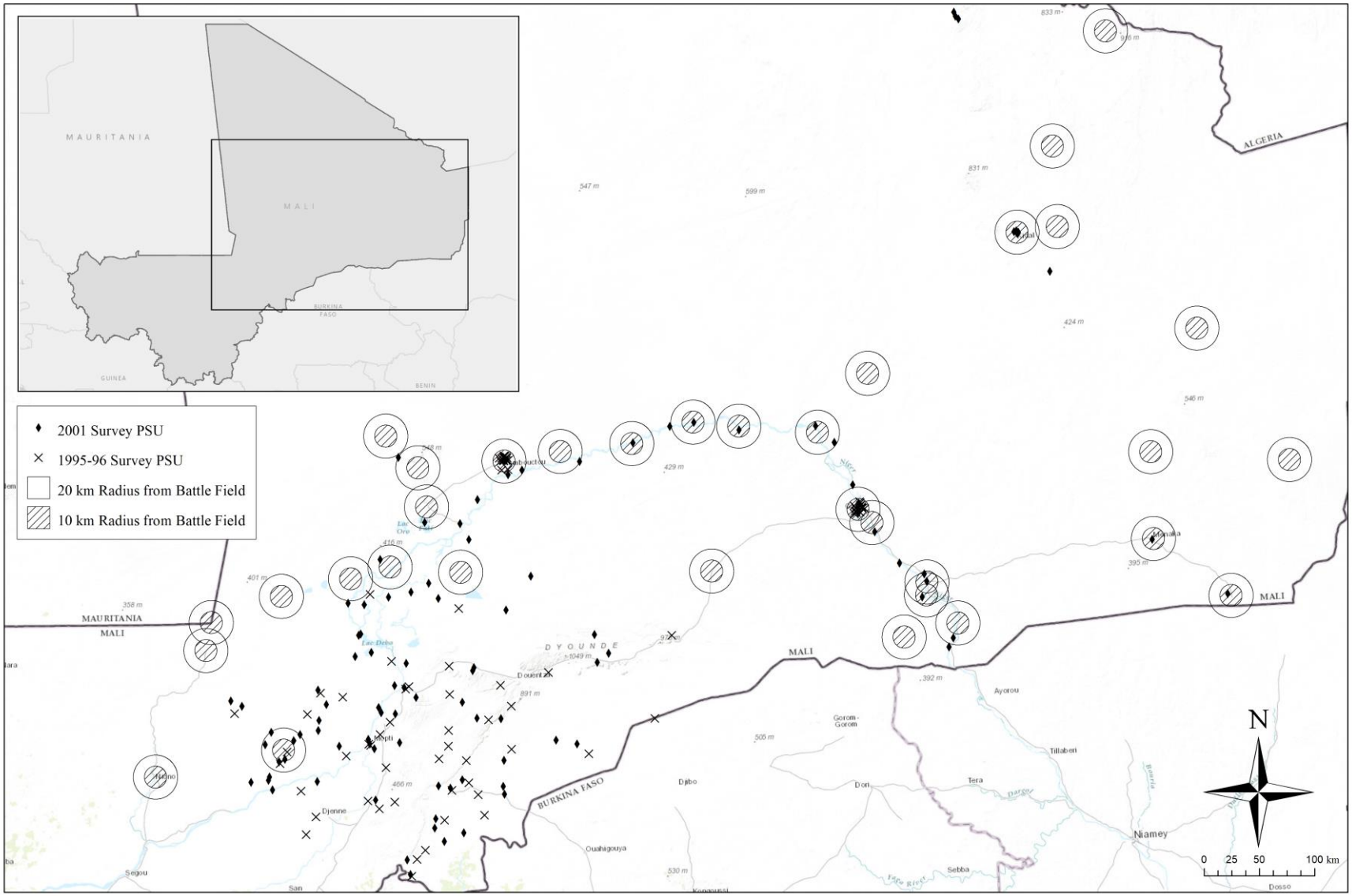


Figure 3-1: Mali regional map, sampled communities, and battle fields

Note: Authors plotted battle fields and sampled communities (primary sampling unit, PSU) based on GIS information using ArcGIS software. The source for the battle fields is the UCPD database and that for sampled communities is MDHS1995/96 and 2001.

Table 3-1: Descriptive Table

Variable	Full Sample (1)	Non - Conflict region (2)	Conflict region (3)	Difference (4)=(3)-(2)
N	2899	2047	852	
Panel A: Child and Household characteristics				
Child characteristics				
Birth Order	4.543	4.598	4.078	-0.520***
	(0.073)	(0.081)	(0.106)	(0.133)
Sex; 0=male, 1=female	0.493	0.501	0.427	-0.074***
	(0.012)	(0.013)	(0.024)	(0.027)
Twin; 0=single, 1=multiple	0.022	0.022	0.021	-0.001
	(0.004)	(0.005)	(0.008)	(0.001)
Mother's age at child's birth (months)	334.842	335.572	328.690	-6.881
	(2.996)	(3.353)	(2.770)	(4.347)
Household characteristics				
Mother's highest educational in single years	0.590	0.488	1.453	0.966***
	(0.057)	(0.057)	(0.200)	(0.209)
Mother's Height for Age (HAZ)	-0.442	-0.462	-0.273	0.190***
	(0.035)	(0.039)	(0.042)	(0.057)
Never married =1, married=0	0.020	0.017	0.042	0.024**
	(0.004)	(0.005)	(0.009)	(0.010)
Wealth Index	-0.253	-0.307	0.210	0.518***
	(0.040)	(0.044)	(0.090)	(0.101)
Type of residence (1=urban, 0=rural)	0.204	0.157	0.605	0.448***
	(0.030)	(0.034)	(0.076)	(0.085)
Panel B: Height for Age Z-score (HAZ)				
All periods	-1.341	-1.361	-1.179	0.182*
	(0.058)	(0.064)	(0.081)	(0.103)
Born After the war (a)	-1.365	-1.393	-1.123	0.270**
	(0.073)	(0.080)	(0.100)	(0.128)
Born During the war (b)	-1.274	-1.269	-1.319	-0.050
	(0.086)	(0.096)	(0.126)	(0.158)
Diff. in mean (b)-(a)	0.091	0.124	-0.196*	-0.321
	(0.117)	(0.130)	(0.116)	(0.207)
Panel C: Total Deaths				
exposed in-utero	-	-	22.556	-
			(1.615)	
exposed after birth	-	-	33.827	-
			(1.907)	
exposed in-utero and after birth	-	-	37.816	-
			(1.407)	

Note: Cluster (PSU) level robust standard errors in parentheses. ***, **, * mean significant level at 1%, 5%, 10%, respectively.

Table 3-2: Effects of Exposure to Conflict on Child Health (Main Result)

	Dependent Variable: Height for Age Z-score					
	(1)	(2)	(3)	(4)	(5)	(6)
Dummy within 10 km in Utero	-0.574**					
	(0.260)					
Dummy within 10 km after birth		-0.079				
		(0.300)				
Dummy within 10 km			-0.232			
in Utero or after birth			(0.249)			
Total Deaths of violence within 10 km in Utero				-0.010**		
				(0.004)		
Total Deaths of violence within 10 km after birth					0.005	
					(0.005)	
Total Deaths of violence within 10 km						-0.006
in Utero or after birth						(0.004)
Birth Order	-0.101***	-0.101***	-0.101***	-0.102***	-0.101***	-0.101***
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
Sex; 0=male, 1=female	0.050	0.050	0.050	0.051	0.050	0.051
	(0.062)	(0.062)	(0.062)	(0.062)	(0.062)	(0.062)
Twin; 0=single, 1=multiple	-0.713**	-0.714**	-0.715**	-0.713**	-0.713**	-0.715**
	(0.296)	(0.296)	(0.296)	(0.296)	(0.296)	(0.296)
Mother's age at child's birth (months)	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Mother's highest educational in single years	0.018	0.019	0.019	0.018	0.019	0.019
	(0.026)	(0.025)	(0.025)	(0.026)	(0.026)	(0.025)
Mother's Height-for-Age (HAZ)	0.251***	0.250***	0.251***	0.251***	0.250***	0.251***
	(0.032)	(0.033)	(0.033)	(0.032)	(0.033)	(0.033)
Never married =1, married=0	-0.033	-0.030	-0.030	-0.036	-0.031	-0.031
	(0.272)	(0.273)	(0.272)	(0.272)	(0.273)	(0.273)
Wealth Index Score	0.245***	0.244***	0.244***	0.246***	0.245***	0.244***
	(0.087)	(0.087)	(0.087)	(0.087)	(0.087)	(0.087)
Urban; 0=rural, 1=urban	0.355***	0.356***	0.356***	0.355***	0.356***	0.356***
	(0.120)	(0.120)	(0.120)	(0.120)	(0.120)	(0.120)
N	2899	2899	2899	2899	2899	2899
R-squared	0.341	0.341	0.341	0.341	0.341	0.341

Note: All equation include other controls: ethnicity dummies, region fixed effects, birth fixed effects, and birth cohort – region fixed effects. Cluster (PSU) level robust standard errors in parentheses. ***, **, * mean significant level at 1%, 5%, 10%, respectively.

Table 3-3: Robustness Checks (Placebo Test)

	Dependent Variable: Height for Age Z-score					
	(1)	(2)	(3)	(4)	(5)	(6)
Placebo-Dummy within 10 km in Utero	-0.028					
	(0.213)					
Placebo-Dummy within 10 km after birth		0.168				
		(0.254)				
Placebo-Dummy within 10 km			0.138			
in Utero or after birth			(0.214)			
Placebo-Total Deaths of violence within 10 km in Utero				-0.003		
				(0.005)		
Placebo-Total Deaths of violence within 10 km after birth					0.005	
					(0.004)	
Placebo-Total Deaths of violence within 10 km						0.002
in Utero or after birth						(0.003)
N	4904	4904	4904	4904	4904	4904
R-squared	0.252	0.252	0.252	0.252	0.252	0.252

Note: The placebo-treatment is assigned to each child so that each battle that occurred 60 months later than the actual battle. All the controls used in Table 2 are included as well as covariates, ethnicity dummies, region fixed effects, birth fixed effects, and birth cohort – region fixed effects. Cluster (PSU) level robust standard errors in parentheses. ***, **, * mean significant level at 1%, 5%, 10%, respectively.

Table 3-4: Robustness Checks (Selective Migration)

	Dependent Variable: Height for Age Z-score					
	(1)	(2)	(3)	(4)	(5)	(6)
Dummy within 10 km in Utero	-0.612**					
	(0.281)					
Dummy within 10 km after birth		-0.323				
		(0.331)				
Dummy within 10 km			-0.423*			
in Utero or after birth			(0.252)			
Total Deaths of violence within 10 km in Utero				-0.008*		
				(0.004)		
Total Deaths of violence within 10 km after birth					0.003	
					(0.005)	
Total Deaths of violence within 10 km						-0.007
in Utero or after birth						(0.004)
N	2113	2113	2113	2113	2113	2113
R-squared	0.360	0.359	0.360	0.360	0.359	0.359

Note: All coefficients are estimated using only sample who responded that he/she has lived the residence from before the conflict to the DHS survey, and thus, the sample size used in this table decrease from the main results (Table 2). All the controls used in Table 2 are included as well as covariates, ethnicity dummies, region fixed effects, birth fixed effects, and birth cohort – region fixed effects. Cluster (PSU) level robust standard errors in parentheses. ***, **, * mean significant level at 1%, 5%, 10%, respectively.

Table 3-5: Robustness Checks (Selective Fertility)

	# of births in last five years	Highest educational years	Height for Age (HAZ)	Wealth index
	(1)	(2)	(3)	(4)
Mother has been pregnant at the outbreak of the violence within 10 km	0.102	-0.415	0.089	0.188
	(0.072)	(0.289)	(0.123)	(0.170)
Mother has been pregnant at the outbreak of the violence over the Azawad	0.076**	0.037	-0.059	0.020
	(0.037)	(0.122)	(0.071)	(0.097)
Mother lives within 10 km from battle fields	0.112**	0.720**	0.163	0.254*
	(0.056)	(0.308)	(0.111)	(0.145)
N	2353	2353	2353	2353
R-squared	0.014	0.044	0.034	0.150

Note: All coefficients are estimated using woman level dataset. Other controls are ethnicity dummies and region fixed effects. Cluster (PSU) level robust standard errors in parentheses. ***, **, * mean significant level at 1%, 5%, 10%, respectively.

Table 3-6: Robustness Checks (Mortality)

	Neonatal mortality	Infant mortality			Under-five mortality		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Dummy variable specification							
Dummy within 10 km in Utero	0.0750	0.0791			0.0623		
	(0.0701)	(0.0650)			(0.0646)		
Dummy within 10 km after birth			0.0938			0.0450	
			(0.0589)			(0.0747)	
Dummy within 10 km				0.1035*			0.0705*
in Utero or after birth				(0.0544)			(0.0425)
N	4215	4215	4215	4215	4215	4215	4215
R-squared	0.071	0.075	0.075	0.075	0.088	0.088	0.088
Panel B: Intensity variable specification							
Total Deaths of violence within 10 km in Utero	0.0003	0.0005			0.0003		
	(0.0007)	(0.0009)			(0.0009)		
Total Deaths of violence within 10 km after birth			0.0003			0.0007	
			(0.0009)			(0.0011)	
Total Deaths of violence within 10 km				0.0009			0.0010
in Utero or after birth				(0.0009)			(0.0009)
N	4215	4215	4215	4215	4215	4215	4215
R-squared	0.071	0.075	0.075	0.075	0.088	0.088	0.088

Note: All the controls used in Table 2 are included as well as covariates, ethnicity dummies, region fixed effects, birth fixed effects, and birth cohort – region fixed effects. Cluster (PSU) level robust standard errors in parentheses. ***, **, * mean significant level at 1%, 5%, 10%, respectively.

Table 3-7: Mechanism (Access to Prenatal Care and Assistance at Delivery)

	Delivery at Hospital (Yes=1, No=0)	Number of Antenatal care taken	Delivery with Assistance (Yes=1, No=0)	Prenatal Care (Yes=1, No=0)
	(1)	(2)	(3)	(4)
Dummy within 10km in Utero	-0.026	-0.181	0.016	0.045
	(0.062)	(0.362)	(0.060)	(0.057)
N	2899	2253	2899	2899
R-squared	0.430	0.344	0.423	0.289
Total Deaths of violence within 10km in Utero	-0.001	-0.005	-0.000	0.000
	(0.001)	(0.006)	(0.001)	(0.001)
N	2899	2253	2899	2899
R-squared	0.430	0.344	0.423	0.289

Note: All the controls used in Table 2 are included as well as covariates, ethnicity dummies, region fixed effects, birth fixed effects, and birth cohort – region fixed effects. Cluster (PSU) level robust standard errors in parentheses. ***, **, * mean significant level at 1%, 5%, 10%, respectively.

Appendix Table 3-1: List of Battles and Deaths

Conflict id	Date of Start	Date of End	Deaths	Conflict id	Date of Start	Date of End	Deaths
1	1990-06-28	1990-08-28	0				
2	1990-08-06	1990-08-06	4	35	1994-06-10	1994-06-12	30
3	1990-07-02	1990-07-02	4	36	1994-06-16	1994-06-19	8
4	1990-07-20	1990-08-10	100	37	1994-07-02	1994-07-17	12
5	1990-08-03	1990-08-03	11	38	1994-11-04	1994-11-04	1
6	1990-08-06	1990-08-06	2	39	1994-07-17	1994-07-17	17
7	1990-08-06	1990-08-06	3	40	1994-05-30	1994-05-30	3
8	1990-06-28	1990-06-28	4	41	1994-07-25	1994-07-25	40
9	1990-07-01	1990-07-31	94	42	1994-10-04	1994-10-04	3
10	1990-06-28	1990-06-28	0	43	1994-10-06	1994-10-06	22
11	1990-09-03	1990-09-04	55	44	1994-10-21	1994-10-22	13
12	1990-08-06	1990-08-06	9	45	1994-06-13	1994-06-13	25
13	1990-07-17	1990-07-21	40	46	1994-04-21	1994-04-21	4
14	1990-07-29	1990-07-29	2	47	1994-10-19	1994-10-20	0
15	1991-06-01	1991-07-31	50	48	1994-07-15	1994-07-28	20
16	1991-03-01	1991-04-30	53	49	1994-12-01	1994-12-01	16
17	1991-05-20	1991-05-20	20	50	1994-06-12	1994-06-12	0
18	1991-03-01	1991-04-30	53	51	1994-05-26	1994-05-27	9
19	1991-12-12	1991-12-12	12	52	1994-07-01	1994-07-01	4
20	1992-01-15	1992-01-31	2	53	1994-11-25	1994-11-25	8
21	1992-06-07	1992-06-15	7	54	1994-05-26	1994-05-27	4
22	1992-06-30	1992-06-30	0	55	1994-07-01	1994-07-01	4
23	1992-05-20	1992-05-20	10	56	1994-07-14	1994-07-14	18
24	1992-02-08	1992-02-18	58	57	1994-12-18	1994-12-18	13
25	1993-12-27	1993-12-27	0	58	1994-06-19	1994-06-19	80
26	1994-07-03	1994-07-03	3	59	1994-11-13	1994-11-13	14
27	1994-11-20	1994-11-20	1	60	1994-04-01	1994-09-21	48
28	1994-05-26	1994-05-27	13	61	1994-10-22	1994-10-23	51
29	1994-06-19	1994-06-29	50	62	1994-10-23	1994-10-25	0
30	1994-06-12	1994-06-12	26	63	1994-06-08	1994-06-08	1
31	1994-12-03	1994-12-03	3	64	1994-07-14	1994-07-14	0
32	1994-11-20	1994-11-20	6	65	1994-06-19	1994-06-19	80
33	1994-11-30	1994-11-30	16	66	1994-06-13	1994-06-14	60
34	1994-06-14	1994-06-14	3	67	1995-01-23	1995-01-23	2

Appendix Table 3-2: Exposure variables with different distance (20 km)

	Dependent Variable: Height for Age Z-score					
	(1)	(2)	(3)	(4)	(5)	(6)
Dummy within 20 km in Utero	-0.546***					
	(0.205)					
Dummy within 20 km after birth		0.076				
		(0.253)				
Dummy within 20 km			-0.297**			
in Utero or after birth			(0.144)			
Total Deaths of violence within 20 km in Utero				-0.010**		
				(0.004)		
Total Deaths of violence within 20 km after birth					0.005	
					(0.005)	
Total Deaths of violence within 20 km						-0.006
in Utero or after birth						(0.004)
N	2899	2899	2899	2899	2899	2899
R-squared	0.341	0.341	0.341	0.341	0.341	0.341

Note: All the controls used in Table 2 are included as well as covariates, ethnicity dummies, region fixed effects, birth fixed effects, and birth cohort – region fixed effects. Cluster (PSU) level robust standard errors in parentheses. ***, **, * mean significant level at 1%, 5%, 10%, respectively.

Appendix Table 3-3: Descriptive Table for Explanatory Variables (Urban Sample)

Variable	Full Sample (1)	Non - Conflict region (2)	Conflict region (3)	Difference (4)=(3)-(2)
N	824	216	608	
Child characteristics				
Birth Order	4.216	4.339	3.947	-0.393*
	(0.132)	(0.194)	(0.117)	(0.226)
Sex; 0=male, 1=female	0.534	0.570	0.454	-0.116**
	(0.033)	(0.038)	(0.035)	(0.051)
Twin; 0=single, 1=multiple	0.033	0.040	0.019	-0.021
	(0.014)	(0.021)	(0.008)	(0.022)
Mother's age at child's birth (months)	328.821	329.993	326.261	-3.732
	(8.639)	(12.641)	(3.512)	(13.120)
Household characteristics				
Mother's highest educational in single years	1.325	1.222	1.550	0.329
	(0.146)	(0.173)	(0.231)	(0.289)
Mother's Height for Age (HAZ)	-0.354	-0.387	-0.282	0.105
	(0.090)	(0.133)	(0.049)	(0.142)
Mother's Weight for Height (WHZ)	-0.190	-0.132	-0.317	-0.184
	(0.096)	(0.131)	(0.123)	(0.180)
Never married =1, married=0	0.046	0.045	0.048	0.003
	(0.016)	(0.022)	(0.013)	(0.026)
Wealth Index	0.455	0.453	0.458	0.004
	(0.104)	(0.139)	(0.132)	(0.192)

Note: Cluster (PSU) level robust standard errors in parentheses. ***, **, * mean significant level at 1%, 5%, 10%, respectively.

Appendix Table 3-4: Robustness checks (Placebo-treatment shifting 48 to 72 months)

	Dependent Variable: Height for Age Z-score					
	Dummy variable			Total Deaths		
	In-Utero	After birth	In-Utero or After birth	In-Utero	After birth	In-Utero or After birth
	(1)	(2)	(3)	(4)	(5)	(6)
Placebo-treatment shifting						
48 months	0.216	-0.001	0.182	0.005	-0.009	-0.003
	(0.247)	(0.382)	(0.212)	(0.005)	(0.009)	(0.005)
50 months	0.369	0.309	0.263	0.008*	-0.002	0.002
	(0.242)	(0.298)	(0.213)	(0.005)	(0.007)	(0.005)
52 months	0.235	0.184	0.220	-0.001	-0.003	-0.002
	(0.267)	(0.284)	(0.207)	(0.005)	(0.008)	(0.004)
54 months	0.271	0.120	0.228	-0.000	-0.003	-0.002
	(0.261)	(0.269)	(0.208)	(0.004)	(0.006)	(0.003)
56 months	0.065	0.175	0.131	0.000	-0.003	-0.001
	(0.223)	(0.211)	(0.185)	(0.003)	(0.004)	(0.003)
58 months	-0.037	0.321	0.129	-0.001	0.002	0.000
	(0.273)	(0.233)	(0.219)	(0.004)	(0.004)	(0.003)
60 months	-0.028	0.168	0.138	-0.003	0.005	0.002
	(0.213)	(0.254)	(0.214)	(0.005)	(0.004)	(0.003)
62 months	0.089	0.420*	0.261	-0.001	0.006	0.002
	(0.203)	(0.227)	(0.198)	(0.005)	(0.004)	(0.003)
64 months	-0.263	0.138	-0.003	-0.004	-0.001	-0.002
	(0.227)	(0.237)	(0.195)	(0.005)	(0.004)	(0.003)
66 months	-0.158	0.095	-0.057	-0.005	-0.000	-0.002
	(0.251)	(0.225)	(0.188)	(0.004)	(0.004)	(0.003)
68 months	-0.040	0.058	-0.056	-0.008**	0.001	-0.003
	(0.313)	(0.208)	(0.182)	(0.004)	(0.003)	(0.003)
70 months	-0.363	0.107	-0.091	-0.004	-0.002	-0.003
	(0.240)	(0.200)	(0.171)	(0.003)	(0.004)	(0.003)
72 months	-0.347	-0.061	-0.142	-0.006	-0.003	-0.005
	(0.295)	(0.200)	(0.199)	(0.006)	(0.004)	(0.004)

Note: The placebo-treatment is assigned to each child so that each battle that occurred 48-72 months later than the actual battle. In this table, we show the results for bimonthly placebo-treatment. All coefficients are estimated as with Table 2 respectively. All the controls used in Table 2 are included as well as covariates, ethnicity dummies, region fixed effects, birth fixed effects, and birth cohort – region fixed effects. Cluster (PSU) level robust standard errors in parentheses. ***, **, * mean significant level at 1%, 5%, 10%, respectively.

Appendix Table 3-5: Descriptive Table for Other Explanatory Variables

Variable	Full Sample (1)	Non - Conflict region (2)	Conflict region (3)	Difference (4)=(3)-(2)
N	2899	2047	852	
Ethnicity (%)				
Bambara	0.088	0.096	0.017	-0.079***
	(0.018)	(0.020)	(0.007)	(0.022)
Malinke	0.018	0.020	0.003	-0.016***
	(0.005)	(0.005)	(0.002)	(0.006)
Peulh	0.165	0.176	0.072	-0.105**
	(0.028)	(0.031)	(0.039)	(0.050)
Sarakole	0.059	0.066	0.001	-0.065***
	(0.017)	(0.019)	(0.001)	(0.019)
Songhai	0.166	0.111	0.636	0.525***
	(0.021)	(0.020)	(0.054)	(0.060)
Dogon	0.356	0.397	0.010	-0.387***
	(0.038)	(0.042)	(0.006)	(0.042)
Tuareg	0.040	0.022	0.198	0.176***
	(0.006)	(0.006)	(0.033)	(0.033)
Senoufo / Minianka	0.003	0.003	0.009	0.006
	(0.002)	(0.002)	(0.007)	(0.007)
Bobo	0.006	0.007	0.005	-0.002
	(0.002)	(0.002)	(0.004)	(0.004)
Month of Birth (%)				
January	0.089	0.085	0.120	0.036**
	(0.007)	(0.008)	(0.014)	(0.016)
February	0.075	0.075	0.071	-0.004
	(0.005)	(0.006)	(0.009)	(0.011)
March	0.079	0.079	0.084	0.005
	(0.006)	(0.007)	(0.011)	(0.013)
April	0.078	0.077	0.083	0.006
	(0.007)	(0.007)	(0.011)	(0.014)
May	0.086	0.088	0.068	-0.021
	(0.007)	(0.008)	(0.012)	(0.014)
June	0.072	0.073	0.062	-0.011
	(0.006)	(0.007)	(0.010)	(0.012)
July	0.089	0.090	0.081	-0.009
	(0.006)	(0.007)	(0.009)	(0.012)
August	0.079	0.079	0.077	-0.002
	(0.007)	(0.007)	(0.011)	(0.013)
September	0.071	0.072	0.063	-0.009
	(0.007)	(0.007)	(0.009)	(0.012)
October	0.081	0.079	0.093	0.014
	(0.007)	(0.007)	(0.016)	(0.017)
November	0.094	0.094	0.098	0.004
	(0.006)	(0.007)	(0.018)	(0.019)
December	0.108	0.109	0.099	-0.010
	(0.008)	(0.008)	(0.013)	(0.016)
Year of Birth (%)				
1992	(0.001)	0.001	0.000	-0.008
	0.001	(0.001)	(0.000)	(0.001)
1993	(0.075)	0.075	0.074	-0.001
	0.011	(0.013)	(0.017)	(0.021)
1994	(0.071)	0.067	0.101	0.034
	(0.010)	(0.011)	(0.022)	(0.024)
1995	0.147	0.149	0.133	-0.015
	(0.021)	(0.023)	(0.031)	(0.039)
1996	0.118	0.121	0.094	-0.027*
	(0.008)	(0.009)	(0.014)	(0.016)
1997	0.119	0.119	0.120	0.001
	(0.010)	(0.011)	(0.018)	(0.021)
1998	0.115	0.113	0.128	0.015
	(0.011)	(0.012)	(0.023)	(0.026)
1999	0.118	0.115	0.143	0.028
	(0.009)	(0.010)	(0.022)	(0.024)
2000	0.188	0.190	0.172	-0.018
	(0.015)	(0.017)	(0.023)	(0.029)
2001	0.048	0.050	0.034	-0.015
	(0.006)	(0.007)	(0.010)	(0.012)

Note: Cluster (PSU) level robust standard errors in parentheses. ***, **, * mean significant level at 1%, 5%, 10%, respectively.

Appendix Table 3-6: Descriptive Table for Outcomes in Robustness Checks

Variable	Full Sample (1)	Non - Conflict region (2)	Conflict region (3)	Difference (4)=(3)-(2)
Fertility				
N	2353	1660	693	
# of births in last five years				
All periods	1.677	1.673	1.719	0.047
	(0.019)	(0.021)	(0.033)	(0.039)
Born After the war (a)	1.663	1.661	1.681	0.020
	(0.024)	(0.026)	(0.045)	(0.052)
Born During the war (b)	1.710	1.699	1.795	0.096**
	(0.026)	(0.030)	(0.032)	(0.043)
Diff. in mean (b)-(a)	0.046	0.038	0.114*	0.076
	(0.034)	(0.038)	(0.059)	(0.068)
Highest educational years of Mother				
All periods	0.572	0.479	1.408	0.929***
	(0.055)	(0.058)	(0.179)	(0.189)
Born After the war (a)	0.605	0.501	1.575	1.074***
	(0.066)	(0.068)	(0.245)	(0.254)
Born During the war (b)	0.500	0.427	1.078	0.651***
	(0.090)	(0.101)	(0.148)	(0.182)
Diff. in mean (b)-(a)	-0.105	-0.074	-0.497*	-0.422
	(0.126)	(0.137)	(0.291)	(0.307)
Height for Age () of Mother				
All periods	-0.460	-0.480	-0.278	0.202***
	(0.033)	(0.036)	(0.042)	(0.055)
Born After the war (a)	-0.440	-0.452	-0.325	0.127**
	(0.040)	(0.044)	(0.040)	(0.060)
Born During the war (b)	-0.505	-0.545	-0.186	0.359***
	(0.049)	(0.053)	(0.085)	(0.100)
Diff. in mean (b)-(a)	-0.065	-0.093	0.139	0.232**
	(0.061)	(0.067)	(0.083)	(0.112)
Wealth Index				
All periods	-0.261	-0.310	0.182	0.492***
	(0.039)	(0.043)	(0.085)	(0.096)
Born After the war (a)	-0.250	-0.293	0.154	0.447***
	(0.046)	(0.050)	(0.118)	(0.128)
Born During the war (b)	-0.285	-0.351	0.236	0.586***
	(0.075)	(0.084)	(0.096)	(0.130)
Diff. in mean (b)-(a)	-0.036	-0.058	0.082	0.140
	(0.103)	(0.114)	(0.154)	(0.191)
Mortality				
N	4215	2957	1258	
Neonatal Mortality (<=1 month)				
All periods	0.068	0.067	0.068	0.001
	(0.005)	(0.005)	(0.019)	(0.020)
Born After the war (a)	0.069	0.070	0.069	-0.001
	(0.006)	(0.006)	(0.025)	(0.025)
Born During the war (b)	0.062	0.061	0.068	0.006
	(0.009)	(0.010)	(0.022)	(0.024)
Diff. in mean (b)-(a)	-0.007	-0.008	-0.001	0.007
	(0.011)	(0.012)	(0.035)	(0.035)
Infant Mortality (<=12 months)				
All periods	0.135	0.137	0.121	-0.016
	(0.007)	(0.007)	(0.021)	(0.022)
Born After the war (a)	0.140	0.143	0.122	-0.021
	(0.008)	(0.008)	(0.028)	(0.029)
Born During the war (b)	0.120	0.120	0.118	-0.002
	(0.012)	(0.013)	(0.019)	(0.024)
Diff. in mean (b)-(a)	-0.020	-0.023	-0.003	0.019
	(0.015)	(0.016)	(0.035)	(0.037)
Under-5 Mortality (<=60 months)				
All periods	0.171	0.173	0.159	-0.013
	(0.007)	(0.007)	(0.020)	(0.021)
Born After the war (a)	0.174	0.176	0.161	-0.015
	(0.008)	(0.008)	(0.026)	(0.027)
Born During the war (b)	0.163	0.163	0.155	-0.008
	(0.014)	(0.015)	(0.020)	(0.025)
Diff. in mean (b)-(a)	-0.012	-0.012	-0.006	0.007
	(0.016)	(0.018)	(0.034)	(0.037)
Health Care				
Delivery at Hospital (Yes=1, No=0)				

All periods	0.178	0.168	0.268	0.101**
	(0.021)	(0.024)	(0.036)	(0.044)
Born After the war (a)	0.173	0.166	0.240	0.074
	(0.024)	(0.027)	(0.048)	(0.055)
Born During the war (b)	0.192	0.172	0.340	0.168***
	(0.031)	(0.035)	(0.049)	(0.061)
Diff. in mean (b)-(a)	0.018	0.006	0.100	0.066
	(0.045)	(0.049)	(0.073)	(0.089)
Number of Antenatal care taken				
All periods	1.305	1.157	2.628	1.471***
	(0.115)	(0.125)	(0.251)	(0.281)
Born After the war (a)	1.311	1.164	2.701	1.536***
	(0.131)	(0.139)	(0.324)	(0.353)
Born During the war (b)	1.287	1.134	2.446	1.312***
	(0.191)	(0.216)	(0.289)	(0.367)
Diff. in mean (b)-(a)	-0.024	-0.030	-0.255	-0.224
	(0.241)	(0.266)	(0.440)	(0.510)
Delivery with Assistance (Yes=1, No=0)				
All periods	0.147	0.130	0.296	0.166***
	(0.017)	(0.019)	(0.045)	(0.049)
Born After the war (a)	0.148	0.132	0.300	0.169***
	(0.022)	(0.023)	(0.059)	(0.063)
Born During the war (b)	0.146	0.127	0.286	0.159***
	(0.022)	(0.024)	(0.045)	(0.051)
Diff. in mean (b)-(a)	-0.002	-0.005	-0.015	-0.021
	(0.035)	(0.039)	(0.073)	(0.087)
Prenatal Care (Yes=1, No=0)				
All periods	0.200	0.164	0.525	0.361***
	(0.020)	(0.022)	(0.041)	(0.046)
Born After the war (a)	0.213	0.179	0.537	0.358***
	(0.025)	(0.026)	(0.054)	(0.060)
Born During the war (b)	0.162	0.118	0.495	0.377***
	(0.023)	(0.026)	(0.037)	(0.045)
Diff. in mean (b)-(a)	-0.051	-0.061	-0.043	0.145**
	(0.035)	(0.037)	(0.064)	(0.069)

Note: Cluster (PSU) level robust standard errors in parentheses. ***, **, * mean significant level at 1%, 5%, 10%, respectively.

Chapter 4

Does teacher's disability matter? A case from students' preference decision between teachers with and without visual impairments teaching in Nepal's regular mainstream schools[1]

4.1 Introduction

Inclusive education and labor market participation of people with disabilities (PwDs) is one of the effective strategies to reduce discrimination and to achieve their social inclusion as well as economic independence. However, PwDs still face challenges in access to education and jobs in developing countries despite them representing the 15 % of the world's population globally (WHO and world Bank, 2011). Among them, 80% are likely to live in low and middle income countries (ILO, 2007).

On the other hand, right to education and employment for PwDs is enshrined respectively in Article 24 and 27 of the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD). Article 27 further emphasizes the opportunity to gain a living by work freely chosen or accepted in a labour market and work environment that is open, inclusive and accessible to PwDs (UN 2006). However, in most countries, these provisions are yet to be implemented. Thus, the employment of PwDs in formal sectors in developing countries still remains largely untapped (Lamichhane 2015b). Perceived productivity differential between PwDs and people without disabilities, labour market imperfections related to discrimination and prejudice, and perverse disincentives arising from disability benefits are some of the factors affecting negatively their labor market participation (Lamichhane 2015b). Additionally, discrimination toward PwDs is

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widespread and Views on disability are often inflected by religious teachings which regard it as a punishment for the prior misdeeds of the parents. For example in Nepal, more than one third of their respondents misperceived disability as the result of various supernatural factors such as fate, punishment of the gods, evil eye curses, or punishment for parents' sins (UNICEF/NPC 2001). Almost similar cases for some developing countries were reported by Yeo and Moore (2003) stating that disability is considered to be associated with evil, witchcraft, bad omens or infidelity. While reasons behind the lower level of access to education and labor markets among them are multiple, lack of affirmative action can be regarded one of the serious issues for combating disability based discrimination and promoting inclusion and full participation of them in the society.

As a part of promoting inclusion and increasing their labor market participation, government of Nepal has been providing opportunities to individuals with visual impairments for teaching jobs in regular mainstream schools, that is, in schools which serve mainly students without disabilities (Lamichhane 2015a; Lamichhane 2012). Compared to other developed countries, Nepal is still behind toward achieving the quality of life of PwDs. Low level of access to education and labor market is still a great challenge. In this sense, teaching by individuals with visual impairments in local mainstream schools in Nepal can be regarded as an unprecedented and remarkable change given the circumstances that disability-based discrimination especially in developing countries is still a major challenge (Lamichhane 2015a).

Therefore, it is important to study this affirmative labor and education policy of Nepal that enables individuals with visual impairments to involve in teaching jobs. As a preliminary attempt to study this affirmative policy, in this paper, we examine students' preference decision between two groups of teachers; teachers with and without visual impairments who teach in the same mainstream schools. In this study, we define students' preference as the degree to which a student likes a specific group of teachers in this case either teachers with or without visual impairments.

When PwDs suffer with attituditional discrimination in societies, examining students' preference decision over two group of teachers help us understand if inclusion and visibility of disability in schools and communities can help reduce discrimination on disability.

The central research question posed in this paper thus is empirical: Can inclusion and familiarity with PwDs reduce discrimination against PwDs? To answer this question, we examine the socio economic background of both students and teachers on students' preference decision. By this study, it is the author's intention to first to bring Nepal's affirmative policy of making teaching jobs inclusive to individuals with visual impairments in regular mainstream schools into the global attention and second to assist policy makers, governments and development agencies to further expand such policies in other sectors of jobs.

There are two novelties to this study. To begin with, the first author has collected unique data from nearly 3000 students and more than 120 teachers of seven different schools in four districts of Nepal: Chitwan, Kashki, Palpa and Kapilbastu, using carefully structured questionnaires. The size and coverage of this survey are large in Nepal, where only few studies on disability issues are available. Second, the topic of the study itself is new and not researched both in developed and developing countries. So, we intend to address very important policy issue that can at least partially contribute in the existing knowledge on the importance of making teaching and learning inclusive and accessible to PwDs. The structure of the paper is as follows. Section 1.2 presents literature review and study context; section 2 explains the dataset from Nepal; Section 3 describes the empirical strategy; In section 4, results and findings are presented; The last section presents concluding remarks.

4.1.2 Study context and literatures on students' preference of teachers

In Nepal, previous to 1964, people with visual impairments had no real access to education, as there were no schools either in special or inclusive settings that could accommodate their individual needs. In 1964, however, education for persons with visual impairments was formally begun in an inclusive setting in the Laboratory School in Kathmandu. Three years later, the first special school for persons with hearing impairments was also established in Kathmandu (UNICEF 2003). Similarly, special schools for persons with intellectual impairments were established in the 1960s.

There are three educational options for persons with disabilities in Nepal: inclusive schools which used to be called as integrated schools, special schools, and local schools. Integrated schools are nowadays referred as inclusive schools which has been offering education for children with visual impairments from the beginning once their education formally started in 1964. Inclusive schools, equipped with separate resource classes with specialized teachers to prepare students with disabilities for the placement in mainstream classes are able to offer specific resources and facilities to their disabled students. Special schools are basically for students who are deaf and hard of hearing and who are with severe intellectual disabilities that have appropriate equipment and training to match the students' educational needs. Local mainstream schools are facilities that offer no special resources or support for students with disabilities. Even though education of children with visual impairments are provided in inclusive educational setting, such schools are not available locally. In other words, there are certain designated inclusive education offering schools where these students have to enroll.

As people with visual impairments from the beginning have been studying with their nondisabled peers in an inclusive educational setting, their desire to teach in regular mainstream schools in line with people without disabilities can be considered natural. However, until 1989, they were not allowed to teach in regular mainstream schools. As a result, they launched a demonstration after the restoration of democracy in 1989

demanding that they be provided teaching jobs in mainstream schools claiming that they obtained same credentials equivalent to their non-disabled counterparts (Lamichhane 2012). Due to the political activism on the part of these people, government of Nepal for the first time implemented a pilot project by allowing 21 quotas for those with visual impairments. (Lamichhane 2012). Since then, teaching in mainstream schools have been the major source of employment of educated visually impaired individuals. At present, nationwide nearly 400 individuals are reported to teach in mainstream schools (Lamichhane 2015a). Similarly, in the second amendment of Civil Service Act 1993 in 2007 (GON 2007), the government implemented a reservation quota system for people who are marginalized, including those with disabilities. The provision set in this amended act ensures that 45 percent quotas are reserved for people who are marginalized. According to the provision in this act, the reserved 45 percent quotas are converted into 100 percent, and 5 percent from this 100 percent is allocated for PwDs. This recent legal provision of reservation system is a significant accomplishment and can be regarded as an affirmative action taken by the government of Nepal to increase the access to public services by qualified individuals who are marginalized including those with disabilities (Lamichhane 2015b). Because of this newly set legal provision, it is expected that the labor supply of individuals with visual impairments as a teacher in mainstream schools will further increase.

As to the related literature is concerned, not on disability but in general, there have been some studies on students' preference of teachers and vice versa. For example, a study by Hull and Hull (1988) analyzed students' preference between male and female teachers and found that students generally preferred female teachers based on the supportive style and material provided to them. Similarly, Feldman (1992, 1993) found that sex of teacher sometimes matters for students' preference of teachers. Additionally, there are some research on the effectiveness of minority teachers in educating minority students e.g. (Falch et al., 2005).

In contrast to the numerous studies on students' preference over teachers in general, to the authors' best knowledge, there is no study examining students' preference on teachers with and without visual impairments who teach in the same mainstream schools. The only descriptive study we found on teachers with visual impairments (TVIs) is by Lamichhane (2015a). With the interviews of teachers and school principals as well as students' information in Nepal, in his study, Lamichhane explored the strengths and challenges of these teachers while teaching students without disabilities in mainstream schools. His study found that TVIs tend not to teach subjects such as science and mathematics that require frequent use of a black or white board or illustrations of formulas. Additionally, compared to teachers without visual impairments (non-TVIs), his study reported positive attitudes and good communication skills, as well as giving more social and moral lessons as particular strengths of TVIs. However, the same study also found that due to the lack of an adequate support system, educational materials and resources in schools, these teachers faced challenges in lesson preparation, marking students' examination papers or teaching picture-based contents.

One of the possible reasons why studies on students' preference decision on TVIs are not available might be attributed to the lack of dataset given the fact that countries providing opportunity for them to teach in regular mainstream schools are rare. The global historical trend of TVIs is primarily to teach students with visual impairments mainly in special schools for blind and visually impaired. However, as stated earlier, teaching students without disabilities in mainstream schools by this group is common in Nepal. They were found basically teaching subjects such as social studies, history, Nepali language, population and environmental sciences (Lamichhane, 2015a).

4.2 Dataset from Nepal

Students and teachers in seven mainstream schools from grade 6-9 were the participants for the survey. These schools from the four different districts of Nepal: Chitwan, Kapilbastu, Palpa and Kashki districts represent the central and Western part of the country. At the time of implementing the survey, the size of the students in these schools was ranged from 1200 to 1500. All of these schools were major schools in the respective districts and had been providing teaching opportunity for individuals with visual impairments. In these schools, 15 individuals with visual impairments were teaching. Also, all these teachers were Braille users. The first author administered structured questionnaires to all students from grade six to nine as these teachers were mostly teaching in these grades. Total students surveyed were 3022.

Additionally, teachers were also surveyed with the structured questionnaires. The survey was conducted in six-week sessions from January to February of 2011. The survey covers a wide variety of socioeconomic information including students' demographic characteristics, educational background, and information on parents together with the hypothetical question on their preference decision whether to choose TVIs or non-TVIs next year given the condition that the content of the classes will be same.

All required procedures were completed from the University of Tokyo before administering the survey. The study was carried out with informed consent from the participants, who were aware that they could withdraw from the study at any time, during or after, without incurring any personal consequences. Before administrating the surveys to the students and teachers, a requesting letter from the graduate school of economics of the University of Tokyo was submitted to each school administrations for their approval of surveys.

4.3 Empirical Strategy

4.3.1 Operationalization of main concept

In these schools, students are assigned into different sections of the same grades through their annual test scores. In each grades of these schools, there were two sections, A and B. Students who get odd number of places, i.e. with the 1^{st}, 3^{rd}, 5^{th}, 7^{th} … roll numbers are assigned to one section and the remaining students are assigned to the other. This is for mixing both talented and average students in both sections. The class reassignment occurs annually prior to the start of academic year. Since students cannot manipulate their test scores and thus cannot decide in which section to be enrolled and which teacher's class for example TVIs or non-TVIs to be taken, it can be said that students' assignment into different sections is random and occurs exogenously. This was the system of assigning students into different sections in these schools. Additionally, if same subjects were taught by TVIs in one and non-TVIs in other section of the same grade, students were administered the same questions in the exams, jointly prepared by both group of teachers. So, regardless of which teacher teaches, students have to follow the same trend of teaching. The first author verified these issues through school principals prior to the survey implementation.

Based on the aforementioned background, a hypothetical and subjective question was included in the survey to reveal students' preferences whether to take classes taught by TVIs or non-TVIs next year given the condition that the contents of the classes will be exactly same no matter which teacher they would prefer. They were given three choices: taking classes taught by TVIs; taking classes taught by non-TVIs; and do not care which teacher teaches. So, the responses are operationalized as multinomial and it takes three values.

4.3.2 Specification of the variables

We basically focus on three factors to investigate the correlation between inclusion and teacher preference. First factor is inclusive environment denoting that a student sees PwDs at his/her house or neighborhood. Second factor is inclusive education denoting that a student has been learning at the inclusive class and third factor is experience of learning with TVIs.

In order to specify the inclusive environment, we construct three variables: *Home* $_i$, which takes the value of one if *i* th respondent has PwDs at family or community and zero otherwise; *Family* $_i$ which takes the value of one if *i* th respondent has PwDs at family and zero otherwise; *Community* $_i$, which takes the value of one if *i* th respondent has PwDs at community and zero otherwise. Likewise, to specify the inclusive education, we also construct three variables: *Classmate* $_i$, which takes the value of one if *i* th respondent has any interaction with classmate who has disabilities and zero otherwise; *Spoken* $_i$, which takes the value of one if *i* th respondent has spoken with classmate who has disabilities and zero otherwise; *Friend* $_i$, which takes the value of one if *i* th respondent has friends who has disabilities and zero otherwise. Moreover, in order to specify experience of learning with TVIs, we construct two variables: *WithTVIs* $_i$, which takes the value of one if *i* th respondent has learned with TVIs and zero otherwise; *YearTVIs* $_i$, which is the number of total years *i* th respondent learned with TVIs.

Table 4-1-1 shows the descriptive statistics of the dependent variable used in the study. Column 1, 2 and 3 respectively shows the results for male, female and full samples. Majority of students (83.8 percent) were indifferent between choosing TVIs or non-TVIs, whereas 7.4 percent and 8.1 percent respectively chose TVIs and non-TVIs. As stated by Lamichhane (2015a), reasons why students choose TVIs might be connected to explaining more, doing more interaction in the classroom and adopting different techniques on the part of these teachers whereas non-TVIs in occasions simply write on the board. On the other hand, vast majority of the students being indifferent on their preference decision indicate the likelihood of them being more concerned on their educational utility than

teachers' physical conditions. In other word, students being indifferent over both groups of teachers is the reflection of their evaluation which may indicate that for qualified individuals, their impairment does not hinder them to enter in teaching jobs.

Table 4-1-2 shows the results for the independent variables. Column 1, 2, 3 and 4 respectively shows the results for respondents being in-different, prefer TVIs, prefer non-TVIs and results for full samples. The results for other variables are shown in Appendix Table 4-1. With regard to the disability specific variables, mean value of having PwDs at family or community was 56.7% in Column (4) suggesting that more than half of students have PwDs at family or neighborhood. Likewise, respectively, the mean value of respondents' interaction with classmate who has disabilities, respondents who have ever spoken with classmate with disabilities and respondents who have friend with disabilities was 86.8, 78.9 and 44.9%. Additionally, mean value of student who has been learning with TVIs was about 90%. Regarding the individual characteristics, mean value of student who has any disabilities was about 7% and female respondents was about 57% (see Column 4).

Likewise, Column 4 shows that the average age of TVI (32.43) is lower than their counterparts (38.81) but Compared to the age of non-TVIs who are preferred by students, the age of TVIs is higher by 4 years (see Column 2 and 3.). Moreover, average years of schooling of TVIs were slightly higher (15.29 years) than that of their counterparts (14.80 years. However, in terms of teaching experiences, Non-TVIs were in dominating position with 16.59 years of average teaching which was only 7.032 years for TVIs (see Column 4). This gap can be explained by the fact that teaching by individuals with visual impairments in local mainstream schools in Nepal was possible only after 1990. Furthermore, the data revealed that 37.7 percent of non-TVIs received at least one training while that percentage is again decreased for TVIs by 14 percentage points.

4.3.3 Estimation model

The correlations of the inclusion on teacher preference are analyzed using multinomial logistic regression. The base outcome is "Indifferent between TVIs vs. Non-TVIs" (y = 0). The estimation models are as follows:

$$(1)\ y_i = \alpha + \beta_1 Home_i + \beta_2 Classmate_i + \beta_3 WithTVIs_i + \gamma_1 X_i + \varepsilon_i$$

$$(2)\ y_i = \alpha + \beta_4 Family_i + \beta_5 Community_i + \beta_6 Spoken_i + \beta_7 Friend_i + \beta_8 YearTVIs_i + \gamma_2 X_i + \varepsilon_i$$

where subscripts *i* indicate respondent student. y_i is the teacher preference choice, X_i is a vector of teacher characteristics (Age of TVI, Age of Non-TVIs, Years of schooling of TVIs, Years of schooling of Non-TVIs, Teaching years of TVIs, Teaching years of Non-TVIs, Training of TVIs, Training of Non-TVIs, Salary of TVIs, Salary of Non-TVIs) and Individual / household characteristics (female dummy, disability dummy, years of schooling of father, years of schooling of mother, father's white color job dummy, mother' white color job dummy, family size, poor dummy). $\beta_1, \ldots, \beta_8$ and $\gamma$are parameters to be estimated. ε_i is an error term.

4.4 Results and Findings

Results for the estimation model 1 are presented in Table 4-2-1. In Column 1 and 5, we can observe that the coefficients for Having PwDs at family or community are positively significant suggesting that students having members with disabilities at his/her family or community are more likely to choose visually impaired teachers and this coefficients is stronger especially for female students. This finding supports that higher preference over TVIs might be an antecedent to peer effect of disability. Presence of disability at home or in the community as well as in school as peer may influence students' preference over TVIs. This is consistent with the hypothesis that being familiar on disability issues through

the opportunity to study or work together increases the greater understanding of disability.

Additionally, as shown in column 1 and 5, students from poor groups are statistically significant to prefer TVIs . This finding is also consistent with the casual observation that people facing discrimination and possible exclusion from the mainstream of development perceive positively the other groups who are also considered facing similar pattern of discriminatory behavior in society. Also in Column 1 and 5, the results further indicate that for those whose mother does a white-collar job are statistically significant to choose these teachers, suggesting that the example set by women's empowerment and success in work environment can enable their family members toward greater acceptance of diversity. When women, who are believed to face discrimination compared to their male counterparts, are empowered and engaged in jobs, they may educate their children not to be discriminatory to others.

In the case of preference decision over non-TVIs (y=2), the coefficients for interaction to classmate with disabilities are negatively significant (see Column 2, 4 and 6) and that ranges from 0.043 and to 0.055 for female and male respectively. Complimenting this finding, students having interaction with friends with disabilities and the students who have been learning with TVIs are also negative to prefer the class of non-TVIs.

Additionally, while male students from larger household size are more likely to choose Non-TVIs, same is not the case for female students. This is an interesting finding, suggesting that the impact of empowerment of male and female appears to be opposite with regard to the preference decision. This might reflect the possibility of male people being prejudiced over PwDs compared to their women counterparts.

In order to further specify the effects of inclusion, we show the results for Model 2 in Table 4- 2-2. As observed in model 1 Table 4-2-1, we find similar correlation between preference for TVIs and having PwDs in community. However, we obtain slightly

different but interesting results for interaction with PwDs at family. For the preference of both TVIs and Non-TVIs, the coefficients for having PwDs at family are positively significant. These findings indicate some possibilities of differences in perceiving the role of PwDs within and outside the family. If a person lives in a family with a disabled member and PwDs are not encountered in the community, then it is easy for misperceptions, stigma, and even fear of PwDs to develop. Therefore, it is not surprising that when such people have more encounters with PwDs that these negative attitudes dissipate as they get a clearer understanding of the humanity and capabilities of disabled people. So students from such families are more likely to prefer a TVI when PwDs are included in their communities. However, if a child comes from a family with a disabled member, the impact of that on their preference for a TVI or non-TVI is more complicated. On the one hand, greater familiarity would make it more likely for them to prefer a TVI. However, it could be that added responsibilities in the home (e.g., having to care for a disabled grandparent) or the shift of attention and resources to a disabled sibling (Meyer 2009) might lead children to want to take a break from issues they are dealing with on a daily basis at home. So it is not surprising that they have strong feelings one way or the other (for or against a TVI or a non-TVI) and are less likely to be indifferent.

Furthermore, there is opposite correlation between the preference for Non-TVIs and students having opportunity to speak with PwDs in classroom. We observe similar tendency in the results for Model 1 (see column 2, 4 and 6 in Table 4-2-1). Moreover, in Column (2), the coefficients for years of learning with TVIs is negatively significant at 10% significance level suggesting that student's experience of learning with TVIs increase the probability of preference for TVIs. This is a causal effect rather than a correlation since the variable is affected from the classification that is randomized and not inverse causality (see section 4.3.1).

From these results, we can suggest three implications. First, we can observe the correlation between student's home environment to the preference decision over teachers. Furthermore, our findings suggest that there exists difference between the roles of PwDs

at family and community as visibility of disability in communities seems increasing students' preference over TVIs. Second, we also find the correlation between inclusive education and teacher preference: especially the opportunity to speak with classmate with disabilities is associated to their preference decisions. Third, longer the period of students to learn with TVIs, greater the likelihood of increasing their preference over TVIs. As mentioned earlier, it is possible that this finding has causality as the relationship has a clear causal direction of years of learning with TVIs to preference. This finding denotes that learning with TVIs affects student's consciousness of interaction to adults with disabilities.

4.4.2 Robustness check

In order to test the robustness of our results, we test two methods. First, we estimate the Model 1 and 2 using fixed effects. It is possible that the estimation results depend on school environment at the survey's time or unobserved factors. In order to control these factors, we use three types of fixed effects: School fixed effect, Grade fixed effect and Section fixed effect. The results are shown in Table 4-3-1 and 4-3-2 respectively for model 1 and 2. we can observe the similar tendency as in Table 4-2-1 (results for model 1) and Table 4-3-2 (results for model 2 in Table 4-2-2).

Additionally, we test the independence from irrelevant alternatives (IIA) assumption: an assumption that lies at the center of the Multinomial Logit model is the IIA assumption (Domencich and McFadden 1975), which implies that the odds between any two categories remain unchanged whether we add a new category or eliminate in the existing one. For example, assume that we limit the student's choice of teacher by eliminating the possibility of having a non-TVI in the classroom with a probability of 100%, which leaves the student with only two alternatives: being assigned a TVI with 100% probability, or a lottery where any of both types of teachers are assigned with a probability of 50% (which is equivalent as being indifferent between both types of teachers). It could be the case that all the students who would have chosen a non-TVI would then pick the lottery, and have

at least some chance of being assigned their preferred teacher type, rather than being assigned a TVI (for example, under the existence of discriminatory attitudes against TVI). Such a change would alter the relative odds of the two remaining options, constituting a violation to the IIA assumption. In order to test the validity of this assumption, we estimated, for each model in Table 4-2-1 and 4-2-2 with two additional logit models: one by omitting the "Prefer TVI" alternative, and another omitting the "Prefer non-TVI" alternative (being indifferent between both types of teachers remains the base category in all the models). A Hausman-type test of the equivalence of the corresponding variable coefficient between the three models was performed. The results are presented in Table 4-4. None of the tests rejects the null hypothesis of equivalence of the coefficients, implying that there is no evidence of violations to the IIA assumption. From these checks, we can conclude that our results are not spurious.

4.5 Conclusions

In this study, we have examined Nepal's education policy of providing teaching jobs for individuals with visual impairments in mainstream schools through students' preference decision between TVIs and non-TVIs. Throughout the analysis, we find correlation of student's environment with teacher preference followed by having the opportunity to interact with classmate with disabilities. Additionally, experience of students learning with TVIs affects teacher preference positively. Similarly, the correlation of having members with disabilities at home being positive over the preference of both group of teachers and the positive correlation of having members with disabilities at communities only to the preference over TVIs allow us to argue that when such people have more encounters with PwDs, their possible negative attitudes dissipate as they get a clearer understanding of the humanity and capabilities of disabled people. So students from such families are more likely to prefer a TVI when PwDs are included in their communities. However, we also cannot reject the possibility that if a child comes from a family with a disabled member, the impact of that on their preference for a TVI or non-

TVI is more complicated. As stated in the previous section, on the one hand, greater familiarity would make it more likely for them to prefer a TVI. However, it could be that added responsibilities in the home (e.g., having to care for a disabled member) might lead children to want to take a break from issues they are dealing with on a daily basis at home. So it is not surprising that they have strong feelings one way or the other (for or against a TVI or a non-TVI) and are less likely to be indifferent.

Despite such possibilities, this finding indicates the importance of visibility of PwDs in society. Likewise, we find that the correlation between children's behavior towards classmate with disabilities and preference for TVIs being positive. Moreover, years of learning with TVIs affects teacher preference.

Additionally, we find that the effect of being familiar with disability is stronger for females, suggesting a gender bias in the students' decision to prefer TVIs. Probably, this may be attributed to a better understanding of disability issues on the part of women, who, historically, have been exposed to a similar discrimination in societies, especially in developing countries.

Overall, these findings suggest that policies promoting the inclusive participation of PwDs are likely to be instrumental to increase positive attitude towards disability on the part of nondisabled people. For example, students having friends with disabilities showing higher probability of choosing TVIs indicate that interaction with each other is crucial to understand disability issues. Frequent interaction is possible through inclusive education and inclusive labor market in which one can learn and work together. Together with the implementation of inclusive education, Nepal's Policy to recruit individuals with visual impairments in local mainstream schools can be regarded as an effective strategy. One of the implications of this study therefore, would be that the policy Nepal has implemented in providing opportunity to qualified individuals with visual impairments to teach in mainstream schools can be widen for different sectors of jobs and considered for other parts of the world which have similar situations as Nepal.

These policies of hiring qualified people with visual impairments not only help them achieve economic independence but also make labor market more inclusive and accessible for all which ultimately effect positively in reducing discrimination, mitigating poverty and making societies inclusive to all.

Finally, in order to evaluate the teaching qualities, examining the effect of TVIs on students' performance would be important area of future study. Moreover, though our study could partially demonstrate the impact of inclusion related certain variables on students' preference between TVIs and non-TVIs, one of the limitations is that due to not having a panel survey, we have analyzed only cross sectional relationships and therefore, it will be useful to collect panel data to further verify these results. Studies like this will shed light on a very important but relatively unexplored area, and help governments develop disability inclusive policies toward their social, economic and political participation.

Table 4-1-1: Descriptive statistics for dependent variable

Variable	Male (N = 1046)	Female (N = 1399)	Full (N = 2445)
Dependent Variable			
Choice of teacher			
0 : Indifferent between TVIs vs. non-TVIs	0.819	0.853	0.838
	(0.385)	(0.354)	(0.368)
1: Prefer TVIs	0.0717	0.0765	0.0744
	(0.258)	(0.266)	(0.263)
2 : Prefer Non-TVIs	0.109	0.0708	0.0871
	(0.312)	(0.257)	(0.282)
N	1046	1399	2445

Table 4-1-2: Descriptive statistics for key variables

Variable	(1) Indifferent between TVIs vs. Non-TVIs (y = 0)	(2) Prefer TVIs (y = 1)	(3) Prefer Non-TVIs (y = 2)	(4) Full sample
Disability specific variables				
Having PwDs	0.560	0.665	0.549	0.567
at family or community	(0.497)	(0.473)	(0.499)	(0.496)
In family	0.210	0.308	0.268	0.222
	(0.408)	(0.463)	(0.444)	(0.416)
In community	0.469	0.560	0.413	0.471
	(0.499)	(0.498)	(0.494)	(0.499)
Interaction with classmate	0.874	0.885	0.798	0.868
with disability	(0.332)	(0.320)	(0.402)	(0.339)
Has spoken with	0.794	0.819	0.714	0.789
classmate with disability	(0.405)	(0.386)	(0.453)	(0.408)
Has friend who has	0.455	0.407	0.427	0.449
disability	(0.498)	(0.493)	(0.496)	(0.497)
Has been learning with TVIs	0.907	0.912	0.817	0.900
	(0.290)	(0.284)	(0.388)	(0.300)
Total years of learning	1.593	1.582	1.230	1.561
with TVIs	(1.191)	(1.231)	(1.209)	(1.200)
Individual characteristics				
Respondent has any disabilities	0.0693	0.0989	0.0423	0.0691
	(0.254)	(0.299)	(0.202)	(0.254)
Respondent is female	0.582	0.588	0.468	0.572
	(0.493)	(0.494)	(0.500)	(0.495)

Table 4-1-2 (continued)

Variable	(1) Indifferent between TVIs vs. Non-TVIs (y = 0)	(2) Prefer TVIs (y = 1)	(3) Prefer Non-TVIs (y = 2)	(4) Full sample
Teacher characteristics				
Age of TVIs	32.66	33.14	29.64	32.43
	(5.058)	(5.065)	(4.902)	(5.118)
Age of Non-TVIs	38.66	37.35	41.54	38.81
	(11.63)	(12.13)	(12.43)	(11.77)
Years of schooling of TVIs	15.37	15.56	14.30	15.29
	(1.933)	(1.861)	(2.260)	(1.982)
Years of schooling of	14.80	14.92	14.70	14.80
Non-TVIs	(2.234)	(2.268)	(2.322)	(2.243)
Teaching years of TVIs	7.171	7.676	5.141	7.032
	(5.434)	(5.753)	(5.191)	(5.468)
Teaching years of Non-TVIs	16.34	15.46	20.01	16.59
	(11.76)	(11.61)	(13.57)	(11.97)
Training of TVIs	0.235	0.247	0.244	0.237
	(0.424)	(0.433)	(0.431)	(0.425)
Training of Non-TVIs	0.379	0.418	0.329	0.377
	(0.485)	(0.495)	(0.471)	(0.485)
Salary of TVIs	12.56	12.73	11.77	12.50
	(2.378)	(2.401)	(2.360)	(2.389)
Salary of Non-TVIs	11.69	11.70	12.04	11.72
	(2.377)	(2.467)	(2.237)	(2.373)
N	2050	182	213	2445

Note: Standard deviation in parenthesis. Results of other variables are shown in Appendix table 1.

Table 4-2-1: Marginal effects on students' preference decision (Model 1)

	(1)	(2)	(3)	(4)	(5)	(6)
	Full		Male		Female	
	Prefer TVIs (y=1)	Prefer Non-TVIs (y=2)	Prefer TVIs (y=1)	Prefer Non-TVIs (y=2)	Prefer TVIs (y=1)	Prefer Non-TVIs (y=2)
Having PwDs	0.029**	0.004	-0.002	0.007	0.049***	0.004
at family or community	[0.012]	[0.012]	[0.017]	[0.020]	[0.016]	[0.014]
Interaction to classmate	-0.001	-0.048***	-0.020	-0.055**	0.013	-0.043**
with disability	[0.018]	[0.016]	[0.026]	[0.027]	[0.023]	[0.018]
Has been learning with TVIs	0.015	-0.040**	0.023	-0.021	0.006	-0.045**
	[0.021]	[0.016]	[0.027]	[0.028]	[0.027]	[0.020]
Respondent has disability	0.015	-0.040	0.030	-0.041	0.007	-0.045
	[0.019]	[0.027]	[0.027]	[0.040]	[0.026]	[0.040]
Respondent is female	0.003	-0.034***	-	-	-	-
	[0.010]	[0.011]				
Age of TVIs	0.003	-0.010***	0.002	-0.015***	0.005	-0.006**
	[0.002]	[0.002]	[0.003]	[0.004]	[0.004]	[0.003]
Age of Non-TVIs	-0.003**	-0.001	-0.004*	-0.004	-0.002	0.001
	[0.002]	[0.002]	[0.002]	[0.004]	[0.002]	[0.002]
Years of schooling of TVIs	0.002	-0.011	0.016	-0.030**	-0.021	0.003
	[0.008]	[0.007]	[0.011]	[0.013]	[0.014]	[0.009]
Years of schooling of	0.002	-0.000	0.001	-0.001	0.005	0.002
Non-TVIs	[0.003]	[0.003]	[0.005]	[0.005]	[0.005]	[0.004]
Teaching years of TVIs	-0.000	0.002	-0.004*	0.008**	0.005*	-0.002
	[0.002]	[0.002]	[0.003]	[0.004]	[0.003]	[0.002]
Teaching years of Non-TVIs	0.002	0.002	0.005*	0.005	-0.003	0.001
	[0.002]	[0.002]	[0.002]	[0.004]	[0.002]	[0.002]
Training of TVIs	0.012	-0.013	0.036	-0.046	-0.015	0.003
	[0.024]	[0.022]	[0.030]	[0.041]	[0.033]	[0.024]
Training of Non-TVIs	0.016	0.003	-0.027	0.001	0.048**	0.009
	[0.014]	[0.016]	[0.022]	[0.029]	[0.020]	[0.018]
Salary of TVIs	-0.006	0.010	-0.012	0.028**	0.006	-0.002
	[0.006]	[0.006]	[0.007]	[0.011]	[0.009]	[0.007]
Salary of Non-TVIs	0.002	-0.002	0.005	0.003	0.001	-0.004
	[0.004]	[0.004]	[0.006]	[0.006]	[0.006]	[0.004]
Family member size	0.001	0.004*	-0.006	0.011***	0.005	-0.001
	[0.003]	[0.003]	[0.004]	[0.004]	[0.004]	[0.004]
Poor	0.023*	-0.007	-0.000	-0.018	0.044**	0.002
	[0.013]	[0.014]	[0.018]	[0.023]	[0.019]	[0.018]
Years of schooling of father	-0.003*	-0.002	-0.001	-0.002	-0.004*	-0.002
	[0.001]	[0.002]	[0.002]	[0.003]	[0.002]	[0.002]
Years of schooling of mother	0.002	0.002	0.000	-0.000	0.003	0.002
	[0.002]	[0.002]	[0.002]	[0.003]	[0.002]	[0.002]
Father's white job	-0.022	0.021	-0.030	-0.015	-0.007	0.045
	[0.022]	[0.023]	[0.035]	[0.041]	[0.027]	[0.028]
Mother's white job	0.057**	-0.006	0.066*	0.010	0.052	-0.036
	[0.027]	[0.041]	[0.039]	[0.067]	[0.035]	[0.049]
Number of Observations	2445		1046		1399	
Pseudo R-squared	0.058		0.080		0.081	

Note: Robust standard errors in brackets. ***, ** and * mean significant level at 1%, 5% and 10%.

Table 4-2-2: Marginal effects on students' preference decision (Model 2)

	(1)	(2)	(3)	(4)	(5)	(6)
	Full		Male		Female	
	Prefer TVIs (y=1)	Prefer Non-TVIs (y=2)	Prefer TVIs (y=1)	Prefer Non-TVIs (y=2)	Prefer TVIs (y=1)	Prefer Non-TVIs (y=2)
Having PwDs at family	0.028**	0.033**	0.029	0.009	0.027*	0.049***
	[0.012]	[0.014]	[0.018]	[0.025]	[0.016]	[0.015]
Having PwDs at Community	0.024**	-0.013	-0.009	0.017	0.044***	-0.036**
	[0.011]	[0.012]	[0.016]	[0.020]	[0.015]	[0.015]
Has spoken with PwDs in classroom	0.001	-0.029**	-0.015	-0.051**	0.012	-0.014
	[0.014]	[0.014]	[0.020]	[0.024]	[0.020]	[0.016]
Has Friend with disability	-0.019	-0.018	-0.009	-0.021	-0.027	-0.017
	[0.014]	[0.013]	[0.020]	[0.022]	[0.018]	[0.016]
Years of learning with TVIs	0.001	-0.016*	0.004	-0.011	-0.001	-0.017
	[0.005]	[0.008]	[0.007]	[0.013]	[0.008]	[0.010]
Respondent has disability	0.010	-0.045	0.019	-0.035	0.005	-0.058
	[0.018]	[0.028]	[0.026]	[0.041]	[0.026]	[0.042]
Respondent is female	0.002	-0.036***	-	-	-	-
	[0.011]	[0.011]				
Age of TVIs	0.002	-0.010***	0.003	-0.016***	0.002	-0.005*
	[0.002]	[0.002]	[0.003]	[0.004]	[0.004]	[0.003]
Age of Non-TVIs	-0.004**	-0.002	-0.004	-0.005	-0.002	-0.001
	[0.002]	[0.002]	[0.002]	[0.004]	[0.003]	[0.002]
Years of schooling of TVIs	0.004	-0.008	0.017	-0.027**	-0.017	0.006
	[0.008]	[0.008]	[0.012]	[0.013]	[0.014]	[0.009]
Years of schooling of Non-TVIs	0.002	0.000	0.001	-0.001	0.004	0.003
	[0.003]	[0.003]	[0.005]	[0.005]	[0.004]	[0.004]
Teaching years of TVIs	0.000	0.003	-0.005*	0.009**	0.006**	-0.002
	[0.002]	[0.002]	[0.003]	[0.004]	[0.003]	[0.003]
Teaching years of Non-TVIs	0.002	0.003	0.005*	0.005	-0.002	0.003
	[0.002]	[0.002]	[0.003]	[0.004]	[0.002]	[0.002]
Training of TVIs	0.019	-0.006	0.046	-0.039	-0.016	0.010
	[0.024]	[0.024]	[0.032]	[0.045]	[0.032]	[0.026]
Training of Non-TVIs	0.012	0.005	-0.030	0.003	0.041*	0.013
	[0.014]	[0.017]	[0.023]	[0.030]	[0.021]	[0.019]
Salary of TVIs	-0.009	0.005	-0.014*	0.025**	0.003	-0.008
	[0.006]	[0.007]	[0.008]	[0.012]	[0.009]	[0.008]
Salary of Non-TVIs	0.001	-0.001	0.004	0.004	-0.000	-0.004
	[0.004]	[0.004]	[0.006]	[0.006]	[0.006]	[0.004]
Family member size	0.001	0.004	-0.006	0.011***	0.005	-0.002
	[0.003]	[0.003]	[0.004]	[0.004]	[0.004]	[0.003]
Poor	0.022*	-0.010	-0.003	-0.020	0.044**	0.004
	[0.013]	[0.014]	[0.019]	[0.022]	[0.019]	[0.017]
Years of schooling of father	-0.003*	-0.003	-0.001	-0.002	-0.003	-0.003
	[0.001]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Years of schooling of mother	0.002	0.002	0.001	0.000	0.003	0.003
	[0.002]	[0.002]	[0.003]	[0.003]	[0.002]	[0.002]
Father's white job	-0.020	0.025	-0.031	-0.013	-0.008	0.049*
	[0.022]	[0.022]	[0.035]	[0.040]	[0.027]	[0.028]
Mother's white job	0.058**	-0.007	0.067*	0.004	0.052	-0.034
	[0.027]	[0.041]	[0.038]	[0.070]	[0.035]	[0.048]
Number of Observations	2445		1046		1399	
Pseudo R-squared	0.064		0.085		0.094	

Note: Robust standard errors in brackets. ***, ** and * mean significant level at 1%, 5% and 10%.

Table 4-3-1: Marginal effects on students' preference decision using fixed effects (Model 1)

	(1)	(2)	(3)	(4)	(5)	(6)
	Full		Male		Female	
	Prefer TVIs (y=1)	Prefer Non-TVIs (y=2)	Prefer TVIs (y=1)	Prefer Non-TVIs (y=2)	Prefer TVIs (y=1)	Prefer Non-TVIs (y=2)
Panel A: School fixed effect						
Having PwDs	0.027**	0.002	-0.002	0.001	0.046***	0.003
at family or community	[0.012]	[0.012]	[0.017]	[0.020]	[0.016]	[0.014]
Interaction to classmate	0.009	-0.044***	-0.018	-0.055**	0.027	-0.044**
with disability	[0.018]	[0.016]	[0.027]	[0.027]	[0.023]	[0.020]
Has been learning with TVIs	0.019	-0.034*	0.026	-0.003	0.012	-0.056***
	[0.020]	[0.018]	[0.028]	[0.030]	[0.027]	[0.021]
Pseudo R-squared	0.072		0.102		0.104	
Panel B: Grade fixed effect						
Having PwDs	0.030**	0.004	-0.001	0.009	0.051***	0.003
at family or community	[0.012]	[0.012]	[0.017]	[0.020]	[0.016]	[0.014]
Interaction to classmate	0.000	-0.046***	-0.021	-0.053*	0.012	-0.045**
with disability	[0.017]	[0.015]	[0.027]	[0.028]	[0.023]	[0.019]
Has been learning with TVIs	0.017	-0.036**	0.024	-0.017	0.014	-0.043**
	[0.021]	[0.016]	[0.028]	[0.028]	[0.027]	[0.019]
Pseudo R-squared	0.072		0.101		0.107	
Panel C: Section fixed effect						
Having PwDs	0.028**	0.002	-0.002	0.003	0.048***	0.003
at family or community	[0.012]	[0.012]	[0.017]	[0.020]	[0.016]	[0.014]
Interaction to classmate	0.008	-0.044***	-0.017	-0.054**	0.025	-0.044**
with disability	[0.018]	[0.016]	[0.027]	[0.027]	[0.023]	[0.020]
Has been learning with TVIs	0.020	-0.032*	0.025	-0.001	0.016	-0.051**
	[0.020]	[0.017]	[0.028]	[0.030]	[0.027]	[0.021]
Pseudo R-squared	0.077		0.110		0.117	
Number of Observations	2445		1046		1399	

Note: Robust standard errors in brackets. ***, ** and * mean significant level at 1%, 5% and 10%. All equation include Age of TVIs / Non-TVIs, Years of schooling of TVIs / Non-TVIs, Teaching years of TVIs / non-TVIs, Training of TVIs / Non-TVIs, Salary of TVIs / Non-TVIs, family member size, poor, years of schooling of father, years of schooling of mother, father's white color job. In order to test the robustness of the main results (Table 2-1 and Table 2-2), all equation also include high-caste, rural, ethnicity dummies, religion fixed effects. Estimation results for above equations using grade fixed effects is showed in Panel A, the ones using section fixed effects is in Panel B and the ones using school fixed effects is in Panel C.

Table 4-3-2: Marginal effects on students' preference decision using fixed effects (Model 2)

	(1)	(2)	(3)	(4)	(5)	(6)
	Full		Male		Female	
	Prefer TVIs (y=1)	Prefer Non-TVIs (y=2)	Prefer TVIs (y=1)	Prefer Non-TVIs (y=2)	Prefer TVIs (y=1)	Prefer Non-TVIs (y=2)
Panel A: School fixed effect						
Having PwDs at family	0.027**	0.032**	0.029*	0.007	0.026	0.047***
	[0.012]	[0.014]	[0.018]	[0.025]	[0.016]	[0.015]
Having PwDs at Community	0.025**	-0.014	-0.008	0.010	0.043***	-0.036**
	[0.011]	[0.012]	[0.017]	[0.020]	[0.015]	[0.015]
Has spoken with PwDs in classroom	0.005	-0.026*	-0.015	-0.046*	0.017	-0.015
	[0.014]	[0.014]	[0.021]	[0.024]	[0.020]	[0.016]
Has Friend with disability	-0.010	-0.022*	-0.002	-0.029	-0.014	-0.025
	[0.014]	[0.013]	[0.020]	[0.022]	[0.020]	[0.017]
Years of learning with TVIs	0.002	-0.014	0.005	-0.005	0.003	-0.020*
	[0.005]	[0.008]	[0.006]	[0.011]	[0.007]	[0.012]
Pseudo R-squared	0.077		0.106		0.116	
Panel B: Grade fixed effect						
Having PwDs at family	0.029**	0.031**	0.033*	0.004	0.029*	0.048***
	[0.012]	[0.014]	[0.018]	[0.025]	[0.016]	[0.015]
Having PwDs at Community	0.025**	-0.013	-0.010	0.020	0.044***	-0.036**
	[0.011]	[0.012]	[0.017]	[0.021]	[0.015]	[0.015]
Has spoken with PwDs in classroom	0.004	-0.028**	-0.017	-0.048**	0.017	-0.014
	[0.014]	[0.014]	[0.021]	[0.024]	[0.020]	[0.016]
Has Friend with disability	-0.020	-0.020	-0.003	-0.022	-0.036**	-0.023
	[0.014]	[0.013]	[0.021]	[0.022]	[0.017]	[0.016]
Years of learning with TVIs	0.001	-0.015*	0.004	-0.007	-0.000	-0.017*
	[0.005]	[0.008]	[0.006]	[0.012]	[0.007]	[0.010]
Pseudo R-squared	0.077		0.106		0.122	
Panel C: Section fixed effect						
Having PwDs at family	0.027**	0.030**	0.032*	0.001	0.027*	0.045***
	[0.012]	[0.014]	[0.018]	[0.025]	[0.016]	[0.016]
Having PwDs at Community	0.025**	-0.013	-0.009	0.015	0.043***	-0.035**
	[0.011]	[0.012]	[0.017]	[0.020]	[0.015]	[0.015]
Has spoken with PwDs in classroom	0.005	-0.026*	-0.016	-0.046**	0.019	-0.014
	[0.014]	[0.014]	[0.021]	[0.023]	[0.020]	[0.016]
Has Friend with disability	-0.011	-0.024*	0.003	-0.027	-0.021	-0.028*
	[0.015]	[0.013]	[0.021]	[0.022]	[0.020]	[0.016]
Years of learning with TVIs	0.002	-0.013	0.005	-0.004	0.002	-0.019*
	[0.005]	[0.008]	[0.006]	[0.011]	[0.007]	[0.012]
Pseudo R-squared	0.082		0.114		0.130	
Number of Observations	2445		1046		1399	

Note: Robust standard errors in brackets. ***, ** and * mean significant level at 1%, 5% and 10%. All equation include family member size, poor, years of schooling of father, years of schooling of mother, father's white color job. In order to test the robustness of the main results, all equation also include high-caste, rural, ethnicity dummies, religion fixed effects, grade fixed effects, section fixed effects and school fixed effects to test the robustness of the main results.

Table 4-4: Hausman-type specification tests for the IIA assumption

	All students	Male students	Female students
Model 1			
Chi2	11.05	8.50	11.78
Prob > Chi2	0.962	0.996	0.923
Degrees of Freedom	21	22	20
Model 2			
Chi2	8.73	8.50	13.43
Prob > Chi2	0.966	0.996	0.921
Degrees of Freedom	18	22	22

Note: The IIA assumption of the Model 1, 2 is tested using Hausman-type specification test. See section 3.2.

Appendix Table 4-1: Descriptive statistics for Individual characteristics.

Variable	Indifferent between TVIs and Non-TVIs (y = 0)	Prefer TVIs (y = 1)	Prefer Non-TVIs (y = 2)	Full sample
Individual / family characteristics				
Respondent is female	0.582	0.588	0.465	0.572
	(0.493)	(0.494)	(0.500)	(0.495)
Number of household member	6.235	6.363	6.629	6.279
	(1.933)	(1.895)	(1.764)	(1.918)
Years of schooling of Father	0.702	0.764	0.746	0.710
	(0.458)	(0.426)	(0.436)	(0.454)
Years of schooling of Mother	5.721	5.110	4.962	5.610
	(4.353)	(4.083)	(3.980)	(4.308)
Father`s white color job	3.410	3.495	2.873	3.370
	(4.010)	(3.826)	(3.726)	(3.974)
Mother`s white color job	0.0824	0.0604	0.0798	0.0806
	(0.275)	(0.239)	(0.272)	(0.272)
Poor	0.0259	0.0495	0.0188	0.0270
	(0.159)	(0.217)	(0.136)	(0.162)
Rural	0.378	0.286	0.244	0.359
	(0.485)	(0.453)	(0.431)	(0.480)
High caste	0.520	0.610	0.638	0.537
	(0.500)	(0.489)	(0.482)	(0.499)
Indegeneous others	0.812	0.753	0.883	0.813
	(0.391)	(0.433)	(0.323)	(0.390)
Religion				
Hindu	0.864	0.852	0.869	0.864
	(0.342)	(0.356)	(0.339)	(0.343)
Buddha	0.0883	0.115	0.0892	0.0904
	(0.284)	(0.320)	(0.286)	(0.287)
Christian	0.0405	0.0275	0.0329	0.0389
	(0.197)	(0.164)	(0.179)	(0.193)
Others*	0.007	0.005	0.009	0.007
	(0.0824)	(0.0741)	(0.0967)	(0.0831)

Appendix Table 4-1 (continued)

Variable	Indifferent between TVIs and Non-TVIs (y = 0)	Prefer TVIs (y = 1)	Prefer Non-TVIs (y = 2)	Full sample
Grade				
6*	0.229	0.286	0.305	0.240
	(0.420)	(0.453)	(0.462)	(0.427)
7	0.239	0.176	0.197	0.231
	(0.427)	(0.382)	(0.399)	(0.421)
8	0.249	0.231	0.277	0.250
	(0.432)	(0.422)	(0.449)	(0.433)
9	0.283	0.308	0.221	0.280
	(0.451)	(0.463)	(0.416)	(0.449)
Section				
A	0.358	0.324	0.446	0.363
	(0.479)	(0.469)	(0.498)	(0.481)
B	0.448	0.440	0.371	0.440
	(0.497)	(0.498)	(0.484)	(0.497)
C	0.186	0.220	0.183	0.189
	(0.389)	(0.415)	(0.388)	(0.391)
D*	0.00829	0.0165	0	0.00818
	(0.0907)	(0.128)		(0.0901)
N	2050	182	213	2445

Note: Standard deviation in parenthesis. * denotes reference group.

Chapter 5

Conclusion

This dissertation presented three empirical studies on the context of economic development, especially physical capital and human capital. As wrote in the introduction, investment in physical capital and human capital is the most important task that is at the center of the development strategy. If either one is missing it will not work, and thus we have to emphasize both.

In order to contribute to the knowledge of the physical capital, Chapter 2 investigated the effects of railroads on the price convergence. This paper found that railroad's construction has promoted the price convergence in the Meiji era. To discuss the effects of the distance between stations and markets, we defined four ways as the distance in the range from 10 km to 40 km. Regardless of the distance, the main results indicate the price convergence in all commodities. Moreover, this research tried two verifications: comparison with existing transportation; discussion of distance between markets. Given the nature of goods, it has been revealed that the impact of the railroads on prices is not uniform. Specifically, the following three findings were found: there are cases where water transport takes precedence; no railway is used in the market that is too close; if the distance between markets is too far, the railroads are not used since these cost more.

This paper remains two further work. First, the main results may be underestimated since it is not clear whether distant markets are connected or not. We should check carefully the assumption that the market integrates into one. Second, the study lacks the perspectives on changes in demand and supply. The discussion needs to more dataset such as population, production, transaction costs, and volume. If human capital information is merged with the dataset, the study can demonstrate a pathway from the railroads' construction to the human capital.

Chapter 3 showed the impacts of conflicts on child health, in order to refer to the importance of human capital. This paper verified that the conflict in northern Mali damages child health. Likewise, the impact was greater when the child was exposed to prolonged and more server conflicts. The paper also found that the negative impact emanated mainly from in-utero conflict exposure. In other hands, the study tried to discuss the mechanism that the conflicts affected the child health, however, the pathway did not become clear. In order to discuss the issue, the study needs other information such as the number of beds per region. The biggest constraint of the conflict case is the limitation of the dataset. In addition, the study assumed that the conflict was exogenous, and needs to check the assumption more carefully since the conflict field is biased toward urban areas. If the study adds more information such as the number of administrative facilities and details in the proportion of ethnicity, the study can try to remove the biases.

Chapter 4 researched the relationships between discrimination and inclusion. This study estimated the differences in students' preference decision between TVIs and non-TVIs and found the correlation between students' preference and the opportunity to interact with PwDs in several ways. These findings suggested that policies promoting the inclusive participation of PwDs were likely to be instrumental to increase positive attitude towards disability on the part of non disabled people. Remained problems are to discuss the causality. In order to verify the causal inference, the paper needs to utilize other quasi-experimental events. Additionally, the results have less representative implication since the study handled the cases of some schools in Nepal. In addition, it is endogenous that whether people have disabilities or not, and the opportunity to interact with PwDs. However, a clear limitation of the study is that it is difficult to survey representative datasets including PwDs and their condition. Some public survey such as DHS has started to include the information of PwDs, however, the study needs more details.

This dissertation considered each of the important factors in the development strategy and also adopted perspectives over the existing research. As pioneers showed, comprehensive theories and empirical research in economic development are still difficult. However, this study devised that each element can be considered while keeping the level of modern causal inference.

Chapter 2 can serve as an important material in developing countries that will develop transportation in the future. This is because there are not many studies investigating the infrastructure development in domestic economic integration, and this research adopted the distance of market integration and the knowledge of existing means of transportation respectively. Even if fine infrastructure development is realized, economic growth will not be realized if we neglect human capital. Therefore, Chapter 3 estimated the damage of the conflict which is the most direct and important event that will damage children's health. In countries such as Mali where repeated conflicts occur, we verify that child health has been damaged. If children's health is compromised, the effect of education and vocational training, which is most important in human capital, is hard to appear. Moreover, even if investment in infrastructure and human capital is in place, the disparity will exist forever unless a system that considers comprehensive society is constructed. Chapter 4 suggested that inclusive education in early childhood can be expected to reduce discrimination sentiment.

The remaining issues are as described above, and this research is far from the debate based on the integrated theory. The economic development and the poverty reduction have the aspect of accumulating knowledge by countermeasure therapy without waiting for the maturity of the basic theory due to the nature of the problem. However, this research contributed to research on development by arranging the nuclei of modern development strategies and expanding the frame of empirical research in each field. In the future, the accumulation of rigorous empirical research will be necessary so that people who tear with poverty can be reduced as soon as possible.

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