THE SOCIO-ECONOMIC, ENVIRONMENTAL, AND HEALTH IMPACTS OF TARIFF REFORMS IN INDONESIA

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DECLARATION

I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

I certify that my thesis consists of 193 pages and approximately 46,300 words, which includes three unpublished papers in Chapters 2-4. The ideas, development, and writing up of all the papers in the thesis were the principal responsibility of myself, the candidate, working within the Arndt-Corden Department of Economics, Crawford School of Public Policy, ANU College of Asia and the Pacific under the supervision of *Professor Budy P. Resosudarmo* (Chair of Supervisory Panel), *Professor Hall Hil* (Panel Member), and *Dr. Arianto Patunru* (Panel Member).

Yessi Vadila

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ABSTRACT

How does trade liberalization affect the welfare of the people? This paper attempts to answer the issue in the context of Indonesia by examining the socio-economics, environmental, and health impacts of trade liberalization in Indonesia. In this study, we focus on the consequences of tariff reform as the main instrument of trade liberalization on three specific measures: income inequality, air pollution, and child mortality rates.

In all three empirical studies, we define tariff reform as reductions in the national average nominal (unweighted) import tariffs of tradable goods. The national tariff data are sourced from several Indonesian Customs Tariff Books series and the UNCTAD-TRAIN database.

The first paper estimates the socio-economic impacts of tariff reform on provincial income inequality and poverty in Indonesia, using a panel dataset of 26 provinces for the period of 1977-2012. Our study provides evidence from a long period of trade liberalisation analysis and offers some valuable insights into the nexus between trade liberalisation and income distribution. We find that relative inequality reduced more in regions that were exposed more to input tariff liberalisation. The results also suggest that tariff cuts still play an important part in poverty reduction

The second study investigates the effects of tariff reforms on air pollution across 232 Indonesian districts from 1993 to 2002. Air pollution data is derived from satellite data for air quality applications which are primarily collected by National Aeronautics and Space Administration (NASA). We find that air pollution increased less in districts with greater exposure to input tariff reduction. The potential channels analysis supports the positive impact of tariff reform on air pollution through composition and technical effects.

The third paper aims to contribute to the debate over the nexus between trade liberalization and health by examining the effects of tariff reform on regional health outcomes in Indonesia. The focus is on infant and under-five mortality rates as specific measures of health. Exploiting the Indonesian Basic Health Survey 2007, we link tariff reform exposures and regional child mortality rates in 282 districts in Indonesia. We find that infant and under-five mortality rates were higher in districts with greater exposure to input tariff reform. Examining potential mechanisms behind this result, we find that higher exposures to input tariff cuts were associated with a lower average food expenditure per capita and a lower share of agricultural workers.

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1. CHAPTER 1

Introduction

1.1 Background and Motivation

If Jagdish Bhagwati (2004) started his book defending globalisation by asking whether the world still needed another book on globalisation, then perhaps we should start this study by questioning whether the academic world needs another thesis on globalisation?

There have been many studies trying to explore the welfare impact of globalisation, yet, both globalisation proponents and opponents of globalisation still stand their ground and whether globalisation itself enhances or worsens welfare is still an interesting debate in many parts of the world. It is because there is no single conclusion of the studies. Various results have been yielded from different methodologies used and different cases. Wood (1995) argues that trade has likely hurt unskilled workers. Edwards (1998) finds that openness to trade leads to increased income inequality in more developed economies, but not in less developed countries. Savvides (1998), however, concludes that more open, less developed economies experienced increased income inequality in the late 1980s. Gourdon et al. (2008) find that the effects of lower tariffs on income inequality depend on relative factor endowments: in poor countries with a high share of less-educated labour, lower tariffs will raise inequality. Moreover, while both Lindert and Williamson (2001) and O'Rourke (2002) support the position that economic globalisation is a force for income convergence between countries, they state that the effect on inequality within countries is less clear.

Meanwhile, economic globalisation has been rapidly expanding. It cannot be reversed or slowed down rapidly (Pangestu, 2012). Yet, recently, the issue of whether globalization and particularly trade liberalisation bring benefits to the society, is back on trend. The issue arose mainly because there have been perceptions that trade liberalisation is insufficient, if not fails, to bring obvious benefits of globalisation. People can still clearly see poverty, unemployment, and inequality, for instance, in the newspaper, statistics, and even in their daily life. This situation is exploited by the politicians to gain popularities by introducing jargons on nationalism, which is just the other name of protectionism (Patunru et al., 2018). However, as mentioned by Patunru et al. (2018), globalisation may bring good and bad effects, and trade may create winners and losers. We have to optimise the benefits and minimise the potential negative impacts, by creating a well-functioning compensation mechanism and providing a conducive labour market, e.g., free movement across sectors. Therefore, as Bhagwati (2004) argues, we actually need a comprehensive understanding of how globalisation works and how to improve it.

Globalisation covers various forms of international integration, such as the free flow of trade, finance, investment, and people. Trade liberalisation is one important form of globalisation. Trade has been liberalised rapidly over the past few decades in many countries, especially in developing countries. Trade liberalisation is believed to boost economic growth which in turn is expected to increase welfare of the people. The most common dimensions of welfare being assessed are economic growth, poverty rate, and income distribution. Many economists such as Bhagwati (1994), Edwards (1998), Dollar and Kray (2001) as well as Berg and Krueger (2003) support the welfare enhancing the effect of trade liberalisation. They argue that liberalising trade is an effective policy to increase trade volume, spur growth and reduce poverty.

On the other hand, some economists such as Barro (2000), Rodriguez and Rodrik (2001) and Bergh and Nilson (2010) suggest that the welfare effects of trade liberalisation are not always clear. They claim that liberalising trade may harm competing domestic industries and lower government revenue as well as increasing income inequality, at least in the short term. Interestingly, the empirical evidence for this issue is mixed.

Looking into regional impact, Goldberg and Pavcnik (2007) find that trade liberalisation has mixed effects on poverty for Latin American countries (Goldberg & Pavcnik, 2007). On the other hand, Bergh and Nilson (2010) argue that there is no significant effect of trade liberalisation on poverty. Moreover, Celik and Basdas (2010) conclude that trade liberalisation has different effects for different country groups. Even within a country, the results can be mixed. Topalova (2007) shows that tariff reduction contributes to poverty reduction in rural India, but does not significantly affect urban areas. In addition, Topalova (2010) argues that exposure to liberalisation leads to slower declines in poverty and lower consumption growth in India.

Meanwhile, for the case of Brazil, Castilho et al. (2012) argue that trade liberalisation contributes to lower poverty in rural areas, but the effects are smaller for urban areas. In general, there is no single conclusion on the effects of trade liberalisation on welfare in terms of income and growth, let alone on other aspects of welfare. Trade liberalisation can impact different countries differently, as their situations also vary. More evidence is needed to better understand the effects of trade liberalisation in different countries.

Indonesia offers an interesting case to study the welfare effects of trade liberalisation. It has liberalised its trade since the 1970s (Hill, 1996) and has been actively participating in the World Trade Organization (WTO) as well as in many regional and bilateral trade agreements (Pangestu et al., 2015; Patunru et al., 2018). Indonesia's simple average applied most favoured nation (MFN) tariff had decreased from around 30% in the late

1970s to around 6% in 2012. Meanwhile, Indonesia's economy has expanded strongly over recent decades, notwithstanding the notable decline in the late 1990s due to the Asian financial crisis. The country grew 5.5% annually on average from the early 1980s to the early 2010s. In 2017, Indonesia was the 16th largest economy in the world based on nominal GDP and ranked in 7th place for the purchasing power parity (PPP) basis.[1] Indonesia is also the fourth most populous nation in the world, with more than 260 million people in 2017, accounting for around 3.5 percent of the population of the global population.[2] Moreover, with vast economic and geographical variations across its regions, Indonesia may have various regional impacts of trade liberalisation.

There have been some studies on the effects of trade liberalisation, particularly in the form of tariff reduction, on poverty in the Indonesian context. For instance, Kis-Katos and Sparrow (2015) have empirically shown that input tariff reduction reduces the depth and severity of poverty. However, their study only covers the late phases. Meanwhile, there has been little discussion about inequality effects of trade liberalisation, and there is much less information about the impacts of trade liberalisation on environment and health, especially in the context of Indonesia.

1.2 Research Scope and Objectives

This thesis looks more closely at the welfare impact of trade liberalisation in Indonesia. Specifically, it investigates the impact of trade liberalisation on multiple aspects of welfare: the socio-economic, environment, and health. This study uses tariff reform as the measure of trade liberalisation because tariffs are relatively easier to be measured and comparable across time. Hence, we have to limit the discussion of trade liberalisation

[1] Source: World Bank, 2018.
[2] Source: United Nations Department of Economic and Social Affairs, 2018.

away from non-tariff measures (NTMs) and treat NTMs as other unobserved variables. The Indonesian case provides an ideal setting to study the effects of tariff reform because the tariff reductions were large and were proportional to initial sectoral tariffs: industries with higher initial tariffs experienced larger cuts.

The primary limiting scope of this study is the main variable for analysis that focuses on tariff reform as a trade liberalisation policy. In other words, the thesis only covers the partial impact of trade liberalisation contributed by tariff reductions. Due to data limitation, trade liberalisation in the form of reductions of non-tariff measures is beyond the scope of this thesis.

The following are the specific objectives of the research:

1. to analyse of the impact of trade policy in the form of import tariff cuts on income inequality and poverty rates;
2. to empirically investigate the impact of reductions in import tariffs on the aerosol index as a measure of air pollution;
3. to provide a quantitative estimate of the impact of trade policy in the form of tariff reductions on the child mortality rate as an important health measure.

1.3 Methodology

This dissertation is aimed at assessing the impact of trade liberalisation on welfare in Indonesia. Trade liberalisation is measured by tariff reform, a series of reductions of import tariffs in Indonesia. Welfare is measured by three different aspects of socio-economics, environment, and health which are represented by income inequality and poverty rates, air pollution and child mortality rates.

Three empirical papers in this dissertation analyse the impact of tariff reform at the regional level in Indonesia. The identification strategy of this paper exploits variation in sectoral composition across regions in Indonesia in the initial, pre-reform period. Following Amiti and Konings (2007), Amiti and Cameron (2012) and Kis-Katos and Sparrow (2015), we construct regional output tariff exposure measures by weighting national sectoral tariffs with the relative importance of a sector in a region. We also generate regional input tariff exposure measures by further weighting the manufacture output tariff by the relative importance of a sector as an input in the aggregate output (see also Topalova, 2007; Edmonds et al., 2010; Kovak, 2010; McCaig, 2011; Fukase, 2013; Castilho et al., 2012; Kis-Katos and Sparrow, 2015).

This dissertation adopts two approaches with regard to the relative importance of a sector in a region. The first approach is by calculating the relative share of employment in sector s in region r ($L_{s,r}$) in the total labour force in region r (L_r), using pre-reform Census data. This labour-weighted approach is adopting the method by Kis-Katos and Sparrow (2015). We call this type of output tariff exposure the labour-weighted region level output tariff exposure (TL) and, for each time t, it is calculated as:

$$TL_{r.t} = \sum_{s=1}^{s} \left(\frac{L_{s,r}}{L_r} x \, T_{s,t} \right) \tag{1}$$

where $T_{s,t}$ is the average national tariff in sector s at time t. The weight used is calculated over the total labour force including workers in non-traded sectors. The use of labour data in the pre-reform period for the employment weight is to control for unobserved counterfactuals of what would have been the evolution of the outcome variable across Indonesian regions in the absence of tariff reform. According to McCaig (2011), the use of pre-reform time-invariant weights is common in many empirical micro literatures, such as Bernard and Jensen (2004) and Lemieux (2002).

The second approach we use to calculate the relative importance of a sector in a region is by constructing manufacturing output weighted tariff exposure by weighting the national sectoral tariff by the initial relative share of each sector of industrial output in a region, based on Industrial Statistical data in the pre-reform period. We then define provincial manufacturing-weighted output tariff exposure, TO, as:

$$TO_{r,t} = \sum_{s=1}^{S} \left(\frac{Q_{s,r}}{Q_r} x\, T_{s,t} \right) \quad (2)$$

where $Q_{s,r}$ is the industrial output of sector s in region r, while Q_r is the total industrial output in region r.

Following the idea of Amiti and Konings (2007), Topalova (2010), and Amiti and Cameron (2012) that emphasize the importance of input channel, we further contsruct an input tariff measure. Then, by adopting he methods used by Kis-Katos and Sparrow (2015), we calculated a provincial manufacturing-weighted input tariff exposure (TI), by further weighting the provincial output tariff, TO, with the input share of each sector computed from the pre-reform input-output table:

$$TI_{r,t} = \sum_{s=1}^{S} \left[\frac{Q_{s,r}}{Q_r}\, x\, \sum_{j=1}^{J} \left(\frac{M_{j,s}}{M_s}\, x\, T_{j,t} \right) \right] \quad (3)$$

The input specific weight ($M_{j,s}/M_s$) is the initial share of input j over all inputs of any sector s in the pre-reform era, and $T_{j,t}$ is the corresponding national tariff of input j in year t. The input weight used is based on total input purchases, including domestic and imported inputs. If only imported inputs were used, the estimation would suffer from an endogeneity bias, as argued by Amiti and Cameron (2012).

To examine the effect of regional exposure to tariff reductions on welfare, we estimate the following general model:

$$\Delta y_{r,t} = \alpha + \beta_1 \Delta TO_{r,t} + \beta_2 \Delta TIr_{,t} + \Delta X'_{r,t}\, \gamma + I'_r \theta \; + \lambda_{g,t} + \Delta \varepsilon_{r,t} \qquad (4)$$

where $y_{r,t}$ is the regional level dependent variables at region r in year t. $X_{r,t}$ is a set of the average time variant regional characteristics. We also include interactive major island-year fixed effects, $\lambda_{g,\,t,}$ to control for shocks over time that affects trade across all regions but may vary across different major island groups within Indonesia.[3] The coefficient of interest, β, captures the average effect of trade reform on regional outcomes y, which is different in each empirical chapter. We alternate the regional output tariff and input tariff exposures calculated using labour-weighted measures with manufacturing ones to better capture the impact of tariff cuts on each dimension of welfare being examined: income inequality, poverty rates, air pollution, and child mortality rates.

The first difference method used in the main equation (equation 4) eliminates potential bias due to any endogenous factors affecting the national tariff by controlling for the country's variation over time and by limiting the variation only at the regional level. We also incorporate a vector of initial conditions $I_{r,}$ to deal with any potential confounders such as policies related to the initial regional sectoral structure and urban-rural differences.

This dissertation comprises three main chapters of empirical analysis which are aimed at analysing the welfare impact of tariff reform using three different quantitative methodologies. The first empirical chapter (Chapter 2) is aimed at examining the impact of tariff reform on income inequality and poverty rate by combining tariff data with provincial household and industrial data. The main method used in this chapter is the first difference econometric model using a panel dataset of 26 provinces for the period 1977 to 2012. The first difference method eliminates potential bias due to endogenous national tariffs by controlling for the country's variation over time and by limiting the variation

[3] There are five main islands dummies: Sumatera, Java, Kalimantan, Sulawesi and the outer islands.

only at the province level. To deal with potential confounders such as any policies related to the initial province sectoral structure and urban-rural differences, we incorporate a vector of initial conditions which includes sectoral labour shares (aggregated to one digit sectors), rural population shares and in some specifications, also the initial level of the respective dependent variable. A placebo test is also utilised in an attempt to eliminate the possibility of the endogeneity problem. Furthermore, we conduct a sensitivity analysis with regards to crisis periods in Indonesia, different economic specifications and various trade episodes.

The second empirical chapter (Chapter 3) investigates the impact of tariff reform on air pollution in Indonesian districts in the period 1993 to 2002. A district level measure of exposure to tariff reduction was constructed by combining information on regional labour and production, and national input-output tables, with exogenous tariff reductions over three-year intervals. In this study, we also develop a set of air pollution measures from satellite-based data on air pollution. A first difference econometric method is used in analysing the impact of tariff reduction on the aerosol index as a measure of air pollution quality. To check for endogeneity, a placebo test is conducted by regressing changes in the independent variable on future changes in tariff measures. We extend the analysis by incorporating a spatial effects model to deal with potential spatial spill-over. Finally, we consider a variety of potential causal channels that may explain the observed relationships.

Lastly, the third empirical chapter (Chapter 4) is aimed at addressing the effect of tariff reform exposures on regional health outcomes in Indonesia. The analysis focuses on infant and under-five mortality rates as specific measures of health. This chapter uses a derivative first difference econometric model to link tariff reform exposures and regional child mortality rates in 282 districts in Indonesia. The main health indicators are taken from the Indonesian Basic Health Survey 2007, the largest basic health survey ever conducted by the Indonesian Ministry of Health. In addition, we take into account any sources of potential bias by conducting a sensitivity analysis with regards to initial conditions, district splitting, migration, and pre-existing trends. In this paper, we extend the analysis by investigating some possible channels as to how district tariff exposures affect child mortality rates.

1.4 Expected Contribution

The expected contributions of this research are threefold. The first relates to understanding the socio-economic impact of trade liberalisation. This study provides a long period data analysis which covers important (major) episodes of trade liberalisation in Indonesia, to better capture the effects of the reform. Hence, it will be one of the first studies that empirically examines the impact of trade liberalisation on both inequality and poverty in Indonesia.

Secondly, to the author's knowledge, the study of the environmental impact of trade liberalisation is the first research into the case of Indonesia. Our study extends the literature by constructing a particular emission type, namely air pollution, and also districts' environmental control variables such as local precipitation and temperature. Furthermore, this paper includes spatial regression to mitigate the issue of spillover.

Lastly, the research also makes a significant contribution by addressing the health impacts that are ignored in most previous studies on the effect of trade liberalisation. It is among a few studies that provide quantitative estimates of the trade and health nexus in the literature. To the author's knowledge, this is, in fact, the first empirical research on this issue in Indonesia.

By extension, this thesis in general hopes to give insights to policymakers on the impacts of trade liberalisation from a more comprehensive perspective, as it provides a multi-dimensional analysis: socio-economic, environmental and health.

1.5 Outline of the Thesis

The thesis consists of five chapters with three unpublished papers. The next three chapters present three empirical studies which focus on the impacts of tariff reform on inequality, poverty, air pollution, and child mortality rates. The final chapter summarises the main findings of the three papers and provides an overall discussion of the research.

The introduction discusses the background and motivation of the research and follows with an explanation of the research scope and objectives, methodology, expected contributions, and outline of the thesis.

Chapter 2 investigates the socio-economic impact of trade liberalisation in Indonesia. Employing a first difference econometric model, this chapter assesses the impact of tariff reductions on income inequality and poverty rates in Indonesian provinces in the period 1979 to 2012.

Meanwhile, Chapter 3 assesses the environmental impact of trade liberalisation in Indonesia. In this chapter, a first difference econometric model is used to analyse the effects of tariff reduction on air pollution measures in 232 Indonesian districts from 1993 to 2002.

The third empirical chapter, Chapter 4 provides an analysis of the health impact of trade liberalisation in Indonesia. Exploiting a rich Basic Health Research dataset for 2007, this chapter investigates the effects of tariff reductions on infant and under-five mortality rates in 282 Indonesian districts.

The final chapter summarises the thesis, discussing key findings and limitations of the research as well as exploring prospects for future research.

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Appendix 1 Preliminary Non-Tariff Measures Analysis.

Appendix 1-A: Tariff Data across Time

Year	MFN Tariffs (%)	Year	MFN Tariffs (%)
1987	16.58	1998	9.05
1988	17.08	1999	8.73
1989	17.59	2000	6.66
1990	15.25	2001	5.56
1991	15.18	2002	5.56
1992	15.11	2003	5.56
1993	15.04	2004	5.47
1994	13.69	2005	5.47
1995	12.34	2006	5.47
1996	9.70	2007	5.52
1997	9.38	2008	5.32

Source: Indonesian Customs Tariff Books series and the UNCTAD-TRAIN database.

Source: Indonesian Customs Tariff Books series and the UNCTAD-TRAIN database.

Appendix 1-B: Non-Tariff Measures Data across Time

Table 1-B. *Nominal and Effective Rates of Protection, 1987, 1995 and 2008* [a] *(%)*

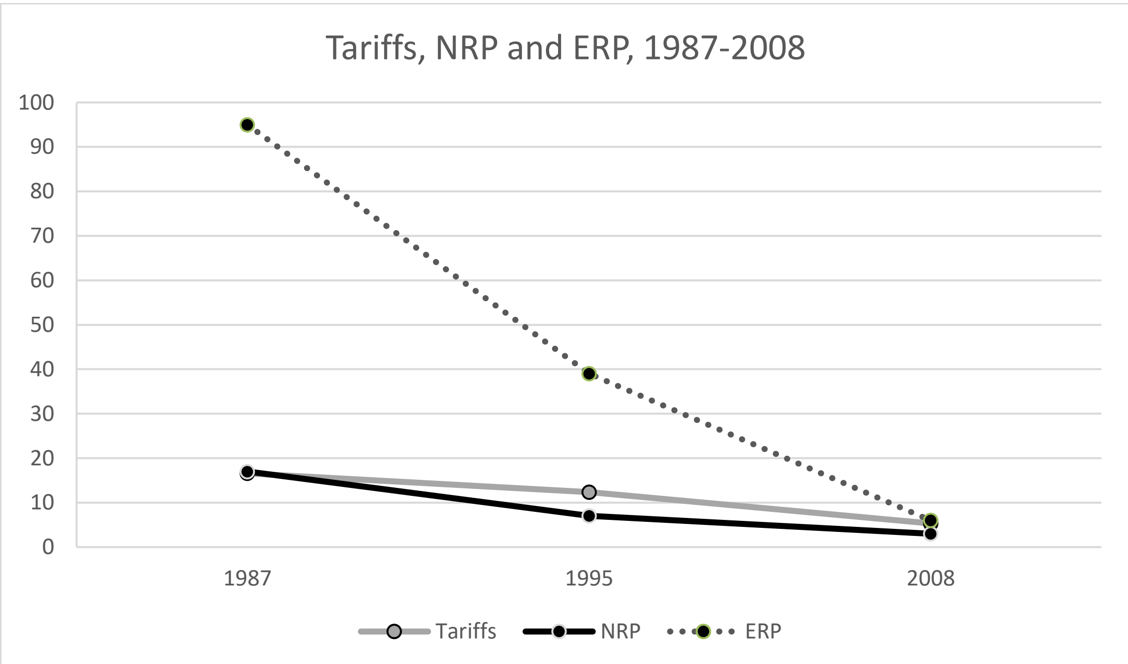
Sector	NRP			ERP_H		
	1987	1995	2008	1987	1995	2008
Food crops	19	11	17	28	16	24
Estate & other crops	3	–2	–7	12	–2	–9
Livestock	21	11	1	34	17	1
Forestry	–17	–41	–4	–20	–45	–5
Fisheries	5	22	0	4	30	0
Oil & gas extraction	0	1	1	–1	1	1
Other mining	0	2	–6	–4	2	–7
Food, beverages & tobacco	26	10	5	221	65	14
Textiles, apparel & leather	34	0	1	150	1	0
Wood products	17	–9	0	149	60	0
Paper products	29	5	1	292	12	0
Chemicals	17	7	2	52	39	8
Oil refining & LNG	0	3	0	–2	7	0
Non-metal products	27	9	2	157	221	7
Basic metals	8	2	2	14	–1	3
Machinery & transport equipment	48	23	5	278	116	8
Other manufacturing	35	8	2	104	24	4
All tradables sectors (175-sector IO table)						
Weighted mean	17	7	3	95	39	6
Maximum	100	94	42	600	600	508
Minimum	–18	–51	–36	–38	–56	–47
Weighted standard deviation	23	16	11	185	114	27
Coefficient of variation[b]	1.3	2.2	3.9	1.9	2.9	4.9

[a] NRP: nominal rate of protection ; ERP_H: effective rate of protection calculated by the Humphrey (1969) method;

Sources: Stephen V. Marks & Sjamsu Rahardja (2012).

Appendix 1-C: Non-Tariff Measures Analysis in Existing Studies

George Fane and Timothy Condon, (1996) argue that restrictive no-tariff barriers (NTB) coverage has been greatly reduced since the mid-1980s to 1995, in all traded sectors, and particularly in manufacturing sectors. On the other side, after comparing the 1987, 1995 and 2005 nominal rate of protections (NRPs) and effective rate of protections (ERPs), Stephen V Marks and Sjamsu Rahardja (2012) find that in general, nominal and effective rates of protection have reduced significantly, especially in manufacturing, and particularly in machinery and transport equipment, paper products, and food, beverages and tobacco. They conclude that, based on empirical evidence, Indonesian trade policies are considerably less protective than in the past, especially in manufacturing. However, in a recent study, Stephen V. Marks (2017) convince that the value-added-weighted nominal and effective rates of protection or all tradable sectors were lower in 2008 than in 2015, so that the Indonesian economy is subject to more interventions in 2015 than in 2008.



Tariffs: most favoured nations tariffs (MFN); NRP: weighted mean nominal rate of protection ; ERP_H: weighted mean effective rate of protection calculated by the Humphrey (1969) method
Source: Indonesian Customs Tariff Books series and the UNCTAD-TRAIN database; Stephen V. Marks & Sjamsu Rahardja (2012).

2. CHAPTER 2

Tariff Reform, Inequality, and Poverty in Indonesia

2.1 Introduction

Countries around the world have been undertaking significant trade liberalisation since the 1980s (Hill, 1996).[4] Liberalisation is marked by a reduction or even elimination of tariff and non-tariff trade barriers. It has been argued that significant tariff reductions across the world have helped push global economic growth in recent decades (Dollar, 1992; Sachs & Warner, 1999; Edwards, 1998). Indeed, the world economy has grown by approximately 3% each year over the past twenty years.[5] However, average within-country inequality also increased by almost 20%, while the global Gini index has gone up and down but remains relatively high at above 0.65 since 1980 (Millanovic, 2009; Hillebrand, 2008). One interesting growing debate is whether trade liberalisation causes increasing inequality. Hence many studies have attempted to empirically show whether trade liberalisation, particularly in the form of tariff reduction, causes inequality.

Indonesia offers a compelling case to study the inequality effects of trade liberalisation. It has conducted a series of comprehensive trade liberalisation moves, particularly in the form of tariff reduction, recent decades (Hill, 1996). During the same period,[6] Indonesia has achieved reasonably stable growth with continuing increases in income inequality.

[4] Until the 2007-2008 global financial crisis (GFC). This study also does not cover the period of 'trade wars' after Donald Trump was elected.

[5] Up to GFC, which brought the world's real GDP down sharply in 2009, and then recovered slowly in the following years before returned to 3% in 2017.

[6] Except during the Asian financial crisis in 1997-1998.

Moreover, Indonesia is the world's largest island country and the fourth most populous country in the world, so with its regional variations, Indonesia may yield significant contributions to the literature.

Indonesia's simple average of applied most favoured nation (MFN) tariff decreased from around 30% in the late 1970s to around 6% in 2012.[7] Figure 1 shows the tariff reduction profile in Indonesia from 1977 to 2012. In the meantime, economic growth has been persistent. The economy grew by approximately 5.5% per year from the early 1980s to the early 2010s, while inequality in Indonesia, measured by the Gini coefficient, increased from 0.34 in 1980 to 0.41 in 2013, reaching the highest point ever (Asra, 2000; Yusuf et al., 2014). On the other hand, poverty in Indonesia has reduced significantly over the past four decades, albeit at a decreasing rate of reduction (Suryahadi et al., 2012). Whether trade liberalisation causes the Gini coefficient to increase has been an important topic of public debate since the early 2010s (Yusuf et al., 2014).

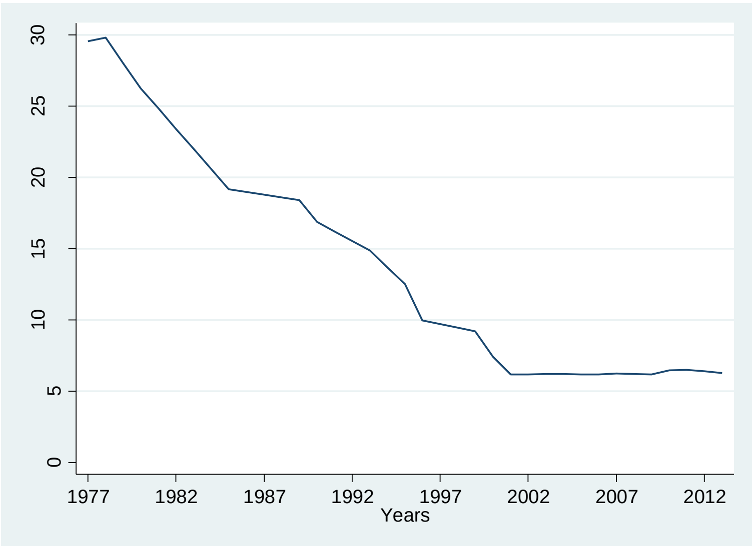


Figure 2.1. Average MFN tariff 1977 2012.

[7] During this period non-tariff barriers (NTBs) might increase, but the measurement of NTBs is challenging and thus not included in the scope of this study.

There are a number of studies on inequality in Indonesia, for example, Hughes and Islam (1981), Resosudarmo and Vidyattama (2006), Asra (2000), Hill (2008), Leigh and van der Eng (2009), Akita, et al. (2011), Zulfan Tadjoeddin (2013) and Nugraha and Lewis (2013). However, these studies do not particularly observe the impact of liberalisation on inequality. On the other hand, for the poverty impact of trade liberalisation, Kis-Katos and Sparrow (2015) empirically showed that input tariff reduction reduces the depth and severity of poverty. However, their study only covers the late phases of trade liberalisation and excludes major episodes of tariff reform before 1990.

We examine the impact of the trade reform, as measured by tariff reduction, on income inequality and poverty in Indonesia from 1980 to 2012. We provide an extended period data analysis which covers important (major) episodes of trade liberalisation in Indonesia, to better capture the effects of the reform. To the best of our knowledge, this is the first study that empirically examines the impact of trade liberalisation on both inequality and poverty in Indonesia.

The next section provides a brief literature review in the context of trade, inequality, and poverty. Section 3 presents the data and measurements and Section 4 outlines the methodology. Results and discussions follow in Section 5, while Section 6 discusses the sensitivity analysis and investigates potential sources of bias. Section 7 concludes.

2.2 Literature Review

2.2.1 Trade and income distribution

The principal analytical link between trade and income inequality is derived from the Stolper-Samuelson theorem, a variant of the Heckscher-Ohlin model. The theorem postulates that in a two-country-two-factor framework, an increase in the relative price of a commodity (as a result of tariff imposition) raises the return of the factor used intensively in the production of the commodity. So, removing tariffs in a developing country where low-skilled labour is abundant would result in an increase in the relative wages of the low-skilled workers and a reduction in the return of the high-skilled workers, leading to a reduction in income inequality.

Accordingly, tariff reduction is expected to increase developing countries' outputs of labour-intensive sectors and reduce those of capital-intensive sectors. An increase in outputs of labour-intensive sectors will increase the real incomes of unskilled labour mostly comprised of the poor (Bhagwati & Srinivasan, 2002). Meanwhile, the declining outputs of capital-intensive sectors will reduce the real income of capital owners who are typically among the rich. Thus, for developing countries, more trade induces a reduction in income inequality. Calderon and Chong (2001) find that increasing trade openness reduces inequality in developing countries.

However, the neoclassical theory is based on an assumption of full employment and perfect inter-sectoral labour mobility. In reality, labour market adjustments are often imperfect (Dix-Carneiro, 2014). In the short run, the imperfection of labour mobility may hurt workers in import-competing sectors because lost protection can reduce wages or create unemployment (Hasan et al., 2007). Furthermore, some studies show that increasing trade openness increases inequality in all countries (Barro, 2000; Lundberg and Squire, 2003).

Nevertheless, despite the Stolper-Samuelson theorem having its own limitation from assumptions that often deviate from the real world, the general argument is broadly accepted. Corden (1974) suggests that we could analyse the signs of the output changes resulting from tariff reduction to determine the signs of factor price changes, given that factors specific to or intensive in different activities are known. He further explains that tariff reduction has two types of income distribution effects. Firstly, the revenue raised reflects redistribution from particular consumers to other sections of the community with government roles by increasing public spending or reducing other types of taxes. Secondly, tariffs bring redistribution effects as they change domestic price structures.

On the other hand, some studies find no significant relationships between trade liberalisation and income inequality (Edwards, 1999; White and Anderson, 2001; Ravallion, 2001; Higgins and Williamson, 2002; Dollar and Kraay, 2002). All in all, how trade reform, including tariff reduction, affects income inequality in developing countries remains an empirical question.

2.2.2 Trade and Poverty

Theoretically, trade liberalisation could help in reducing poverty, at least in the long run, even though it might not be the most significant factor in poverty alleviation (Winters et al., 2004). Some economists such as Bhagwati (1994), Edwards (1998), Dollar and Kray (2001) as well as Berg and Krueger (2003) support this idea that trade liberalisation has succeeded in pushing growth and in reducing poverty in developing countries. They point out that trade liberalisation improves trade flow and income, which in turn encourages growth and reduces poverty.

However, the empirical evidence shows no guarantee that freer trade is always - beneficial for the poor. Goldberg and Pavcnik (2007) find that trade liberalisation has mixed effects on poverty for Latin American countries (Goldberg & Pavcnik, 2007). On the other hand, Bergh and Nilson (2010) argue that there is no significant effect of trade liberalisation on poverty. Moreover, Celik and Basdas (2010) conclude that trade liberalisation has different effects for different country groups. Even within a country, the results can be mixed. Topalova (2007) shows that tariff reduction contributes to poverty reduction in rural India but does not significantly affect urban areas. In addition, Topalova (2010) argues that exposure to liberalisation leads to a slower decline in poverty and lower consumption growth In India. Meanwhile, for the case of Brazil, Castilho et al. (2012) argue that trade liberalisation contributes to lower poverty in the rural area, but with smaller effects for urban areas.

There are three main pathways in which more trade affects poverty: through impacts on the prices of liberalised goods, through firms' profits, employment and wages and through the impact on government revenue (McCulloch et al., 2001). However, they argue that the impact of trade liberalisation on poverty is country-specific. Thus it is important to examine the pathways through which higher trade might affect poverty in particular countries and how to develop suitable responses to ensure that trade benefits the poor.

2.3 Data and measurements

2.3.1 Data

We define tariff reform as reductions in the national average nominal (unweighted) import tariffs of tradable goods over the period of 1980-2012. The national tariff data are sourced from several Indonesian Customs Tariff Books series[8] and the UNCTAD-TRAIN database.[9]

The impact of national tariff reforms might have different impacts across regions (Topalova, 2010). The regional analysis also has an advantage that it allows us to extend our analysis on the reform impact at household levels. Following Amiti and Konings (2007), Amiti and Cameron (2012) and Kis-Katos and Sparrow (2015), we construct regional tariff exposure measures by weighting national sectoral tariffs with the relative importance of a sector in a province. The sector importance in a province is calculated from sectoral labour shares or by sectoral manufacture output shares. We match the tariff data with information on provincial labour and market structure in the initial, pre-reform period, based on the 1976 Indonesian Census.[10] We thus examine the concordance between sectoral information in tariff data and the census; we are thus able to construct four different sectors in agriculture, three sectors in mining and nine sectors in manufacturing. Table 2.1 summarises the evolution of simple average MFN tariffs for 16 tradable sectors during the period 1977-2012.

We also generate input tariff measures by further weighting manufacture output tariffs by the relative importance of a sector as an input in the aggregate output. The regional sectoral input structure is generated from the 1976 input-output (IO) table. The pre-reform period base is chosen to avoid the shifting of sectoral structural in the measures over the period.

[8] Many of the books are only available in hard copies. We thus calculated the sectoral tariff by first manually inputting the tariff books' data to further analyse it with concordance of UNCTAD-TRAIN database.

[9] Downloaded through the WITS system of the World Bank.

[10] We use the 1% random sample data which is available in IPUMS database system (Minnesota Population Centre, 2013).

The outcome variables are primarily computed from the annual national socio-economic survey, *Susenas (Survey Sosial Ekonomi Nasional)*. Poverty rates are calculated using the Indonesian provincial poverty line set by Statistics Indonesia, while the Gini coefficients are calculated based on several rounds of household surveys. The income share of the top and bottom quintiles are calculated using monthly per capita expenditure from the *Susenas* data. Thus, we take per capita expenditure as a proxy for per capita income.[11]

We include some control variables from the Statistical Yearbook of Indonesia: real regional gross domestic product per capita (GRDP) as proxy for regional wealth; mining, agriculture and manufacturing value added of GRDP to control sectoral differences; average years of schooling and the infant mortality rate as proxies for education and health conditions, respectively. We also add real government spending relative to GRDP and government own share income relative to GRDP, both from the Ministry of Finance database, as proxies for governance. Furthermore, we construct political variables: political fractionalisation index and voter participation rate as additional controls. The political variables are computed based on elections data from Sudibyo (1995), Kristiadi et al. (1997) and Bhattacharya and Resosudarmo (2013). The political fractionalisation index measures the diversity of people's choices of different political parties. The value ranges from 0 to 1, with 1 being the most diversified choices. We follow the argument of Bhattacharya and Resosudarmo (2013) that low diversity reflects a lack of democracy.[12] On the other hand, the participation rate is measured merely by the number of people who vote relative to the number of eligible voters. We adopt the theory of turnout (Lijphart, 1997) and hypothesise that a higher participation rate is associated with greater economic and social equality.

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[11] We will henceforth use the term 'income' instead of 'expenditure'.

[12] Wang (2012) shows that higher level of party polarization in a country leads to better democracy in that country.

We do the analysis at the province level. Indonesia currently has 33 provinces, but for consistency, we grouped new provinces into their original 26 provinces. Furthermore, we combined Jakarta and West Java to avoid dealing with the regional spillover between the two provinces,[13] so we ended up with 25 provinces for the analysis. A descriptive summary of the changes in our main dependent and tariff variables over time is presented in Table 2.2, while descriptive statistics for all variables used and the province list as well as variable descriptions are presented in the Appendix to this chapter.

2.3.2 Measurement of provincial tariff exposure

To examine the effects of trade liberalisation on inequality and poverty, we first consider a measurement of provincial tariff exposure using average nominal tariffs weighted by the relative importance of a sector in a region, as suggested by Topalova (2007) and Edmonds et al. (2010).[14] We adopt the method by Kis-katos and Sparrow (2015) in constructing regional tariff exposures, by incorporating labour weighted and manufacturing weighted tariffs approach. The identification strategy of this paper exploits variation in the sectoral composition across provinces in Indonesia in the initial, pre-reform period.

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[13] West Java (e.g. Bogor, Tangerang and Bekasi) is considered a spill-over from Jakarta. The growth of Jakarta has been highly influencing urbanisation and growth in West Java (Jones & Mamas, 1996; Firman & Dharmapatni, 1995; Hill, 2008).

[14] This approach has been further modified and used by Kovak (2010), Kis-Katos & Sparrow (2011), McCaig (2011), Fukase (2013), Castilho et al. (2012), and Kis-Katos & Sparrow (2015).

Table 2.1. Evolution of the average most favoured nation tariff rates by sectors, selected years.

	1977	1980	1984	1987	1990	1993	1996	1999	2002	2005	2008	2012
Agriculture												
Plants and Animals	35.2	35.9	26.9	25.3	24.1	15.3	10.3	8.7	5.3	5.4	5.8	5.8
Forestry	26.1	24.3	14.1	11.7	11.4	11.2	5.8	5.4	4.6	4.6	4.5	4.2
Hunting	25.3	27.6	23.2	18.0	13.8	13.7	8.2	6.0	4.3	4.2	4.1	4.5
Fishery	29.7	26.3	18.2	16.4	15.7	15.6	9.6	8.7	5.3	5.2	5.1	5.2
Mining												
Coal mining	14.7	6.0	4.7	4.5	4.6	4.4	4.2	4.2	3.8	3.8	3.7	3.7
Metal ores mining	5.0	2.0	3.9	4.6	4.2	4.2	4.1	4.1	4.1	4.1	4.1	4.1
Other mining	19.2	11.9	7.8	7.0	6.9	6.4	5.0	4.6	3.8	3.8	3.7	3.9
Manufacturing												
Food, beverages & tobacco	43.0	40.3	25.1	22.3	20.9	20.0	16.2	15.2	9.2	9.2	9.2	13.0
Textiles, apparel, leather	40.6	42.6	33.9	32.5	27.3	20.4	14.0	12.1	7.3	7.4	7.9	7.5
Wood & product	34.4	31.5	29.1	26.8	23.5	21.5	14.1	14.6	8.1	8.1	8.1	6.3
Paper and products	29.8	25.7	18.5	16.8	16.4	16.0	8.7	7.7	4.9	4.9	4.8	3.9
Chemicals and products	30.2	25.7	23.9	24.5	23.5	15.6	14.0	13.4	10.3	10.4	10.2	13.4
Non-metallic-mineral products	49.3	41.2	22.8	20.2	18.9	18.2	10.0	8.8	6.1	6.1	7.2	7.1
Basic metals	19.4	13.7	11.1	10.2	9.9	10.2	7.3	7.1	5.5	5.7	5.3	5.4
Metal products	28.4	25.4	28.2	24.2	18.5	16.9	10.9	10.5	6.8	6.7	6.5	6.3
Other manufacturing	42.5	40.2	38.2	35.6	30.5	28.4	16.8	16.1	9.6	9.6	9.5	8.2

Note: Sectors are constructed based on a concordance table between tariff and census labour market data.

Source: Indonesia Customs Book and UNCTAD-TRAINS database.

Table 2.2. Descriptive statistics on changes in main outcomes and tariff variables over time.

Variables	Average change per period	Standard deviation of change per period	N
Dependent var.			
Gini coefficient (%)	0.201	2.682	875
Expenditure share of the top 20% (%)	-0.064	3.057	875
Expenditure share of the bottom 20% (%)	0.036	0.923	875
Poverty rate (%)	-0.379	2.681	875
Explanatory variables			
Labour-weighted tariffs (%)	-0.242	0.380	875
Manuf. Output-weighted tariffs (%)	-0.840	1.458	875
Manuf. Input-weighted tariffs (%)	-0.588	0.845	875

The relative importance of a sector in a province is measured by calculating the relative share of employment in sector s in province p ($L_{s,p}$) in the total labour force in province p (L_p) using the 1976 Census data. From this, we estimate the labour-weighted province-level exposure to the tariff (TL) at time t according to:

$$TL_{p.t} = \sum_{s=1}^{S}\left(\frac{L_{s,p}}{L_p} x\ T_{s,t}\right) \tag{2.1}$$

Where $T_{s,t}$ is the average national tariff in sector s at time t. The weight used is calculated over total labour, including workers in non-traded sectors. The use of an initial, pre-reform period for the employment weight is to control for the unobserved counterfactuals of what would have been the evolution of inequality and poverty across Indonesian provinces in the absence of tariff reform. According to Mc Caig (2011), the use of pre-reform time-invariant weights is common in many empirical micro literature, such as Bernard and Jensen (2004) and Lemieux (2002).

Following Kis-Katos and Sparrow (2015), we also construct manufacturing weighted output tariff and input tariff to identify potential separate effects. Output tariff is measured by weighing the national sectoral tariff by the initial relative share of each sector of industrial output in a province, $Q_{s,p}/Q_p$, which is calculated based on Industrial Statistic data from 1975.[15] Q_{sp} is the industrial output of sector s in province p, while Qp is the total industrial output in province p. We then define the manufacturing output tariff (TO) as:

$$TO_{p,t} = \sum_{s=1}^{S} \left(\frac{Q_{s,p}}{Q_p} x \, T_{s,t} \right) \tag{2.2}$$

The manufacturing input tariff (TI) is measured by further weighting the output tariff by input share of each sector computed from the 1975 national input-output table:

$$TI_{p,t} = \sum_{s=1}^{S} \left[\frac{Q_{s,p}}{Q_p} \; x \; \sum_{j=1}^{J} \left(\frac{M_{j,s}}{M_s} \; x \; T_{j,t} \right) \right] \tag{2.3}$$

The input-specific weight ($M_{j,s}/M_s$) is the initial share of input j over all inputs of any sector s in 1975 and $T_{j,t}$ is the corresponding national tariff of input j in year t. These measures are then further weighted by the output industry's initial relative regional importance, $Q_{s,p}/Q_p$.

The input weight used is based on total input purchases, including domestic and import inputs. If otherwise, only imported inputs are used, the estimation would suffer from endogeneity bias as argued by Amiti and Cameron (2012). Since the input-output table

[15] After taking the concordance between input and output data in 1975 into account, we managed to distinguish between 23 different industrial tradable outputs.

for 1975 is only available at the national level, we have to assume that the regional structure of inputs is similar to that at the national level. Figure 2.2 summarises the tariff trends by types over 36 years, while the change in exposure to tariffs is shown in Figure 2.3.[16]

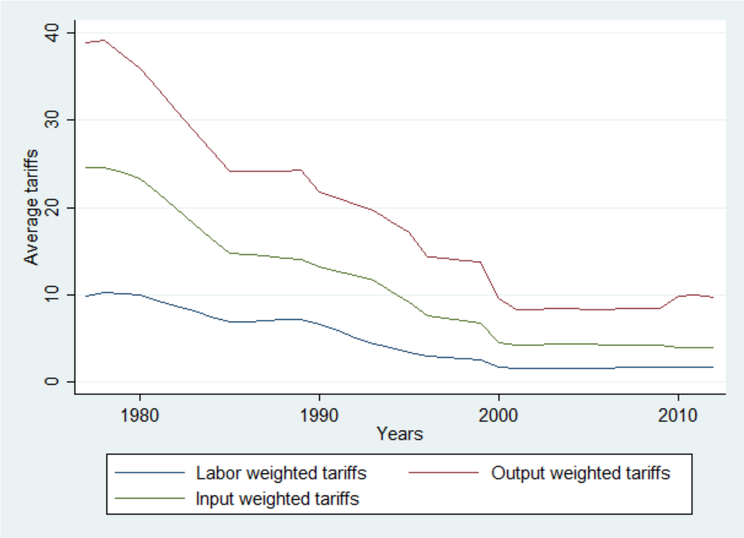

Figure 2.2. Average tariffs with different weights, 1977- 2012.

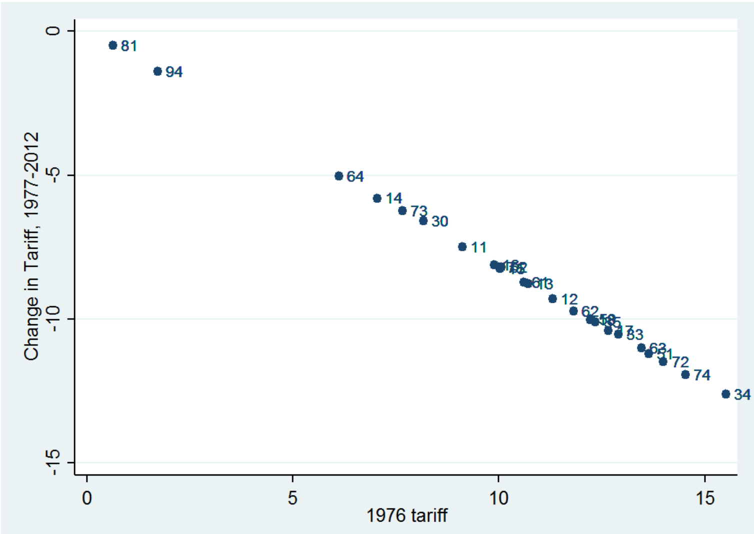

Figure 2.3. Change in exposure to tariffs, 1977-2012, relative to the initial levels.

[16] Figure 2.3. plots the average reductions in tariffs for all sectors over the period of 1977-2012. We can see a high correlation between the initial, 1977 tariff levels and reductions in tariffs. It shows that tariffs reductions happened across all sectors and that tariffs with higher initial levels experienced higher cuts. It also means that there is no sectoral choice in the size and timing of tariff reforms.

2.4 Methods

To examine the effect of regional exposure to tariff reductions on inequality and poverty, we first estimate the following model:

$$Y_{p,t} = \alpha + \beta Tariff_{p,t} + X'_{p,t}\, \gamma + \delta_p + \lambda_{r,t} + \varepsilon_{p,t} \tag{2.4}$$

where $Y_{p,t}$ are province-level dependent variables (Gini, the share of expenditure of the top 20%, the share expenditure of the least 20%, and poverty rate) in province p, year t. $TL_{p,t}$ is the province exposure to the labour-weighted tariff. $X_{p,t}$ is a set of the average time variant province characteristics (regional gross domestic product per capita, sectoral value added share, government spending, government own revenue generation share, average years of schooling and infant mortality rate). We also include interactive major island-year fixed effects, $\lambda_{r,t}$, to control for shocks over time that affects trade across all provinces but may vary across different major island groups within Indonesia.[17] The coefficient of interest, β, captures the average effect of trade reform on regional outcomes related to inequality and poverty. We estimate equation (2.4) as a balanced panel both for inequality and poverty estimations using ordinary least square (OLS) estimation with province fixed effects, $\delta_{p,}$ to control for unobserved province-level heterogeneity.

Fixed effects method is efficient when the unobserved effects are serially uncorrelated. However, when we expect the unobserved factors that change over time to be serially correlated, it is better to use the first difference method.[18] It is also the case when T is relatively large, and N is not very large. We then exercise a first difference approach by

[17] There are five main island dummies: Sumatera, Java, Kalimantan, Sulawesi and the other islands.
[18] Jeffrey M. Wooldridge (2009) argues that if unobserved factors are serially correlated first difference is more efficient than fixed effects. Moreover, first differencing has the benefit of swifting an integrated time series process into a weakly dependent process. We can also claim to the central limit theorem even in the case where T is larger than N.

rearranging Equation 2.4 which can be rewritten as a first difference specification as follows:

$$\Delta Y_{p,t} = \alpha + \beta \Delta TL_{p,t} + \Delta X'_{p,t}\,\gamma + I'_p\theta \; + \lambda_{r,t} + \Delta\varepsilon_{p,t} \qquad (2.5)$$

After differentiating manufacturing output tariffs (TO) and input tariffs (TI), we then estimate the following model:

$$\Delta Y_{p,t} = \alpha + \beta_1 \Delta TO_{p,t} + \beta_2 \Delta TI_{p,t} + \Delta X'_{p,t}\,\gamma + I'_p\theta \; + \lambda_{r,t} + \Delta\varepsilon_{p,t} \qquad (2.6)$$

Likewise the fixed effect method, first difference specification removes province fixed effects and eliminates the unobserved heterogeneity that might be instigated by the initial province sectoral structure in employment and industry output. Furthermore, it eliminates potential bias due to endogenous national tariffs by controlling for country variation over time and by limiting variation only at the province level.

However, if any unobserved time variant confounders exist, the first difference approach can still be biased. The potential cofounders may include structural change, economic performance and any policies related to initial province sectoral structure and urban-rural differences. To deal with this problem, we incorporate a vector of initial conditions, $I_{p,,}$ which includes the 1976 sectoral labour shares (aggregated to one-digit sectors), 1976 rural population shares and, in some specifications, the initial level of the respective dependent variable.

Next, we conduct a placebo test by regressing changes in independent variables on future changes in tariff measures,[19] with the null of no confounding patterns rejected if the future tariff coefficient is not statistically significant. This is to test whether the tariff measures

[19] That is, we first regress y_{pt} on $\Delta Tariff_{pt+1}$ and re-run with $\Delta Tariff_{pt+2}$ for further checking.

are endogenous to inequality or poverty measurements, or if they seize differential trends in inequality or poverty between provinces. We would also expect inequality and poverty to be correlated with future changes in province tariff exposures.

Since our data cover the period of the financial crisis in 1997- 1998, there may be concern that our results are affected by the crisis. One way to deal with this potential relationship is to re-estimate equation 2.2 using pre-crisis data, thus ruling out the crisis effects. However, this could lead to a decrease in sample size, so we decided to use the full sample and interact the tariff measures with a dummy to represent the crisis – it is one for the years 1997 and 1998 and zero otherwise.

Lastly, we experiment with alternative, longer difference periods. We re-examine equations (2.5) and (2.6) using three-year differences[20] and compare the results with the one-year difference described earlier. Lastly, to further exploit the longer time series, we also include period dummies based on combinations of economic episodes[21] and the tariff data. We find concordance with episodes developed by Basri and Hill (2004) and by grouping average tariff rates based on quintile ranking.[22] The episodes are the periods of 1977-84, 1984-90, 1990- 96, the crisis period of 1997- 1998, 1999- 2002 and the period after 2002.[23] We incorporate the episodes dummy as a tariff-episode interaction variable for all tariff measurements and episodes combinations into equation (2.5) and (2.6) for each dependent variable of interest

[20] Starting from 1980, that is: 1980, 1983, 1986, 1989, 1992, 1995, 1998, 2001, 2004, 2007, and 2010.

[21] This is based on the trade episodes used in Hill (1997), Hill (2000), Basri (2001), Basri and Hill (2004) and Miranti (2010).

[22] The quintiles groups of tariff rank: 1977-1983 (average tariff of 9.5%), 1984-1990 (average tariff of 7.1%), 1991-1998 (average tariff of 3.9%), 1999-2000 (average tariff of 1.8%), and 2001-2012 (average tariff of 1.5%)

[23] These are denoted in the regressions as eps1, eps2, eps3, crisis, eps4 and eps5, respectively.

2.5 Results and discussions

2.5.1 General results

The estimation results of equation (2.4) using OLS with province fixed effects are presented in Tables 2-A1 to 2-A4 in the Appendix to this chapter. First, we relate tariff reductions to inequality measures. Table 2-A1 shows the results for Gini coefficients and Tables 2-A2 and 2-A3 show those for the expenditure shares of the wealthiest 20% and of the poorest 20%, respectively. For the Gini estimation, only the manufacturing output-weighted tariff shows a positive and significant relationship with the Gini coefficients. The positive signs indicate that output tariff reduction is associated with lower inequality. Meanwhile, Tables 2-A2 and 2-A3 show that almost all types of tariff measures turn out to be significant. A reduction in any measurement of tariffs is correlated with a decrease in the expenditure share of the upper groups and an increase in the expenditure share of the lowest groups.

Second, we relate tariff reductions to poverty rate. The results are presented in Table 2-A4. All tariff coefficients are positive and statistically significant. Provinces with higher exposure to tariff reductions experienced a greater reduction in their poverty rates. In general, tariff cuts are associated with larger reductions in poverty rates.

So far, all basic estimations include island-year interaction and province fixed effects. The interactive island-year fixed effects may control for shocks over time that affects inequality and poverty across all provinces but may vary for different Indonesian islands, while the province fixed effects analysis control for time-invariant unobserved attributes.

Then, we estimate the first difference method (FD) as in equation (2.5) and (2.6). Taking first difference and removing provincial fixed effects, we remove any potential bias due to unobserved heterogeneity that might be caused by the initial structure of province sectoral employment and industry output. Tables 2-A5 to 2-A8 in the appendix to this chapter show that the results of running FD equations are roughly similar to the basic methods in terms of signs but more significant. In general, tariffs positively affect Gini coefficients. This relationship is robust to the inclusion of year-island dummies and time variant controls and remains so as the initial conditions (population size and labour force structure) are controlled for.

Furthermore, the effects of labour- and manufacturing input-weighted tariffs are higher compared to those of the manufacturing output-weighted tariffs. Meanwhile, in all relative inequality measurements, manufacturing output-weighted and input-weighted tariffs have no significant effect on inequality, except in the case of the input-weighted tariffs on the least income share. Lower input tariffs are associated with higher shares of the poor's per capita income. This association remains after controlling for year-island fixed effects and time variant controls. However, when the initial conditions are controlled for, the coefficient reduces and loses its significance.

For the poverty estimation, the results in Table 2-A8 show that almost all tariff coefficients show positive relations and are statistically significant. Thus, a reduction in the tariff under any measurement is associated with a lower poverty rate. The coefficients for labour-weighted tariffs are the highest, followed by manufacturing input-weighted tariffs. However, when combined, these two measures lose their significance after controlling for initial conditions.

2.5.2 Main results and discussions

We review all the results of the first difference method (FD) as in equation (2.5) and (2.6) in Table 2.3. In the first panel, the results show that labour-weighted tariffs positively affect Gini coefficients. This relationship is robust to the inclusion of year-island dummies and time variant controls and remains so as the initial conditions (population size and labour force structure) are controlled for. However, when output and input tariffs are combined in one regression, only input tariffs show significant effects on Gini coefficients.

We refer to column 7 as our preferred specification for interpreting our results. The resulting equation shows that every percentage decrease in manufacturing input tariff is associated with a 0.22 percentage reduction in the Gini number. The second and third panels in Table 2.3 show the results for the share of top and bottom 20% income groups. In general, a decrease in a labour-weighted tariff is good for relative equality, since it reduces the income share of the richest 20% and raises the income share of the bottom 20% group. This association remains after controlling for year-island fixed effects and time variant controls. However, when the initial conditions are controlled for, the coefficient reduces and loses its significance. Nevertheless, the main message remains that tariff reductions contribute to reductions in inequality. The results are consistent with the Stolper-Samuelson theory of declining skill premium. Top income and lower income groups are associated with skilled and unskilled labour, respectively. A lower skill premium reduces the income of the top group and increases the income of the poor, thus, in turn, decreasing inequality.

Our findings are also consistent with those of Amiti and Cameron (2012) who find that reducing input tariffs reduces the wage skill premium for intermediate-importing firms and improves equality. They argue that the decrease in skill premium comes from lower relative demand for non-production labour in importing firms relative to non-importers. Our study finds that tariff reform significantly associates with lower Gini coefficients, but there is no evidence that tariff cuts lead to more equal income shares between the richest and the poorest. This may indicate that the decrease in Gini coefficients (as a result of manufacturing tariff reform) mainly comes from the narrowing gap in the middle quintiles.

The last panel in Table 2.3 presents the effects of tariff reductions on poverty rates. Overall, there is a positive correlation between poverty rates and the three tariff exposure measures. This implies that a reduction in any type of import tariff is associated with a decrease in poverty. For labour-weighted and output manufacturing weighted tariffs, the relationship is robust to the inclusion of year-island dummies, time variant controls, and initial conditions. However, the input tariffs lose their significance after controlling for initial conditions. Furthermore, the coefficients for output tariffs for poverty estimations are higher in magnitude and statistical significance than the input tariffs.

A one percentage decrease in manufacturing output tariff is associated with a 0.23 percent reduction in the poverty rate. The positive correlation between the poverty rate and tariff exposure is in general consistent with the previous study by Kis-Katos and Sparrow (2015). However, looking into different effects of manufacturing output and input tariff exposure cuts, our results differ from theirs. We found that labour-weighted tariffs impinge more on inequality and poverty reductions compared to manufacturing weighted ones. This result indicates that a wider impact of tariff reform in the regional economy might be operating through labour channels, as suggested by Kis-Katos and Sparrow (2015).

Table 2.3. First difference (FD) results of inequality and poverty effects of tariff liberalization, labour and manufacturing weighted tariffs.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: Gini							
Labour-weighted tariff	0.859*	0.831*	0.868**	0.871**				
	(0.446)	(0.438)	(0.414)	(0.416)				
Manufacturing output tariff					0.055	0.079	0.095	0.096
					(0.091)	(0.090)	(0.098)	(0.099)
Manufacturing input tariff					-0.043	0.005	0.220*	0.217*
					(0.104)	(0.100)	(0.126)	(0.127)
	Dependent variable: Top20							
Labour-weighted tariff	0.858*	0.819*	0.708	0.642				
	(0.470)	(0.480)	(0.562)	(0.550)				
Manufacturing output tariff					0.006	0.017	-0.006	0.003
					(0.106)	(0.102)	(0.104)	(0.100)
Manufacturing input tariff					0.114	0.175	0.194	0.115
					(0.190)	(0.197)	(0.181)	(0.167)
	Dependent variable: Least20							
Labour-weighted tariff	-0.207**	-0.179**	-0.165	-0.169				
	(0.084)	(0.084)	(0.115)	(0.116)				
Manufacturing output tariff					-0.010	-0.012	-0.008	-0.004
					(0.028)	(0.028)	(0.028)	(0.024)
Manufacturing input tariff					-0.033	-0.037	-0.056	-0.052
					(0.043)	(0.040)	(0.043)	(0.041)
	Dependent variable: Povrate							
Labour-weighted tariff	1.019*	1.094**	1.242**	1.247**				
	(0.545)	(0.519)	(0.576)	(0.578)				
Manufacturing output tariff					0.215**	0.220**	0.229***	0.227***
					(0.096)	(0.088)	(0.089)	(0.088)
Manufacturing input tariff					0.308*	0.296*	0.231	0.238

					(0.170)	(0.162)	(0.183)	(0.180)
Year-island dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-variant controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Initial labour force and rural population shares	No	No	Yes	Yes	No	No	Yes	Yes
Dependent variable 1976	No	No	No	Yes	No	No	No	Yes
Observations	875	875	875	875	875	875	875	875

Notes: The table reports separate weighted tariff measures, generated by first difference (FD) estimates of each dependent coefficient on tariffs and further controls. Time-variant controls include expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

Despite the robustness of our findings, this study poses several caveats. First, data limitation does not allow the analysis to be disaggregated into urban and rural areas, which otherwise could exhibit different responses to tariff reform. Castilho et al. (2012) show that urban areas that are more exposed to tariff liberalisation experienced smaller reductions in household inequality and poverty. In the context of Indonesia, urban and rural areas also have interesting uniqueness, which can add to better understanding of trade and welfare in the region.[24]

Second, we cannot investigate the potentially different effects of different sector liberalisation, again due to data constraints. Third, the results discussed above may be biased due to the exclusion of potential reallocation of labour across provinces. If there is free mobility of labour across geographic units as workers relocate across industries, labour can migrate between provinces and affect the inter-regional labour market dynamic. However, if mobility is limited, the response could be different in outcomes such as wages, which may be the reason for differential inequality and poverty responses across provinces.

Lastly, we could not include the impact of migration in this analysis due to the lack of migration data for the whole period of our analysis. Nevertheless, previous studies help to explain the migration effects of trade liberalisation. Kis-Katos and Sparrow (2015) find that internal migration flows towards regions with relatively high exposure to trade liberalisation. Their study also reveals that immigration, not emigration, is related to districts' exposure to tariff reduction and that migration mainly happens among lower-skilled workers. These results might alter our main results since migration can be correlated with trade reform as well as inequality and poverty. Thus, besides examining

[24] A summary of Indonesian regional economics can be seen, for example, in Hill (1989).

the potential main channels, further research should be carried out to investigate whether migration is a further channel of trade liberalisation on inequality and poverty.[25]

2.6 Sensitivity Analysis

2.6.1 Robustness to any confounding trends

We conduct a placebo test by regressing changes in independent variables on future changes in tariff measures,[26] with the null of no confounding patterns rejected if the future tariff coefficient is not statistically significant. Table 2.4 presents the main results of the changes in each dependent variable as regressed on the future changes in tariff measures.

Table 2.4. Placebo test on inequality measurements regressed on future tariff changes

	Gini	Top20	Least20	Poverty rate
	(1)	(2)	(3)	(4)
Labour-weighted tariff	0.221	0.451	-0.163	0.406
s.e.	(0.547)	(0.698)	(0.151)	(0.492)
Manufacturing Output Tariff	-0.037	0.417	-0.063	-0.045
s.e.	(0.087)	(0.287)	(0.081)	(0.119)
Manufacturing Input Tariff	0.026	0.411	-0.060	0.180
s.e.	(0.107)	(0.284)	(0.081)	(0.233)
Year-island dummies	Yes	Yes	Yes	Yes
Time-variant controls	Yes	Yes	Yes	Yes
Observations	825	825	825	825

Notes: Each block of the table reports separate tariff coefficients, generated by first difference estimates of the change of different dependent variables (Gini, share of top 20%, share of bottom 20% and poverty rates) on future tariffs and further controls. Time-variant controls include the first difference of expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

[25] For instance, Kovak (2010) finds that wages will fall in the regions that have industry with largest tariff cuts and therefore induce workers to migrate away from these geographical units in favour of other areas facing smaller tariff reform.

[26] That is, we first regress y_{pt} on $\Delta Tariff_{pt+1}$ and re-run with $\Delta Tariff_{pt+2}$ for further checking.

The results show that future tariffs are not related to current changes in inequality and poverty measures. Therefore, the placebo test in general shows that labour-weighted tariffs are exogenous, suggesting that positive contributions of tariff reform on equality and poverty reduction not be driven by omitted variables, or differential growth trajectories of regional economies, irrespective of the specifications.[27]

2.6.2 Financial crisis

The financial crisis that hit Indonesia in mid-1997 may affect the estimation results, given the high inflation and large currency depreciation as well as the socio-political problems that followed (Resosudarmo and Kuncoro, 2006). One way to exclude the crisis effect is to re-estimate the models using pre-crisis period figures. This would rule out the total confounding effects of the Indonesian and Southeast Asian crisis altogether. But this could lead to a decrease in sample size, so we decided to use the full sample and multiply the tariff measures with crisis dummies.[28] The main results are seen in Table 2.5.

Table 2.5 shows that the main results are robust, i.e., the size and significance of the coefficients remains relatively unchanged. For inequality regressions, the inclusion of crisis dummies for the labour-weighted tariff exposure specification show no significant impact. Meanwhile, the manufacturing tariff exposures show the significance of the crisis effect. Reduction in manufacturing output tariff exposure is associated with a higher Gini and higher income share for the top quintile group, as well as a lower income share for the poorest quintile group. Therefore, the findings suggest that in a time of crisis, manufacturing output tariff exposure reductions result in increasing inequality. On the

[27] We also conduct placebo tests for a two-period specification. For example, we regress the 1980- 1981 dependent variables' changes on the 1982- 1983 changes in tariff exposure. These tests provide similar results.

[28] It has the value of one for the years 1997 and 1998 and zero otherwise.

other hand, no significant effects could be observed from the reduction in manufacturing input tariff exposure on inequality in a crisis period, except for the income share of the richest quintile, which is significantly reduced.

Regarding poverty regression, this paper notes that the interaction term on manufacturing input tariff exposure is insignificant but that there is an additional effect from manufacturing output tariff exposure. Poverty decreased more during the crisis as a result of manufacturing output tariff exposure reduction.

2.6.3 Robustness to alternative specifications

So far, all the estimations have been on one period difference with the province and island-year fixed effects. Next, this paper also experiments with alternative econometric specifications. We re-examine equations (2.5) and (2.6) using three-year differences[29] and compare the results with the one-year difference described earlier. The main results are presented in Table 2.6 which shows the preferred specification as columns 3 and 7 in Table 2.3. In general, all tariff coefficients in Table 2.6 are similar to the main results in Table 2.3. Thus, our main results are relatively robust to alternative period specification.

[29] Starting from 1980, that is: 1980, 1983, 1986, 1989, 1992, 1995, 1998, 2001, 2004, 2007, and 2010.

Table 2.5. Inequality and poverty effects with crisis dummies.

	Gini		Top20		Least20		Poverty rate	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Labour-weighted tariff (LT)	0.830*		0.819*		-0.178**		1.093**	
	(0.439)		(0.480)		(0.084)		(0.512)	
Manuf. output tariff (OT)		0.124		0.096		-0.017		0.203**
		(0.100)		(0.106)		(0.030)		(0.084)
Manuf. input tariff (IT)		0.181		0.074		-0.045		0.249
		(0.129)		(0.196)		(0.043)		(0.174)
LT x crisis dummy	0.086		0.160		-0.099		0.785**	
	(0.294)		(0.419)		(0.092)		(0.315)	
OT x crisis dummy		-0.299**		-0.365***		0.114**		0.310*
		(0.151)		(0.140)		(0.057)		(0.164)
IT x crisis dummy		0.361		0.508*		-0.133		-0.153
		(0.233)		(0.271)		(0.094)		(0.156)
Year-island dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-variant controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	875	875	475	475	475	475	475	475
R-squared	0.348	0.339	0.233	0.235	0.293	0.297	0.394	0.406

Notes: Each block of the table reports separate weighted tariff coefficients, generated by first difference estimates of the different dependent variables (Gini, share of top 20%, share of bottom 20% and poverty rates) on tariffs and further controls. Time-variant controls include the first difference of expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

Table 2.6. Robustness check with respect to different specifications.

	$Gini_t$-$Gini_{t-3}$		$Top20_t$-$Top20_{t-3}$		$Least20_t$-$Least20_{t-3}$		$Poverty_t$-$Poverty_{t-3}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Labour-weighted tariff	1.644***		1.052		-0.232		1.029***	
s.e.	(0.519)		(0.753)		(0.144)		(0.314)	
Manufacturing Output Tariff		0.367*		0.299*		-0.086		0.130
s.e.		(0.203)		(0.175)		(0.066)		(0.272)
Manufacturing Input Tariff		0.033		0.201		-0.044		-0.043
s.e.		(0.257)		(0.264)		(0.073)		(0.261)
Year-island dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-variant controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Initial labour force and rural population shares	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	275	275	275	275	275	275	275	275

Note: Each block of the table reports separate weighted tariff coefficients, generated by first difference estimates of the change of the different dependent variables (Gini, share of top 20%, share of bottom 20% and poverty rates) on tariffs and further controls. Time-variant controls include the first difference of expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

2.6.4 Trade episodes

To examine the effects of different trade policy episodes on inequality and poverty, we incorporate interaction variables between trade policy episode dummies[30] and tariffs into our main equations. The periods are based on a combination of economic episodes[31] and tariff data. Table 2.7 summarises the main results of including trade policy episode dummies interaction in the regressions.

For the labour weighted tariff regression, we found that tariff reductions in episode 5 are associated with lower Gini coefficients and lower poverty rates. However, looking into different episodes, we saw different magnitudes. The effects of tariff reductions are smaller in all other episodes, except for episode 1 which shows no significant difference with episode 5. In episode 4 and in the time of crisis, the signs are even reversed. Tariff reductions in these episodes are associated with higher Gini Coefficients. For poverty regression, only episode 1 and crisis show significant differences from episode 5. In both episode 1 and crisis, the magnitudes are higher than in episode 5. Lower reductions of tariffs are associated with more poverty reduction in episode 1 and the episode of crisis, compared to episode 5.

Differentiating the input and output manufacturing tariffs, we found that for output tariff, the effects are only significant in episode 2, 3 and crisis. The three results show negative coefficients, which means that in these episodes, tariff reductions are associated with higher Gini coefficients. While for the poverty regression, the base episode has a significant positive impact of tariff reduction on poverty. Tariff cuts are associated with

[30] The episode dummies are: eps1 for year <=1984, eps2 for year= 1984- 1990, eps3 for year 1990- 1996, the crisis (1997- 1998), eps4 for year 1999- 2001 and eps5 for year 2002 and after.

[31] This is based on the trade episodes used in Hill (1997), Hill (2000), Basri (2001), Basri and Hill (2004) and Miranti (2010).

the lower poverty rate in episode 5. The effects are significantly higher in the episode of crisis where tariff cuts are associated with more poverty reduction in the crisis episode compared to episode 5 while other episodes have no significant differences with the base episode. For input tariffs, the impacts of tariff cuts are only significant in episode 4, where tariff cuts are associated with higher values of Gini. On the other hand, tariff reduction in episode 5 shows significant positive correlation with poverty rates. Input tariff reductions are associated with lower poverty rates in all episodes, with significant smaller effects in the episode of crisis.

In general, the results are consistent with the main findings and the crisis episode sensitivity analysis. Labour weighted tariff reductions are associated with lower Gini coefficients in all episodes, except in the time of crisis. While for poverty, labour tariff cuts are associated with lower poverty rates, with higher magnitudes in episode 1 and crisis episode.

Likewise, reduction on output and input tariffs are associated with lower poverty rates, with no differences impacts in different episodes, except for Crisis. Reduction of Output tariffs is associated with more reduction in poverty rates in the crisis episode, compared with episode 5 and other episodes. On the other hand, reductions of input tariffs are associated with a lower decrease in poverty rates in the time of crisis compared to episode 5 and other episodes. Meanwhile, for the Gini coefficient, no significant impacts are found for both output and input tariffs reductions in the base episode.

Overall, the trade policy episodes analysis shows that the positive impact of tariff reductions on inequality is higher in episode 5 compare to other episodes. While for poverty rates, the positive effects of tariff cuts are higher in the episodes of crisis, except for the case of input tariff reductions.

Table 2.7. Regression of tariff on inequality and poverty measures with episode dummies.

	Δ Gini		Δ Top20		Δ least20		Δ Poverty rate	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Labour-weighted tariff (LT)	0.531**		-0.510		2.122		2.141*	
	(0.269)		(0.536)		(1.295)		(1.294)	
LT*Eps1	-0.071		-0.210		0.184**		0.184**	
	(0.044)		(0.128)		(0.083)		(0.081)	
LT*Eps2	-0.116*		-0.222***		-0.007		-0.009	
	(0.061)		(0.050)		(0.065)		(0.066)	
LT*Eps3	-0.121*		-0.428***		0.288		0.287	
	(0.066)		(0.071)		(0.216)		(0.214)	
LT*Eps4	-0.590***		-0.717		0.459		0.442	
	(0.174)		(0.493)		(0.292)		(0.296)	
LT*Crisis	-0.605***		-0.659***		2.113***		2.094***	
	(0.213)		(0.138)		(0.677)		(0.669)	
Manuf. Output tariff (OT)		0.084		-0.012		-0.006		0.282**
		(0.105)		(0.083)		(0.027)		(0.121)
Manuf. Input tariff (IT)		0.007		-0.326		0.066		0.424*
		(0.147)		(0.220)		(0.070)		(0.231)
OT*Eps1		-0.024		-0.009		0.005		0.075
		(0.023)		(0.050)		(0.013)		(0.051)
OT*Eps2		-0.061*		0.041		-0.011		0.065
		(0.035)		(0.073)		(0.021)		(0.080)
OT*Eps3		-0.064*		-0.144***		0.019*		0.050
		(0.039)		(0.048)		(0.011)		(0.030)
OT*Eps4		0.046		0.130		-0.070		0.108
		(0.109)		(0.290)		(0.084)		(0.244)
OT*Crisis		-0.238***		-0.199***		0.042**		0.988***
		(0.072)		(0.075)		(0.021)		(0.193)
IT*Eps1		0.005		-0.083		0.012		0.013
		(0.028)		(0.057)		(0.017)		(0.067)
IT*Eps2		-0.003		-0.175**		0.028		0.009
		(0.049)		(0.074)		(0.020)		(0.108)
IT*Eps3		0.018		0.051		-0.009		0.020
		(0.054)		(0.063)		(0.012)		(0.033)
IT*Eps4		-0.404*		-0.457		0.122		0.027
		(0.241)		(0.539)		(0.172)		(0.346)
IT*Crisis		0.193		0.146		-0.035		-0.671**
		(0.135)		(0.127)		(0.024)		(0.302)
Year-island dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Time-variant controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Initial labour force and rural population shares	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	875	875	875	875	875	875	875	875

Notes: Each column of the table reports separate tariff coefficients, generated by first difference estimates of the reported dependent variables on tariff measurements and further controls. Controls include regional per capita income, sectoral value added, average years of schooling, infant mortality rate, government expenditure, government own revenue share, political diversion index, and election participation rate. Standard errors, robust to heteroskedasticity and clustered at the province level in both panels, are reported in parentheses. ***, **, * mark statistical significance at the 1, 5 and 10% level.

2.6.5 Endogeneity

One may argue that a province with a high poverty rate can lobby for industry relocation or creation that is expected to benefit growth in that province. In such a case, regional exposure is endogenous to inequality and poverty.

However, if the political economy power is relatively persistent and does not change over time, it would be eliminated by the first difference approach. The falsification test described above has also shown that future tariff changes are not related to the current inequality and poverty rate.

Furthermore, any political lobbying could only happen at the national or industrial level which is again already taken out within our regional estimations. In addition, Mobarak and Purbasari (2006) argue that any political lobbying for trade protection is difficult in the case of a developing country like Indonesia in the 1990es where trade reform is closely overseen by international organisations.[32]

Another argument that might arise is that there could be any political motivations of sectoral choice of early tariff reductions in the 1980es. However, As explained earlier, tariff evolution graph shows that there is a high correlation between initial tariff levels and tariff reductions, which shows that tariff reductions occurred across sectors and that higher original tariff industries experienced higher cuts. This shows that highly protected sectors were not favored by any means to avoid or delay tariff reductions.

2.7 Conclusions

This study tries to examine the effects of reducing tariffs on regional poverty and inequality in Indonesia from 1977 to 2012. During this period, Indonesia reformed its trade policy by reducing import tariffs across all tradable sectors. Average import tariffs decreased from around 29.6% in 1977 to approximately 6.4% in 2012. At the same time, Indonesia also experienced increasing inequality and a reduction in poverty.

This study combines tariff data with provincial household and industrial data, which covers 26 provinces over 36 years, to investigate the effects of changes in tariff on inequality and poverty using different types of tariff measurement. The results show that tariff reforms, i.e., a reduction in tariff exposure, partially contributed to lower income inequality in Indonesia, as well as contributing to poverty reduction. The results are robust to alternative tariff measures and different model specifications as well as to controlling

[32] They empirically proved that there is no relationship between a political economy connection variable and tariffs.

for initial conditions. Furthermore, placebo tests confirm that the findings were not altered by confounding trends, which supports our identification strategy.

Despite the generally robust results, our study lacks empirical evidence of the mechanism in which tariff reduction reduces inequality and poverty. Furthermore, we have not been able to control for migration due to data limitations. It is important to see how differences in types of migration and types of migrant responses to trade liberalisation affect people's welfare. This is an area for future research.

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Appendix 2

Appendix 2-A. Tables of Results

Table 2-A1. Basic Results for Gini coefficients.

	Dependent variable: $Gini_{it}$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
tariff_pt	0.038	0.032						
	(0.110)	(0.114)						
outputTpt			0.090*	0.102**			0.089*	0.106**
			(0.050)	(0.050)			(0.051)	(0.051)
inputTpt					0.052	0.055	0.002	-0.008
					(0.042)	(0.045)	(0.039)	(0.043)
Island x year effects	yes	yes	yes	yes	yes	yes	yes	yes
Province fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Political variables	no	yes	no	yes	no	yes	no	yes
Observations	900	900	900	900	900	900	900	900
R-squared	0.723	0.725	0.726	0.729	0.724	0.726	0.726	0.729

Notes: The table reports separate weighted tariff coefficients, generated by ordinary least square (OLS) estimates of Gini coefficients on tariffs and further controls. Time-variant controls include expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

Table 2-A2. Basic Results for the Shares of the Top Quintile.

	Dependent variable: $Top20_{it}$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
tariff_pt	0.559***	0.573***						
	(0.187)	(0.192)						
outputTpt			0.258***	0.275***			0.123	0.126
			(0.083)	(0.085)			(0.092)	(0.097)
inputTpt					0.327***	0.364***	0.259***	0.289***
					(0.074)	(0.076)	(0.083)	(0.088)
Island x year effects	yes	yes	yes	yes	yes	yes	yes	yes
Province fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Political variables	no	yes	no	yes	no	yes	no	yes
Observations	900	900	900	900	900	900	900	900
R-squared	0.603	0.604	0.608	0.609	0.614	0.616	0.616	0.618

Notes: The table reports separate weighted tariff coefficients, generated by ordinary least square (OLS) estimates of the share of the top quintile on tariffs and further controls. Time-variant controls include expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

Table 2-A3. - Basic Results for the Share of the Bottom Quintile

	Dependent variable: $Least20_{it}$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
tariff_pt	-0.137***	-0.154***						
	(0.043)	(0.044)						
outputTpt			-0.054***	-0.063***			-0.026	-0.026
			(0.020)	(0.019)			(0.024)	(0.024)
inputTpt					-0.068***	-0.086***	-0.053**	-0.070***
					(0.018)	(0.018)	(0.022)	(0.023)
Island x year effects	yes	yes	yes	yes	yes	yes	yes	yes
Province fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Political variables	no	yes	no	yes	no	yes	no	yes
Observations	900	900	900	900	900	900	900	900
R-squared	0.662	0.668	0.663	0.669	0.666	0.675	0.667	0.676

Notes: The table reports separate weighted tariff coefficients, generated by ordinary least square (OLS) estimates of the share of the least quintile on tariffs and further controls. Time-variant controls include expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

Table 2-A4. - Basic Results for Poverty Rate

	Dependent variable: $Povrate_{it}$							
	(1)	(2)	(3)	(4)	5)	(6)	(7)	(8)
tariff_pt	0.821***	0.895***						
	(0.248)	(0.225)						
outputTpt			-0.02	0.087			-0.139	-0.039
			(0.1)	(0.09)			(0.099)	(0.091)
inputTpt					0.152*	0.220***	0.229***	0.243***
					(0.091)	(0.085)	(0.086)	(0.087)
Island x year effects	yes	yes	yes	yes	yes	yes	yes	yes
Province fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Political variables	no	yes	no	yes	no	yes	no	yes
Observations	900	900	900	900	900	900	900	900
R-squared	0.714	0.749	0.705	0.74	0.707	0.743	0.708	0.743

Notes: The table reports separate weighted tariff coefficients, generated by ordinary least square (OLS) estimates of poverty rate on tariffs and further controls. Time-variant controls include expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level

Table 2-A5. First Difference Estimates for Gini Coefficient

	Gini															
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Labour-weighted tariff	0.859*	0.831*	0.868**	0.871**												
s.e.	(0.446)	(0.438)	(0.414)	(0.416)												
Manufacturing Output Tariff					0.035	0.081	0.178**	0.177**					0.055	0.079	0.095	0.096
s.e.					(0.070)	(0.073)	(0.087)	(0.087)					(0.091)	(0.090)	(0.098)	(0.099)
Manufacturing Input Tariff									0.533***	0.527***	0.454***	0.460***	-0.043	0.005	0.220*	0.217*
s.e.									(0.114)	(0.108)	(0.147)	(0.145)	(0.104)	(0.100)	(0.126)	(0.127)
N	875	875	875	875	875	875	875	875	875	875	875	875	875	875	875	875
R^2	0.342	0.348	0.364	0.364	0.324	0.337	0.353	0.353	0.367	0.400	0.402	0.403	0.324	0.337	0.354	0.354
Year-island dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-variant controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Initial labour force and rural population shares	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Dependent variable 1976	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes

Note: Each block of the table reports separate weighted tariff coefficients, generated by first difference estimates of the change of Gini coefficients on tariffs and further controls. Time-variant controls include the first difference of expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

Table 2-A6. First Difference Estimates for Top Income Shares

	Top20															
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Labour-weighted tariff	0.858*	0.819*	0.708	0.642												
s.e.	(0.470)	(0.480)	(0.562)	(0.550)												
Manufacturing Output Tariff					0.060	0.098	0.067	0.046					0.006	0.017	-0.006	0.003
s.e.					(0.113)	(0.116)	(0.121)	(0.116)					(0.106)	(0.102)	(0.104)	(0.100)
Manufacturing Input Tariff									0.120	0.193	0.188	0.118	0.114	0.175	0.194	0.115
s.e.									(0.180)	(0.190)	(0.195)	(0.187)	(0.190)	(0.197)	(0.181)	(0.167)
N	875	875	875	875	875	875	875	875	875	875	875	875	875	875	875	875
R^2	0.227	0.233	0.257	0.267	0.229	0.236	0.248	0.262	0.229	0.237	0.249	0.262	0.229	0.237	0.249	0.262
Year-island dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-variant controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Initial labour force and rural population shares	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Dependent variable 1976	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes

Note: Each block of the table reports separate weighted tariff coefficients, generated by first difference estimates of the change of top quintile shares on tariffs and further controls. Time-variant controls include the first difference of expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

Table 2-A7. First Difference Estimates for Least Income Shares

	Least20															
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Labour-weighted tariff	-0.207**	-0.179**	-0.165	-0.169												
s.e.	(0.084)	(0.08)	(0.115)	(0.116)												
Manufacturing Output Tariff					-0.026*	-0.029	-0.029	-0.024					-0.010	-0.012	-0.008	-0.004
s.e.					(0.016)	(0.020)	(0.023)	(0.021)					(0.028)	(0.028)	(0.028)	(0.024)
Manufacturing Input Tariff									-0.044*	-0.050*	-0.064*	-0.056	-0.033	-0.037	-0.056	-0.052
s.e.									(0.024)	(0.026)	(0.034)	(0.034)	(0.043)	(0.040)	(0.043)	(0.041)
N	875	875	875	875	875	875	875	875	875	875	875	875	875	875	875	875
R^2	0.280	0.292	0.309	0.316	0.274	0.287	0.296	0.305	0.275	0.287	0.296	0.306	0.275	0.287	0.297	0.306
Year-island dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-variant controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Initial labour force and rural population shares	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Dependent variable 1976	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes

Note: Each block of the table reports separate weighted tariff coefficients, generated by first difference estimates of the change of the bottom quintile shares of expenditure on tariffs and further controls. Time-variant controls include the first difference of expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

Table 2-A8. First Difference Estimates for Poverty Rate

	Povrate															
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Labour-weighted tariff	1.019*	1.094**	1.242**	1.247**												
s.e.	(0.545)	(0.519)	(0.576)	(0.578)												
Manufacturing Output Tariff					0.363***	0.356***	0.316***	0.317***					0.215**	0.220**	0.229***	0.227***
s.e.					(0.059)	(0.055)	(0.059)	(0.060)					(0.096)	(0.088)	(0.089)	(0.088)
Manufacturing Input Tariff									0.533***	0.527***	0.454***	0.460***	0.308*	0.296*	0.231	0.238
s.e.									(0.114)	(0.108)	(0.147)	(0.145)	(0.170)	(0.162)	(0.183)	(0.180)
N	875	875	875	875	875	875	875	875	875	875	875	875	875	875	875	875
R^2	0.349	0.387	0.393	0.393	0.367	0.400	0.405	0.405	0.367	0.400	0.402	0.403	0.307	0.403	0.406	0.406
Year-island dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-variant controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Initial labour force and rural population shares	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Dependent variable 1976	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes

Note: Each block of the table reports separate weighted tariff coefficients, generated by first difference estimates of the change of poverty rate on tariffs and further controls. Time-variant controls include the first difference of expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

Table 2-A9. Placebo test on inequality measurements regressed on future tariff changes.

	Gini				Top20				Least20			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Labour-weighted tariff	-0.162	-0.308	-0.321	-0.306	0.308	0.289	0.451	0.442	-0.104	-0.136	-0.163	-0.146
s.e.	(0.320)	(0.397)	(0.420)	(0.425)	(0.450)	(0.497)	(0.698)	(0.703)	(0.090)	(0.116)	(0.151)	(0.147)
Manufacturing Output Tariff	-0.038	-0.079	-0.082	-0.080	0.368	0.448	0.417	0.398	-0.058	-0.067	-0.063	-0.070
s.e.	(0.079)	(0.097)	(0.098)	(0.098)	(0.259)	(0.297)	(0.287)	(0.280)	(0.059)	(0.083)	(0.081)	(0.079)
Manufacturing Input Tariff	-0.283*	-0.298**	-0.308**	-0.310**	0.368	0.411	0.411	0.390	-0.058	-0.064	-0.060	-0.062
s.e.	(0.150)	(0.122)	(0.120)	(0.121)	(0.259)	(0.294)	(0.284)	(0.276)	(0.059)	(0.084)	(0.081)	(0.078)
N	825	825	825	825	825	825	825	825	825	825	825	825
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-variant controls and year-island dummies	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Initial labour force and rural population shares	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Dependent variable 1976	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes

Notes: Each block of the table reports separate tariff coefficients, generated by first difference estimates of the change of different inequality measurements (Gini, share of top20% and share of bottom 20%) on future tariffs and further controls. Time-variant controls include the first difference of expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

Table 2-A10. Placebo test on poverty regressed on future tariff changes.

	Poverty rate			
	(1)	(2)	(3)	(4)
Labour-weighted tariff	-0.064	0.542	0.406	0.405
s.e.	(0.342)	(0.405)	(0.492)	(0.500)
Manufacturing Output Tariff	-0.202**	-0.051	-0.045	-0.046
s.e.	(0.082)	(0.116)	(0.119)	(0.120)
Manufacturing Input Tariff	-0.138	0.183	0.180	0.180
s.e.	(0.194)	(0.237)	(0.233)	(0.233)
N	825	825	825	825
Year dummies	Yes	Yes	Yes	Yes
Time-variant controls and year-island dummies	No	Yes	Yes	Yes
Initial labour force and rural population shares	No	No	Yes	Yes
Dependent variable 1976	No	No	No	Yes

Notes: Each block of the table reports separate tariff coefficients, generated by first difference estimates of the change of poverty rate on future tariffs and further controls. Time-variant controls include the first difference of expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

Table 2-A11. Crisis sensitivity - Gini coefficients

	Dependent variable: Δ Gini Coefficients															
	1977-1996 (Pre-crisis)								1977-2012 (Full sample)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Δ Labour-weighted tariff	0.226	0.155							0.859*	0.830*						
	(0.417)	(0.440)							(0.446)	(0.439)						
Δ Output tariff			0.057	0.052			0.052	0.054			0.187**	0.190**			0.117	0.124
			(0.100)	(0.100)			(0.095)	(0.099)			(0.091)	(0.089)			(0.101)	(0.100)
Δ Input tariff					0.053	0.032	0.015	-0.008					0.298**	0.291**	0.185	0.181
					(0.141)	(0.144)	(0.130)	(0.140)					(0.117)	(0.121)	(0.118)	(0.129)
Δ Labour-weighted tariff x crisis dummy$_t$									-0.124	0.086						
									(0.257)	(0.294)						
Δ Output tariff x crisis dummy$_t$											-0.108*	-0.098			-0.295*	-0.299**
											(0.065)	(0.064)			(0.154)	(0.151)
Δ Input tariff x crisis dummy$_t$													-0.137	-0.096	0.349	0.361
													(0.109)	(0.103)	(0.231)	(0.233)
Island x year effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time variant controls	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
Political variables	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
Observation	475	475	475	475	475	475	475	475	875	875	875	875	875	875	876	876
R-squared	0.288	0.293	0.288	0.293	0.287	0.293	0.288	0.293	0.342	0.348	0.346	0.350	0.344	0.349	0.337	0.339

Note: Each block of the table reports separate weighted tariff coefficients, generated by first difference estimates of the change of Gini coefficients on tariffs and further controls. Time-variant controls include the first difference of expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

Table 2-A12. Crisis sensitivity - Share of Expenditure of Top 20%

	Dependent variable: Δ Top20															
	1977-1996 (Pre-crisis)								1977-2012 (Full sample)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Δ Labour-weighted tariff	-0.051	-0.101							0.858*	0.819*						
	(0.467)	(0.455)							(0.470)	(0.480)						
Δ Output tariff			-0.132	-0.127			-0.029	-0.041			0.117	0.120			0.094	0.096
			(0.102)	(0.095)			(0.122)	(0.116)			(0.113)	(0.107)			(0.111)	(0.106)
Δ Input tariff					-0.366*	-0.325	-0.345	-0.295					0.161	0.160	0.065	0.074
					(0.199)	(0.208)	(0.222)	(0.235)					(0.198)	(0.191)	(0.200)	(0.196)
Δ Labour-weighted tariff x crisis dummy$_t$									0.060	0.160						
									(0.381)	(0.419)						
Δ Output tariff x crisis dummy$_t$											-0.064	-0.085			-0.314**	-0.365***
											(0.063)	(0.077)			(0.139)	(0.140)
Δ Input tariff x crisis dummy$_t$													-0.050	-0.053	0.466*	0.508*
													(0.119)	(0.136)	(0.275)	(0.271)
Island x year effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time-variant controls	no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Political variables	no	yes	no	yes	no	yes	no	yes	yes	no	yes	no	yes	no	yes	no
Observation	475	475	475	475	475	475	475	475	875	875	875	875	875	875	875	875
R-squared	0.214	0.243	0.216	0.245	0.221	0.248	0.221	0.249	0.227	0.233	0.226	0.232	0.225	0.231	0.228	0.235

Note: Each block of the table reports separate weighted tariff coefficients, generated by first difference estimates of the change of share of the top 20% on tariffs and further controls. Time-variant controls include the first difference of expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

Table 2-A13. Crisis sensitivity - Share of Expenditure of Bottom 20%

	Dependent variable: Δ Least20															
	1977-1996 (Pre-crisis)								1977-2012 (Full sample)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Δ Labour-weighted tariff	-0.044	-0.015							-0.207**	-0.178**						
	(0.102)	(0.102)							(0.084)	(0.084)						
Δ Output tariff			-0.011	-0.010			-0.027	-0.024			-0.038*	-0.034			-0.019	-0.017
			(0.024)	(0.024)			(0.033)	(0.033)			(0.021)	(0.022)			(0.030)	(0.030)
Δ Input tariff					0.034	0.030	0.054	0.048				-0.070**		-0.058**	-0.052	-0.045
					(0.037)	(0.038)	(0.050)	(0.052)					(0.029)	(0.029)	(0.045)	(0.043)
Δ Labour-weighted tariff x crisis dummy$_t$									0.020	-0.099						
									(0.076)	(0.092)						
Δ Output tariff x crisis dummy$_t$											0.050	0.040			0.123**	0.114**
											(0.031)	(0.030)			(0.059)	(0.057)
Δ Input tariff x crisis dummy$_t$													0.067	0.042	-0.135	-0.133
													(0.056)	(0.051)	(0.097)	(0.094)
Island x year effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time-variant controls	no	yes	yes	yes	yes	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes
Political variables	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
Observation	475	475	475	475	475	475	475	475	875	875	875	875	875	875	875	875
R-squared	0.277	0.302	0.277	0.303	0.278	0.303	0.279	0.304	0.280	0.293	0.287	0.294	0.284	0.293	0.290	0.297

Note: Each block of the table reports separate weighted tariff coefficients, generated by first difference estimates of the change of expenditure share of the bottom 20% on tariffs and further controls. Time-variant controls include the first difference of expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

Table 2-A14. Crisis sensitivity-Poverty Rate

	Dependent variable: Δ Povrate															
	1977-1996 (Pre-crisis)								1977-2012 (Full sample)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Δ Labour-weighted tariff	1.264*	1.396**							1.019*	1.093**						
	(0.67)	(0.665)							(0.545)	(0.512)						
Δ Output tariff			0.390***	0.398***			0.225**	0.230**			0.335***	0.296***			0.211**	0.203**
			(0.087)	(0.085)			(0.106)	(0.108)			(0.075)	(0.053)			(0.097)	(0.084)
Δ Input tariff					0.718***	0.744***	0.553**	0.572**				0.530***		0.459***	0.327*	0.249
					(0.231)	(0.230)	(0.259)	(0.259)					(0.160)	(0.134)	(0.191)	(0.174)
Δ Labour-weighted tariff x crisis dummy$_t$									0.000	0.785**						
									(0.000)	(0.315)						
Δ Output tariff x crisis dummy$_t$											0.000	0.229**			-0.000	0.310*
											(0.000)	(0.102)			(0.000)	(0.164)
Δ Input tariff x crisis dummy$_t$													0.000	0.324*	0.000	-0.153
													(0.000)	(0.170)	(0.000)	(0.156)
Island x year effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time-variant controls	no	yes	yes	yes	yes	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes
Political variables	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
Observation	475	475	475	475	475	475	475	475	875	875	875	875	875	875	875	875
R-squared	0.367	0.404	0.372	0.407	0.380	0.415	0.386	0.422	0.349	0.394	0.356	0.404	0.356	0.399	0.359	0.406

Note: Each block of the table reports separate weighted tariff coefficients, generated by first difference estimates of the change of poverty rate on tariffs and further controls. Time-variant controls include the first difference of expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

Table 2-A15. First Difference Estimates for Gini Coefficient, 2 period differences.

	Gini$_t$-Gini$_{t-3}$															
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Labour-weighted tariff	1.496***	1.466***	1.644***	1.669***												
s.e.	(0.473)	(0.511)	(0.519)	(0.527)												
Manufacturing Output Tariff					0.396***	0.442***	0.379***	0.384***					0.402**	0.430**	0.367*	0.377*
s.e.					(0.123)	(0.127)	(0.142)	(0.142)					(0.174)	(0.177)	(0.203)	(0.206)
Manufacturing Input Tariff									0.372**	0.440***	0.364**	0.361**	-0.015	0.034	0.033	0.019
s.e.									(0.152)	(0.164)	(0.160)	(0.160)	(0.221)	(0.243)	(0.257)	(0.262)
N	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275
R^2	0.292	0.333	0.361	0.362	0.297	0.344	0.357	0.358	0.272	0.319	0.340	0.341	0.297	0.344	0.357	0.358
Year-island dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-variant controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Initial labour force and rural population shares	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Dependent variable 1976	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes

Note: Each block of the table reports separate weighted tariff coefficients, generated by first difference estimates of the change of Gini coefficient on tariffs and further controls. Time-variant controls include the first difference of expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

Table 2-A16. First Difference Estimates for Expenditure Share of the Richest 20%, 2-period difference.

	$Top20_t - Top20_{t-3}$															
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Labour-weighted tariff	1.007*	1.109**	1.052	0.926												
s.e.	(0.606)	(0.556)	(0.753)	(0.756)												
Manufacturing Output Tariff					0.438***	0.491***	0.372**	0.311**					0.393***	0.415***	0.299*	0.261*
s.e.					(0.112)	(0.129)	(0.161)	(0.127)					(0.147)	(0.137)	(0.175)	(0.145)
Manufacturing Input Tariff									0.491**	0.577***	0.458*	0.362*	0.112	0.205	0.201	0.140
s.e.									(0.200)	(0.210)	(0.237)	(0.214)	(0.254)	(0.237)	(0.264)	(0.253)
N	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275
R^2	0.249	0.294	0.330	0.367	0.267	0.312	0.338	0.371	0.254	0.300	0.332	0.367	0.267	0.314	0.339	0.372
Year-island dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-variant controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Initial labour force and rural population shares	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Dependent variable 1976	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes

Note: Each block of the table reports separate weighted tariff coefficients, generated by first difference estimates of the change of expenditure share of the richest 20% on tariffs and further controls. Time-variant controls include the first difference of expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

Table 2-A17. First Difference Estimates for Expenditure Share of the Poorest 20%, 2-period difference.

	Least20$_t$-Least20$_{t-3}$															
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Labour-weighted tariff	-0.302***	-0.241**	-0.232	-0.237*												
s.e.	(0.106)	(0.107)	(0.144)	(0.137)												
Manufacturing Output Tariff					-0.141***	-0.122***	-0.103**	-0.097**					-0.122**	-0.106*	-0.086	-0.080
s.e.					(0.041)	(0.043)	(0.050)	(0.048)					(0.058)	(0.056)	(0.066)	(0.062)
Manufacturing Input Tariff									-0.165***	-0.144***	-0.122***	-0.118**	-0.048	-0.044	-0.044	-0.046
s.e.									(0.043)	(0.043)	(0.046)	(0.048)	(0.067)	(0.069)	(0.073)	(0.070)
N	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275
R^2	0.238	0.275	0.289	0.304	0.264	0.292	0.299	0.312	0.249	0.282	0.293	0.307	0.265	0.293	0.300	0.313
Year-island dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time variant controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Initial labour force and rural population shares	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Dependent variable 1976	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes

Note: Each block of the table reports separate weighted tariff coefficients, generated by first difference estimates of the change of expenditure share of the poorest 20% on tariffs and further controls. Time-variant controls include the first difference of expenditure per capita, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

Table 2-A18. First Difference Estimates for Poverty Rate, 2-period difference.

	$Poverty_t$-$Poverty_{t-3}$															
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Labour-weighted tariff	0.807**	0.818***	1.029***	1.057***												
s.e.	(0.364)	(0.260)	(0.314)	(0.310)												
Manufacturing Output Tariff					0.255*	0.026	0.114	0.132					0.074	0.029	0.130	0.147
s.e.					(0.137)	(0.194)	(0.222)	(0.222)					(0.165)	(0.247)	(0.272)	(0.269)
Manufacturing Input Tariff									0.521**	0.017	0.072	0.086	0.450*	-0.009	-0.043	-0.041
s.e.									(0.223)	(0.194)	(0.201)	(0.199)	(0.265)	(0.260)	(0.261)	(0.256)
N	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275
R^2	0.361	0.559	0.565	0.566	0.363	0.556	0.562	0.563	0.367	0.556	0.561	0.562	0.368	0.556	0.562	0.563
Year-island dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-variant controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Initial labour force and rural population shares	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Dependent variable 1976	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes

Note: Each block of the table reports separate weighted tariff coefficients, generated by first difference estimates of the change of poverty rate on tariffs and further controls. Time-variant controls include the first difference of expenditure per capita, Gini coefficient, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level

Table 2-A19. Regression of tariff on inequality measures with episode dummies.

	Δ Gini				Δ Top20				Δ least20			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Labour-weighted tariff (LT)	0.531**				-0.510				2.122			
	(0.269)				(0.536)				(1.295)			
Manuf. Output tariff (OT)		0.110		0.084		-0.124*		-0.012		0.019		-0.006
		(0.096)		(0.105)		(0.071)		(0.083)		(0.024)		(0.027)
Manuf. Input tariff (IT)			0.067	0.007			-0.330*	-0.326			0.060	0.066
			(0.120)	(0.147)			(0.178)	(0.220)			(0.054)	(0.070)
LT*Eps1	-0.071				-0.210				0.184**			
	(0.044)				(0.128)				(0.083)			
LT*Eps2	-0.116*				-0.222***				-0.007			
	(0.061)				(0.050)				(0.065)			
LT*Eps3	-0.121*				-0.428***				0.288			
	(0.066)				(0.071)				(0.216)			
LT*Eps4	-0.590***				-0.717				0.459			
	(0.174)				(0.493)				(0.292)			
LT*Crisis	-0.605***				-0.659***				2.113***			
	(0.213)				(0.138)				(0.677)			
OT*Eps1		-0.029*		-0.024		-0.060*		-0.009		0.012		0.005
		(0.016)		(0.023)		(0.034)		(0.050)		(0.009)		(0.013)
OT*Eps2		-0.077***		-0.061*		-0.066*		0.041		0.006		-0.011
		(0.016)		(0.035)		(0.039)		(0.073)		(0.012)		(0.021)
OT*Eps3		-0.064***		-0.064*		-0.107***		-0.144***		0.012*		0.019*
		(0.022)		(0.039)		(0.017)		(0.048)		(0.007)		(0.011)
OT*Eps4		-0.126***		0.046		-0.092		0.130		-0.010		-0.070
		(0.041)		(0.109)		(0.123)		(0.290)		(0.050)		(0.084)
OT*Crisis		-0.171***		-0.238***		-0.121***		-0.199***		0.022*		0.042**
		(0.028)		(0.072)		(0.024)		(0.075)		(0.013)		(0.021)
IT*Eps1			-0.017	0.005			-0.088**	-0.083			0.016	0.012
			(0.016)	(0.028)			(0.038)	(0.057)			(0.012)	(0.017)
IT*Eps2			-0.072***	-0.003			-0.114***	-0.175**			0.013	0.028
			(0.022)	(0.049)			(0.039)	(0.074)			(0.013)	(0.020)
IT*Eps3			-0.059**	0.018			-0.138***	0.051			0.016*	-0.009
			(0.025)	(0.054)			(0.030)	(0.063)			(0.009)	(0.012)

IT*Eps4			-0.308***	-0.404*			-0.209	-0.457			-0.003	0.122
			(0.083)	(0.241)			(0.212)	(0.539)			(0.092)	(0.172)
IT*Crisis			-0.174***	0.193			-0.169***	0.146			0.030*	-0.035
			(0.060)	(0.135)			(0.044)	(0.127)			(0.018)	(0.024)
Year-island dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-variant controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Initial labour force and rural population shares	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	875	875	875	875	875	875	875	875	875	875	875	875

Note: Each block of the table reports separate weighted tariff coefficients, generated by first difference estimates of the change of inequality measures on tariffs and further controls. Time-variant controls include the first difference of expenditure per capita, Gini coefficient, the share of agricultural, mining and manufacturing sector in total GDP, years of schooling, infant mortality rate, government expenditure, and government quality. Robust standard errors, clustered at the province level, are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

Table 2-A20. Regression of tariff on poverty measures with episode dummies.

	Δ Poverty rate			
	(1)	(2)	(3)	(4)
Labour-weighted tariff (LT)	2.141*			
	(1.294)			
Manuf. Output tariff (OT)		0.424***		0.282**
		(0.077)		(0.121)
Manuf. Input tariff (IT)			0.712***	0.424*
			(0.182)	(0.231)
LT*Eps1	0.184**			
	(0.081)			
LT*Eps2	-0.009			
	(0.066)			
LT*Eps3	0.287			
	(0.214)			
LT*Eps4	0.442			
	(0.296)			
LT*Crisis	2.094***			
	(0.669)			
OT*Eps1		0.078***		0.075
		(0.018)		(0.051)
OT*Eps2		0.066*		0.065
		(0.039)		(0.080)
OT*Eps3		0.055***		0.050
		(0.020)		(0.030)
OT*Eps4		0.102		0.108
		(0.088)		(0.244)
OT*Crisis		0.627***		0.988***
		(0.131)		(0.193)
IT*Eps1			0.082***	0.013
			(0.028)	(0.067)
IT*Eps2			0.073	0.009
			(0.051)	(0.108)
IT*Eps3			0.050	0.020
			(0.030)	(0.033)
IT*Eps4			0.109	0.027
			(0.121)	(0.346)
IT*Crisis			0.907***	-0.671**
			(0.284)	(0.302)
Year-island dummies	Yes	Yes	Yes	Yes
Time-variant controls	Yes	Yes	Yes	Yes
Initial labour force and rural population shares	Yes	Yes	Yes	Yes
Observations	875	875	875	875

Notes: Each column of the table reports separate tariff coefficients, generated by first difference estimates of the change of poverty rates on tariff measurements and further controls. Controls include regional per capita income, sectoral value added, average years of schooling, infant mortality rate, government expenditure, government own revenue share, political diversion index, and election participation rate. Standard errors, robust to heteroskedasticity and clustered at the province level in both panels, are reported in parentheses. ***, **, * mark statistical significance at the 1, 5 and 10% level.

Appendix 2-B: Descriptive statistics of variables.

Table 2-B1. Descriptive statistics of variables.

Variables	Mean	SD	Min	Max	No. obs
Dependent var.					
Poverty rate (%)	18.83	8.24	3.60	54.75	900
Gini coefficient (%)	31.82	4.09	22.81	47.82	900
Expenditure share of the top 20% (%)	42.77	5.18	30.28	68.36	900
Expenditure share of the bottom 20% (%)	8.34	1.48	3.88	12.47	900
Explanatory variables					
Labour-weighted tariffs (%)	4.86	3.77	0.12	15.85	900
Manuf. output weighted tariffs (%)	18.96	10.13	6.10	49.32	900
Manuf. input weighted tariffs (%)	11.01	7.72	2.35	36.47	900
GRDP per capita (IDR thousands)	6.07	6.32	0.73	34.72	900
Agricultural value added (%)	28.22	11.78	3.39	66.49	900
Mining value added (%)	10.50	16.38	0.00	85.44	900
Manufacture value added (%)	13.13	8.65	0.53	42.44	900
Government spending (IDR million)	101.5	129.57	0.77	1045.52	900
Government own revenue share (%)	24.67	16.74	1.46	77.42	900
Years of schooling (years)	5.37	1.96	1.37	9.71	900
Infant mortality rate (number per 1000)	58.31	19.20	14.00	111.00	900
Political diversion index	0.52	0.23	0.04	0.85	900
Participation rate (%)	87.44	10.86	13.96	99.68	900
Election year	0.22	0.42	0.00	1.00	900
Initial poverty rate (%)	24.86	7.15	3.00	44.30	900
Initial Gini coefficient (%)	31.87	4.45	22.70	41.30	900
Initial rural share (%)	81.25	8.82	51.78	92.15	900
Initial share of agric. workers (%)	66.76	19.69	3.76	88.10	900
Initial share manuf. of workers (%)	4.96	3.44	1.39	12.17	900
Initial share of trade workers (%)	9.28	5.46	1.55	28.00	900
Initial share of service workers (%)	12.33	9.46	4.53	53.21	900

Appendix 2-C: Samples and data.

C1. List of Provinces in the Sample:

Aceh, Sumatera Utara, Sumatera Barat, Riau, Jambi, Sumatera Selatan, Bengkulu, Lampung, Jakarta, Jawa Barat, Jawa Tengah, Yogyakarta, Jawa Timur, Bali, Nusa Tenggara Barat, Nusa Tenggara Timur, Kalimantan Barat, Kalimantan Tengah, Kalimantan Selatan, Kalimantan Timur, Sulawesi Utara, Sulawesi Tengah, Sulawesi Selatan, Sulawesi Tenggara, Maluku, Irian Jaya/Papua.

C2. Descriptions of Variables:

Tariff rate [tariff_pt]: Simple average of most favoured nation (MFN) tariff rates. Source: Author's calculation based on Buku Tarif Bea Masuk Indonesia, 1969-2012 and UNCTAD-TRAINS database.

Gini [gini]: Gini coefficient reported by the Statistical Yearbook. Source: Statistics Indonesia, 1978-2012.

Top 20% income [top20]: Expenditure share of the top 20%. Source: Author's calculation based on Susenas.

Least 20% income [least20]: Expenditure share of the least 10% and the least 20%. Source: Author's calculation based on Susenas.

Poverty rate [povrate]: Percentage of the population in the province who are living below the Indonesian provincial poverty line set by Statistics Indonesia. Source: Statistics Indonesia, 1978-2012.

Real GDP per capita [Ycap]: Real Gross Domestic Product per capita (RGDP) at the provincial level measured in 2002 constant prices. Source: Statistics Indonesia, 1978-2012.

Sectoral value added [agrishare, manushare, miningshare]: The share of agriculture, manufacture, and mining in the RGDP at the provincial level measured in 2002 constant prices. Source: Statistics Indonesia. Source: Ministry of finance Database, several years.

Schooling [school]: Years of schooling. Source: Statistics Indonesia, 1978-2012.

Infant mortality rate [infant]: Number of infant death over 1000 births. Source: Statistics Indonesia, 1978-2012.

Real Government Spending [govspend]: Real total provincial government spending as a share of RGDP. Source: Ministry of Finance Database, several years.

Government own revenue share [govquality]: Real total provincial government self-generated revenue as a share of RGDP. Source: Ministry of Finance Database, several years.

Political Fractionalization Index [poldiv]: Diversity index of political party voters among political parties competing in the national legislative elections in 1977, 1982, 1987, 1992, 1997, 1999 and 2004. This is the probably of finding two voters who voted for different political parties. The index is calculated using the Alesina et al. (1999) methodology. Source: Sudibyo (1995), Kristiadi et al. (1997), Suryadinata (2002), Apriyanto (2007) and Author's calculations.

Political participation rate [partrate]: Participation rate of total eligible voters in the national legislative elections in 1977, 1982, 1987, 1992, 1997, 1999 and 2004. This is the probably of finding two voters who voted for different political parties. Source: Sudibyo (1995), Kristiadi et al. (1997), Suryadinata (2002), Apriyanto (2007) and Author's calculations.

3. CHAPTER 3

Tariff Reform and Air Pollution in Indonesia

3.1 Introduction

The debate over the effects of trade liberalisation on environmental quality has become a focus of attention for academics and policymakers. Anti-liberalisation argues that opening up to international trade will create a race to the bottom as governments lower environmental standards to evoke profitable, yet dirty industrial production for global markets (Daly, 1993; Rauscher, 1995; Tonelson, 2002). Proponents of liberalisation counter that as income grows due to gains from trade, demand for stricter environmental standards will increase, so trade liberalisation induces better environmental conditions (Markusen et al., 1995; Wheeler, 2001). The first of these arguments is built on the premise that comparative advantage in dirty industries is largely driven by environmental standards rather than the traditional theory of factor endowments and technological differences across countries. The second assertion assumes that environmental quality is a normal good which implies a negative relation between pollution and income per capita. In fact, it seems that the two contra arguments can simultaneously or alternatively present.[33]

This study attempts to contribute to the issue by providing empirical evidence on the trade-environment relation in the context of Indonesia. Given its unique geographic & economic characteristics, Indonesia offers an intriguing case study. Indonesia is a very

[33] See for instance Tobey, J.A. (1990), Ulph, A. (1997) Antweiler et al., (1998), Cole, M. A., & Elliott, R. J. (2003), Frankel, J. A., & Rose, A. K. (2005), Harbaugh, W. T., Levinson, A., & Wilson, D. M. (2002)

diverse country, comprised of more than 17,000 islands and blessed with the most varied landscape.[34] Indonesia is also a fast growing country. It is the fourth most populous country in the world, with around $3500 income per capita in 2014 and approximately 5% annual growth on average over the past five years.[35]

In this study, we examine the impact of tariff reductions as an important measure of trade liberalisation on air quality in Indonesian districts over the period 1993 to 2002. Our study extends the literature on the environmental effects of trade liberalisation by focusing on the effects of a particular emission type: air pollution. We also add to the existing empirical studies by constructing a better pollution measure at the district level as well as including some districts' geographical control variables such as local precipitation and temperature. Furthermore, in this study, we incorporate spatial regression to mitigate the issue of spillovers.

Exploiting district pseudo-panel data, we find that reductions in tariffs tend to improve air quality. The finding is robust to any tariff measurements as well as after controlling for neighbourhood effects. In addition, we also explore potential causal channels underlying the observed relationships. We consider a number of endogenous factors that may change with tariff reform and whose change may help to explain the observed impact on air pollution. We first analyse whether our tariff measures predict changes in potential mediating variables. Then, we add these variables to see if they change the estimated relationship between air pollution and tariff reduction. Although most of these potential mediators are correlated with air pollution and tariff reform is correlated with changes in several factors, conditioning on these measures does not change our basic results.

[34] Wonderful Indonesia, www.indonesia.travel

[35] World Bank, 2015.

The next section describes the context and trends in tariff reductions and air pollution and main hypotheses. Section 3.3 presents the data sources and measurements for the analysis and section 3.4 explains the identification strategy. Results and discussions follow in Section 3.5, while section 3.6 provides a sensitivity analysis and the final section concludes.

3.1 Trade Reform and Pollution in Indonesia

Indonesia has conducted comprehensive trade liberalisation in recent decades. The major reforms started in the mid-1980s, when the government lowered tariff restrictions to 60%, reducing the number of tariff levels from 25 to 11 and converting some forms of import licensing to tariff equivalents. Rates on average decreased from 27% in 1986 to 20% in 1991. Another reform was to eliminate the monopoly on imports and simplify customs procedures. The reforms continued in the 1990s. The most important trade reforms were the May 1990, May 1994, and May 1995 deregulation packages.[36]

In 1994 Indonesia hosted an APEC meeting in Bogor and committed to the Bogor goals of free trade and investment by 2020. At the beginning of 1995, Indonesia effectively joined the World Trade Organization (WTO). In May 1995 64% of tariff lines were reduced comprehensively, and the 1995-2003 tariff schedules were introduced, which aimed to have a maximum 1 to 0% tariff in 2003 except for motor vehicle components. This was then followed by another trade liberalisation package in 1996 which reduced the average unweighted tariff down to 12% and NTBs to 3% of tariff lines (Feridhanusetyawan & Pangestu, 2003). Then Indonesia experienced a financial crisis. During the crisis, Indonesia continued its liberalisation under the Letter of Intent (LOI)

[36] In May 1990 there was further reduction in tariffs; May 1994 was investment deregulation which foreign investors allowed to own 100% shares. May 1995 there were 64% reduction in import tariff and further reduction in NTB as well as 1995-2003 tariff reduction programs.

to the International Monetary Fund (IMF) which brought Indonesia to a faster tariff reduction in 1999 than expected under the 2003 plan. Motor vehicle protection was liberalized in June 1999 and local content requirements for milk products removed by the end of 2000.

In regional commitments, Indonesia was to reduce its tariff under the fast track of the Association of Southeast Asian Nations (ASEAN) free trade agreement which took place in 2003. In 2008, ASEAN members and China signed the ASEAN-China free trade agreement which came into force in 2010. After becoming a WTO member in January 1995, Indonesia was committed to reducing all bound tariffs to 40 percent or less, by 2005. Indonesia remained committed to further trade liberalisation and has kept import tariffs low. Indonesia's simple average of applied most favoured nation (MFN) tariff decreased from around 30% in the late 1970s to around 6% in 2012.

Figure 3.1 shows the tariff reduction profile in Indonesia from 1977 to 2012.[37] In our period of analysis, tariff lines reduced from 15.0% in 1993 to 5.6% in 2002, on average. Table 3.1 summarises the detailed evolution of simple average MFN tariff of 20 tradable sectors during the period 1993-2002. Plotting the change in tariffs over the sample period as a function of tariffs at the initial year 1993, we see from Figure 3.2 that the industries with higher initial tariffs experienced the largest tariff reductions relative to initial levels. This correlation shows that tariff reductions were not discriminatory across sectors and did not favour any possible protected sectors.

[37] Source: own calculation derived from tariff data as described in the data section of this paper.

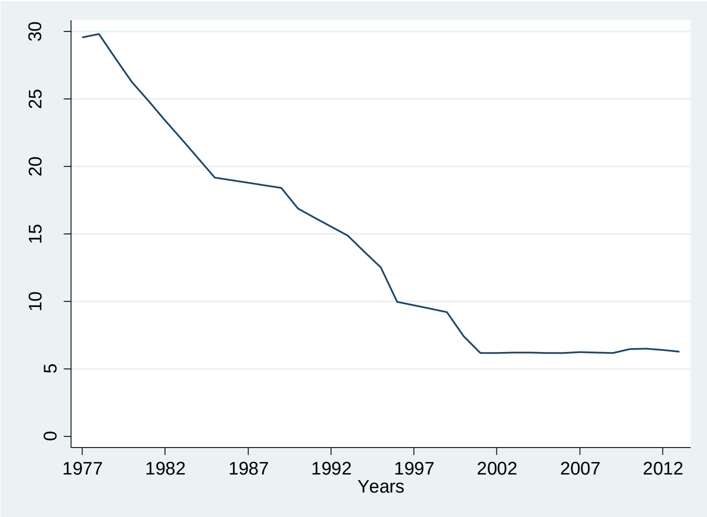

Figure 3.1. Average MFN tariff 1977−2012.

Table 3.1. Evolution of average MFN tariff rates by sector, selected years.

	1993	1996	1999	2002
Agriculture				
Plants and Animals	16.62	12.24	10.6	4.99
Forestry	7.56	3.3	3.3	3.13
Hunting	8.5	6.18	3.17	3.03
Sea Fishery	25.4	17.02	14.08	5.41
Fresh-water fishery	10	0	0	0
Mining				
Coal Mining	5	5	5	5
Metal ores mining	3.96	3.75	4.05	3.46
Stones & sand mining	7.66	5.67	3.98	3.94
Salt mining	20	15	15	8.33
Minerals and chemical mining	3.16	3.21	3.04	2.43
Other mining	4.09	3.54	3.75	3.7
Manufacturing				
Food, beverages & tobacco	22.91	19.69	18.99	11.01
Textiles, apparel, leather	27.59	21	17.7	10.35
Wood & product	27.8	15.61	14.22	8.1
paper and products	19.99	9.11	7.42	4.35
Chemicals and products	11.11	8.44	8.04	5.71
Non-metallic-mineral products	21.1	9.84	7.78	5.81
Basic metals	9.42	7.31	7.2	6.34
Metal products	16.41	9.48	9.01	5.66
Other manufacturing	32.57	18.61	18.26	10.54

Note: Sectors are constructed based on a concordance between tariff and census labour market data.
Source: Indonesia Customs Book and UNCTAD-TRAINS database.

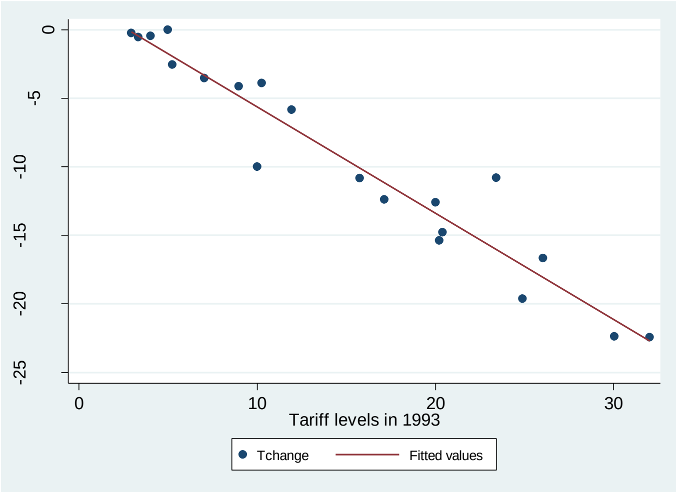

Figure 3.2. Tariff reduction by sector, 1993−2002.

Meanwhile, during our period of analysis, the manufacturing sector grew significantly. Its contribution to GDP increased from 19% in the early 1990s to 25% in the early 2000s. Likewise, the share of manufacturing exports increased from 50% to 70% in the same period. Correspondingly, there was a significant increase in total energy used by the manufacturing sector, from 15.2 tons of oil equivalent (toe) in 1990 to around 31.3 million tons in 2002. In contrast, the energy intensity remained stable from 1990 to 2002. However, pollution intensity, which is measured by carbon dioxide (CO_2) per million (10^6) USD of market value added (MVA), increased by 20%, from 993 to 1181 tons CO_2 per 10^6 MVA.

Similarly, the amount of CO_2 emitted by industry increased by almost 160% during the period, while the total amount of CO_2 emitted from all energy sources increased from 150 million metric tons in 1990 to 310 million metric tons in 2002. In other words, the share of CO_2 emissions from industry was increasing as it grew relatively faster compared to the average of other sectors. However, pollution intensity was increasing in all sectors with a 31% increase from 1990 to 2002 (Resosudarmo and Irhamni, 2008). According to our air pollution data,[38] the average regional air pollution index decreased from 0.84 in 1993 to 0.60 in 1996, climbed to 0.70 in 1999 and jumped to its highest level of 0.93 in 2002.

3.2 Literature Review

Theoretically, trade may have significant impacts, both positive and negative, on the environment (Copeland and Taylor, 2003). Accordingly, the removal of trade barriers can have positive and negative effects on the environment as well. Effective allocations of resources and efficient production due to improved technology are among the positive effects. Trade can bring fiscal revenue and technology transfer which in turn can help environment protection, conservation, and remediation efforts. Moreover, the higher the openness of a country, the more chance that the country will follow strict environmental regulation. On the other hand, trade liberalisation can create environmental degradation by producing more pollution, exploiting natural resources, promoting deforestation and land degradation as well as causing damage to species and habitat.

There are four well-known theories related to trade and environmental issues: the ‘pollution havens hypothesis' (PHH), the ‘race to bottom hypothesis' (RTH), ‘factor endowment' (FEH) and the ‘environmental Kuznets curve' (EKC) hypothesis. The PHH hypothesis examines pollution as the effect of less stringent environmental regulation (Mani and Wheeler, 1998), whereas the RTH theory exhibits the practice of relaxing environmental regulation in order to attract foreign direct investment (FDI) and in turn increasing environmental problems (Anderson and Blackhurst, 1992). On the other hand, the factor endowment hypothesis states that trade is determined by factor endowments and technology while environmental regulation has no significant impact on trade

[38] Detail on the measurement is explained in the data section.

patterns followed by the conclusion that developing countries have low trade impacts on pollution since they specialise in labour-intensive sectors (Grossman and Krueger, 1993; Copeland and Taylor, 2003) . Meanwhile, the EKC theory relates to a trade and environment nexus via income. It postulates that an inverted U-shaped relationship possibly exists between income and pollution (Dasgupta et al., 2002; Stern, 2004).

Meanwhile, studies focusing on the environmental impacts of trade liberalisation present mixed results. To begin with, there are a number of empirical studies (e.g. Grossman and Krueger, 1992; Hettige et al., 1992; Lucas et al., 1992) which show an inverse U-shaped relationship exists between GDP per capita and industrial pollution intensity, implying a corresponding inverse U-shaped relationship between trade and environment as the EKC theory explains (Lee and Holst, 1997). Then, Low and Safadi (1992) argue that freer trade may be good for the environment through its effects on resource allocation and income levels. Lucas et al. (1992) found that for developing countries, the more closed an economy, the more harmful industry was to the environment in the 1970s and 1980s due to import-substituting industrialisation protecting mainly capital and pollution-intensive sectors.

On the other hand, Anderson and Strutt (1999) suggest that trade policy in the 20th century could improve the environment and reduce natural resources depletion, only contributing to a low level of environmental degradation. Using a CGE model, Aldaba and Cororaton (2001) found that trade liberalisation had a small impact on pollution in the case of the Philippines. A recent study from Kyophilapong (2011) reveals that trade liberalisation in Lao PDR decreases CO_2 emissions at a small rate due mainly to output reductions in some sectors as a result of trade liberalisation. However, the study also shows that trade liberalisation exacerbates the rate of resource depletion in some sectors due to increased demands.

3.3 Data and Measurements

3.1.1 Data

We measure tariff reform as reductions in the simple average most favoured nation (MFN) tariff lines for the years of 1993, 1996, 1999 and 2012.[39] The tariff data are derived from UNCTAD-TRAIN database[40] and were cross-checked using several Indonesian Customs Tariff Books series.[41] We match the tariff data with information on district level labour market structure before the analysis period, based on the 1990 Indonesian Census.[42] The census has information on main sectoral occupation to the two-digit level. We examine the concordance between sectoral information in tariff data and the census; we are thus able to construct 20 sectoral tariff lines: 5 different sectors in agriculture, 6 sectors in mining and 9 sectors in manufacturing.[43] Moreover, we use the 1990 national input-output (IO) table[44] to draw a set of information on sectoral input-output structure. We then combine this information with the regional economic structure as well as the associated tariffs to construct regional input and output tariffs, similar to Kis-Katos and Sparrow (2015).

Our primary source of air pollution measurements is the Total Ozone Mapping Spectrometer (TOMS) Data from the Goddard Earth Sciences Data and Information

[39] District level data for some variables are missing in some years, especially in 1997 and 1998. After considering the best possible balanced panel data that we could have, we base our analysis on four equally spaced time periods.
[40] Downloaded through the WITS system of the World Bank
[41] 'Buku Tarip Bea Masuk', various years, was collected in the form of books (hard copy). We thus calculate the sectoral tariff by first manually inputting data from the tariff books into the computer to further analyse it with concordance of UNCTAD-TRAIN database. We found similar results using both sets of data, so in the analysis we use the series of tariffs from the UNCTAD-TRAIN database.
[42] The census is available in IPUMS database system (Minnesota Population Center, 2015).
[43] The 20 sectors are: plants and animals; forestry; hunting; sea fishery; fresh-water fishery; coal; metal ore; stones; salt; minerals and chemicals; other mining; food, beverages and tobacco; textile, apparel and leather; wood and products; paper and products; chemicals; non-metallic products; other manufacturing.
[44] We use an IO table with 66 sectors based on the 1990 economic census which was published by Statistics Indonesia (BPS).

Services Centre website at the National Aeronautics and Space Administration (NASA).[45] Air pollution is proxied by the aerosol index (AI). Some studies reveal that AI is strongly related to the aerosol optical thickness (AOT).[46] Aerosol optical thickness, which is also called interchangeably aerosol optical depth (AOD), is a measure of the clarity (i.e., transparency) of the air in the atmosphere. The more aerosols that are suspended in the atmosphere, the higher the value of AOD. Trends in AOD can be related to pollution caused by humans. Higher AOD values mean more aerosols in the air, or increasing amounts of particulate matter, and vice versa. Thus, more aerosols in the air, in general, indicated higher particulate matter emissions.[47] More explanation on TOMS data and aerosols are provided in the appendix to this chapter.

We control for other geographical factors that may contribute to air quality, such as rainfall and temperature. Data on precipitation and temperature were taken from the Centre for Climate Research (CCR), Dept. of Geography, University of Delaware.[48] According to the CCR, monthly total precipitation (P, mm) and mean air temperature (T, ^{o}C), were compiled from several updated sources of daily and monthly satiation data,[49] considering some spatial interpolation and validation. Precipitation and temperature data are then calculated based on the distribution of pixel values in each region. The zonal statistics were calculated using the ArcGIS software with the help of a GIS expert.[50]

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[45] http://disc.sci.gsfc.nasa.gov/aerosols/data-access

[46] Previous theoretical model simulations have demonstrated that the aerosol index depends on aerosol optical thickness (AOT). See, for instance, Herman et al., 1997; Hsu et al., 1999, and Torres et al., 1998.

[47] Complete explanations can be explored in http://disc.sci.gsfc.nasa.gov/giovanni/additional/users-manual/G3_manual_parameter_appendix.shtml#UV_aerosol

[48] http://climate.geog.udel.edu/~climate/html_pages/download.html#ghcn_T_P2

[49] http://climate.geog.udel.edu/~climate/html_pages/Global2_Ts_2009/README.global_p_ts_2009.html and http://climate.geog.udel.edu/~climate/html_pages/Global2_Ts_2009/README.global_t_ts_2009.html

[50] The GIS software computing was done with the help of Diana Minita, a Master of Environment from Crawford School of Public Policy, Australian National University.

We source some information at the district level for constructing control variables (expenditure per capita, household access to electricity, and population) from the Indonesian Database for Policy and Economic Research (INDO-DAPOER) which is available on The World Bank website. Finally, we use additional information from the annual industrial survey SI (Survey Industry) to examine potential channels of industrial effects on air pollution. The annual industrial survey was initiated in 1975 to incorporate all manufacturing firms with twenty or more employees. The dataset provides comprehensive firm-level data covering over 18,000 establishments in 1993 and more than 21,000 in 2002. We investigate the regionally differential effects of tariffs with regard to industrial characteristics which may be related to air pollution using firm-level data.

Our dataset covers 232 districts from 25 provinces. Indonesia actually had more than 300 districts in 1993 and grew to more than 400 districts in 2002. Unfortunately, our datasets do not cover all existing districts in the corresponding year. After combining different datasets and dealing with district splits[51] we are left with a balanced panel of 232 districts, comprised of rural (*kabupaten*) and urban districts (*kota*). The descriptive statistics of the changes in our main variables are presented in Table 3.2, while the district list and variable descriptions, as well as descriptive statistics for all variables, are presented in the appendix to this chapter.

3.1.2 Measurement of tariff exposure

To examine the effects of tariff reform on air pollution, we consider using average nominal tariffs weighted by initial labour market structure of the region, as constructed by Edmonds et al. (2005) and Topalova (2007) and further modified in many recent

[51] We deal with the district splits by grouping the new district back into its original 1993 district.

papers.[52] We adopt the method by Kis-katos and Sparrow (2015) in constructing regional tariff exposures, by incorporating labour weighted and manufacturing weighted tariffs approach. This method exploits Indonesia's geographic diversity in how households are affected by national tariff changes. The district tariff at time t ($TO_{d,t}$) is calculated according to:

$$TO_{d,t} = \sum_{s=1}^{23} \left[\frac{Q_{s,d}}{Q_d} \; x \; T_{s,t} \right] \tag{3.1}$$

where $Q_{s,d}$ is the district sectoral output and Q_d is total output in a district in the initial year, based on Industrial Statistic data for 1990.[53] $T_{s,t}$ is the tariff in sector s at time t. The use of time-invariant, pre-sample period employment weight is to control for the unobserved counterfactuals of what would have been the evolution of air pollution across Indonesian districts in the absence of tariff reform. Thus, changes in air quality that are not a consequence of trade reform should not be included in the calculation of regional tariffs.

Table 3.2. Descriptive statistics of main variables over time

Variable	Average change per period	SD of change per period	N
Aerosol Index	0.031	0.023	928
Output tariffs (labour weighted)	-3.437	0.308	928
Input tariffs (labour weighted)	-2.445	0.247	928
Output tariffs (manuf. weighted)	-2.834	1.890	928
Input tariffs (manuf. weighted)	-2.515	0.598	928

[52] This method has been further modified and used by Kovak (2010), Kis-Katos & Sparrow (2011), McCaig (2011), Fukase (2013), Castilho et al. (2012), and Kis-Katos & Sparrow (2015).
[53] After taking concordance between input and output data in 1975 into account, we managed to distinguish between 23 different industrial tradable outputs.

Therefore, district exposure to tariff reforms is based only on the tariff cuts and the pre-existing structure of employment within a district.[54] According to McCaig (2011), the use of pre-reform time-invariant weights is common in many empirical micro literature, such as Bernard and Jensen (2004) and Lemieux (2002).

Following Amiti and Konings (2007), Amiti and Cameron (2012) and Kis-Katos and Sparrow (2015), we construct labour-weighted input tariffs in order to identify the separate effects of reducing output and input tariffs on air pollution. District exposure to input tariffs is measured by first weighing the tariff by input share of each sector computed from the 1990 national input-output table $M_{j,s}/M_s$, and then further weighting by the industry's initial (t=1990) manufacturing share relative regional importance, $Q_{s,d}/Q_d$.

$$TI_{d,t} = \sum_{s=1}^{20} \left[\frac{Q_{s,d}}{Q_d} \, x \left(\sum_{j=1}^{20} \frac{M_{j,s}}{M_s} \; x \; T_{j,t}\right)\right] \qquad (3.2)$$

The input specific weight, $M_{j,s}/M_s$, is the initial share of j industry over all inputs of any sector s in 1990 and $T_{j,t}$ is the corresponding tariff of each input j in year t. The input weight is based on total input purchases, including domestic and import inputs. If otherwise, only imported inputs were used, it would lead to endogeneity bias as argued by Amiti and Cameron (2012). Since the 1990 input-output table is only available at the national level, we have to assume that the district-level structure of inputs is similar to the national structure.

Furthermore, to check the robustness of our results, we also compute labour-weighted output and input tariffs. The labour-weighted tariffs are computed by modifying equations (3.1) and (3.2). Thus, utilising 1990 census data, we replace the manufacture

[54] This is apparently not a perfect method for controlling for unobserved confounders as employment weights might change even without changes in tariffs.

weight ($Q_{s,d}/Q_{d}$) by labour output weight: $L_{s,d}/L_{d}$, where $L_{s,d}$ is the number of labour in each sector and L_{d} is the total number of workers in district d in 1990, generated from the 1990 Indonesian Census data.

3.1.3 Measurement of air pollution

This study utilises the wealth of atmospheric composition satellite data for air quality applications which are primarily collected by National Aeronautics and Space Administration (NASA), [55] specifically the aerosol index (AI). The index is obtained using the total ozone mapping spectrometer (TOMS) instrument or the ozone monitoring instrument (OMI). The former satellite was used from 1978 to 2005, and the latter has been used since 2004.[56] The TOMS / OMI aerosol index is a measure of how much the wavelength dependence of backscattered UV radiation from an atmosphere containing aerosols (Mie scattering, Rayleigh scattering, and absorption) differ from that of a pure molecular atmosphere (pure Rayleigh scattering). Quantitatively, the aerosol index (AI) is calculated from the ratio of measured to calculated 360 nm TOMS / OMI radiances. Under most conditions, the AI is positive for absorbing aerosols and negative for non-absorbing aerosols (pure scattering).

We first selected the years of interest and a predefined area (in this case, Indonesia). Then we customised the output plot by using the scale interval and minimum as well maximum range, colour, plot type, and grid lines inclusion. Next, we obtained the output of spatial map data of the aerosol index containing a set of coordinate data (points) with associated attribute tables. We combined the aerosol index layer with Indonesian spatial map data

[55] http://disc.sci.gsfc.nasa.gov/aerosols/data-access
[56] NASA has a series of TOMS data from Nimbus-7 orbit and Earth Probe instrument. The TOMS Nimbus-7 was used from November 1978 to May 1993; TOMS EP was used from July 1997 to December 2005. Both of these satellites include 1.0x1.25 spatial resolution. The OMI has been used since October 2004 up to now, with 1 spatial resolution (http://disc.sci.gsfc.nasa.gov)

layer with polygon features. We then overlaid the district data with AI data and calculated the AI for each district using a polygon-based simple average method. To get the AI for a district, we made some polygons filling the area of the district and calculated the (Euclidean) distance of each polygon to the nearest point of AI values. Finally, we calculated a simple average AI of each district based on total AI values of all polygons in a district divided by the total polygons in the district.[57] The procedure was conducted using ArcGIS software.[58]

3.4 Methods

In order to investigate the impact of tariff reform on air pollution, we estimate the following specification:

$$\Delta y_{d,t} = \alpha + \beta \Delta Tariff_{d,t} + \Delta X'_{d,t}\, \gamma + I'_{d}\theta + \lambda_{r,t} + \Delta \varepsilon_{d,t} \quad (3.3)$$

where $Y_{d,t}$ is the air pollution measure in district d, year t. $Tariff_{d,t}$ is the district exposure to tariff reforms. $X_{d,t}$ is a set of the average time variant district characteristics (temperature, precipitation, expenditure per capita, population and household access to electricity). We also include interactive island-year fixed effects, $\lambda_{r,t}$ to control for shocks over time that affects trade across all districts but may vary across different islands within Indonesia.[59] The coefficient of interest, β, captures the average effect of trade reform on regional outcomes related to the air pollution index. We examine the aerosol index effects of tariff reforms, using both output and input tariffs. Then to check the robustness of our tariff measures, we combine output and input tariffs as shown by equations (3.4). Later, we also check whether our results are sensitive to the way we measure tariffs. We thus

[57] See detailed procedure in appendix.
[58] The GIS software computing was done with the help of Diana Minita, a Master of Environment from Crawford School of Public Policy, Australian National University.
[59] There are five main islands dummies: Sumatera, Java, Kalimantan, Sulawesi and the outer islands.

replace the tariffs in equations (3.3) and (3.4) with manufacturing weighted output and input tariffs.

$$\Delta y_{d,t} = \alpha + \beta_1 \Delta OutputTariff_{d,t} + \beta_2 \Delta InputputTariff_{d,t} + \Delta X'_{d,t}\,\gamma + I'_d\theta + \lambda_{r,t} + \Delta\varepsilon_{d,t} \qquad (3.4)$$

The first difference specification controls for unobserved district-level heterogeneity and addresses potential bias of time-invariant unobservables. This method removes district fixed effects and eliminates the unobserved heterogeneity that might be instigated by the initial regional sectoral structure in employment and industry output. Furthermore, it eliminates potential bias due to endogenous national tariffs by controlling for country variation over time and by limiting variation only at the district level.

However, if any unobserved time variant confounders exist, the first difference approach can be biased. The potential confounders may include structural change, economic performance and any policies related to initial district sectoral structure and urban-rural differences. To deal with this problem, we incorporate a vector of initial conditions, I_d, which includes the 1990 sectoral labour shares (aggregated to one-digit sectors), 1990 rural population shares and in some specifications, the initial levels of the dependent variable.

Moreover, if the tariff measures are endogenous to air pollution measurement, or if they seize differential trends in air quality between districts, we would also expect air pollution to be correlated with future changes in district tariff exposure. Following Kis-Katos and Sparrow (2015), we conduct a placebo test by regressing changes in the independent variable on future changes in tariff measures,[60] with the null of no confounding patterns rejected if the future tariff coefficient is not statistically significant.

Rey and Janikas (2005) argue that spatial interaction might exist between regions which are traditionally ignored in the multiregional analysis. Similarly, Aklin (2014) argues that the effect of trade on pollution is interdependent since pollution is correlated across countries. Thus, the assumption of cross-sectional units independence is not relevant because the disturbance error may come from observed countries or region.

In the context of our study, the assumption of independence of each district in Indonesia might be argued since Indonesia is an archipelago country which has spatial differences in natural resources, population distribution, and many other economic and geographic variables.[61] One could also argue that the air pollution index which is used in this study could not be measured accurately since pollution could flow from and to other regions. Thus the analysis results could be biased. Failing to take spatial dependence into account in the standard techniques will lead to inconsistent standard error estimates (Driscoll & Kraay, 1998).

We deal with this issue by extending model (3.3) to incorporate neighbourhood influence or spatial effects. We take into account the potential spatial spillovers by applying a spatial weight matrix, W. In this study, we used a general spatial weight matrix based on the geographic characteristics of the samples. In this method, following Viton (2010), we define two regions as neighbours if they share any part of a common border. We construct a simple binary contiguity matrix: the element of the spatial weight matrix (W) is one, if location i is adjacent to location j, and zero otherwise. The weight matrix is a binary

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[60] That is, we first regress y_{dt} on $\Delta Tariff_{dt+1}$ and re-run with $\Delta Tariff_{dt+2}$ for further checking.
[61] Several studies on Indonesia apply spatial effects for the same reasons. For example: Magrini (2004); Resosudarmo and Vidyattama (2006); Sugiharti (2014).

matrix with n by n dimension, where n is the number of districts in our sample. We then utilise the spatial models introduced by Anselin & Griffith (1988) and Anselin (2013) - the spatial autoregressive lag model (SAR) and the spatial Durbin model (SEM) -to examine the effect of other regions over a particular area.[62] The SAR and SDM models are defined as specifications in equation (3.5) and equation (3.6), respectively.

$$\Delta\, y_{d,t} = \alpha + \beta \cdot \Delta\, Tariff_{d,t} + \rho W y_{d,t} + \Delta\, X'_{d,t}\, \gamma + \lambda_{d,t} + \Delta\, u \qquad (3.5)$$

$$\Delta\, y_{d,t} = \alpha + \beta_1 \cdot \Delta\, Tariff_{d,t} + \rho W\, \Delta Tariff_{d,t} + \Delta\, X'_{d,t}\, \gamma_1 +$$

$$W\, \Delta\, X'_{d,t}\, \gamma_2 + \lambda_{d,t} + \Delta\, u \qquad (3.6)$$

where $y_{d,t}$ the is the spatial lag of the dependent variable and W is the spatial weight matrix. The SDM specification basically adds average-neighbour values of the independent variables to the specification. The spatial dependence weight matrix consists of 0 and 1, which belong to the neighbourhood: a value of 1 is given for any district n that is adjacent with district d and 0 otherwise. The spatial weight matrix has to be a square matrix [NxN] and symmetric.

3.5 Results and discussions

3.1.4 Main estimations

The effects of tariff reductions on air pollution measures for different specifications are shown in Table 3.3. Panels A and B summarise the results of equation (2.3) estimations, where we alternate output and input tariffs, while panel C shows the results of estimating equation (2.4). In general, there is a positive correlation between tariff exposure and the

[62] We conduct the analysis using STATA software. See http://www.stata.com/ for info on spatial regressions.

aerosol index as the air pollution measure, implying that tariff reduction is associated with a decrease in air pollution.

The results of the model (3.3) estimations show that reductions in both output and input tariffs independently contribute to better air quality. However, when we combine the output and input tariff as in equation (3.4), only input tariffs appear to be significant, while the output tariffs lost significance. The relationship stays after controlling for time-variant controls, year-island interactions, and initial conditions.[63]

Table 3.3. Air pollution effects of tariff reforms, manufacturing weighted tariffs.

Aerosol Index				
Specifications	Model			
	(1)	(2)	(3)	(4)
<u>Panel A</u>				
Output tariffs	0.004**	0.004**	0.004**	0.004**
	(0.002)	(0.001)	(0.001)	(0.001)
<u>Panel B</u>				
Input tariffs	0.018**	0.017**	0.017**	0.017**
	(0.004)	(0.004)	(0.004)	(0.004)
<u>Panel C</u>				
Output tariffs	0.001	0.001	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)
Input tariffs	0.017**	0.016**	0.017**	0.017**
	(0.005)	(0.004)	(0.004)	(0.004)
N observations	696	696	696	696
N districts	232	232	232	232
Year-island dummies	Yes	Yes	Yes	Yes
Time-variant controls	No	Yes	Yes	Yes
Initial labour force and rural population shares	No	No	Yes	Yes
Dependent variable 1993	No	No	No	Yes

Note: Each block of the table reports separate weighted tariff coefficients, generated by first difference estimates of the change of aerosol index on tariffs and further controls. Time-variant controls include the first difference of precipitation, temperature, expenditure per capita, household access to electricity and population. Robust standard errors are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% levels.

[63] The time variant controls are: precipitation, temperature, expenditure per capita, percentage of electricity users and population, all in district level. The initial conditions are: initial sectoral labour shares (measured at one digit level), share of rural population in 1990, and initial value of dependent variable (aerosol index).

Based on the robustness of input tariffs, we choose input tariffs as our preferred measure for capturing district-level exposure to tariff reform in the context of its impact on air pollution. Furthermore, the inclusion of initial levels of pollution index in column 4 helps to examine whether initial air quality is associated with parallel differential trends of potential confounders that affect our estimation results. We found no evidence of this as all results are robust to controlling these initial variables.

In the following discussions, we refer to column 3 as the preferred specification for interpreting the results. The estimation results suggest that one percent reduction in the manufacturing-weighted input tariff corresponds to a 0.017 decline in the aerosol index.[64]

Overall, the reduction of input tariffs seems to have contributed to mitigating the increasing trend of air pollution measures in Indonesia. This finding is against the argument that trade has detrimental effects on the environment, particularly on air pollution. It also supports existing large literature about the effect of trade liberalisation on the environment (Antweiler et al., 2001; Dean, 2002; Harbaugh et al., 2002; Copeland and Taylor, 2003; Frankel and Rose, 2005; Faiz-Ur-Rehman et.al., 2007).

Finally, the coefficients of control variables are generally of expected signs:[65] air pollution declines with precipitation and districts with relatively high temperature have a higher air pollution index. In addition, controlling for other factors, the aerosol index is higher for a district with higher expenditure per capita. Nevertheless, we found no significant contribution of the share of electricity access and population in a district to air pollution.

[64] The standard deviation of aerosol index change per period is 0.023 as can be seen in Table 3.2.

[65] See appendix for the results on additional controls of these regression.

3.1.5 Potential causal channels

How can reductions in input tariffs be beneficial in reducing the air pollution index? From the theory, we know that there are three main mechanisms by which trade affects the environment (Grossman and Krueger, 1991; Copeland and Taylor, 1994). The first is through the scale effect which unambiguously always increases pollution. The second is the composition effect that reflects specialisation in more or less dirty activities. If a country specialises in a relatively more dirty industry, then air pollution will increase, and vice versa. The last mechanism is the technical effect which indicates the utilisation of cleaner technology. It is argued that the environment is assumed to be a normal good.

Thus, higher income induces better environmental standards and cleaner production methods. From the results, we find that import tariff reduction reduces the air pollution index. Since the first mechanism should lead to increasing air pollution, we will focus on investigating explanations through the other two mechanisms: composition and technical changes. If composition effects make a country cease production of dirty industries and specialise in relatively cleaner sectors, then we can expect that trade will be good for the environment. However, we need to check whether tariff reform significantly affects the composition of industries.

We consider a variety of endogenous factors that may be affected by district exposure to tariff reduction and may mediate the observed change in air pollution. We first analyse whether tariffs reform predicts changes in the potential mediating variables at the district level (Table 3.4). Then, to test for mediation, we analyse whether including these additional variables changes the estimated relationships (β) between tariff reform and air pollution (Table 3.5). In all potential causal channel estimations, we use manufacturing weighted tariffs.

We firstly examined the effect of tariff reduction on the share of dirty[66] output in a district. In Table 3.4, we show that there is no statistically significant impact of tariff reduction on the share of dirty production in a district. However, we cannot conclude that tariff reduction in the 1990s had no impact on the dirty or clean industrial composition in a district. It may depend on the definition of dirty industries used.

Next, we investigate the technical change effects. That is, how tariff reform affects the technology used in the industries. Regardless of our limitations in measuring technical change, we try to proxy the effect by examining some available characteristics from the industrial statistics: pollution intensity, output to input ratio and capacity utilisation.[67] We found no statistically significant effects of tariff reduction on districts' pollution intensity and output to input ratio. In contrast, capacity utilisation significantly increased with the reduction of input tariffs. However, when we tested the mediator effects, we could not see a significant impact of the increasing capacity utilisation on the air pollution index (Table 3.5).

In addition, we also conducted mediator checks for other potential channels: import values, total export shares, and dirty export shares. Interestingly, reductions in input tariffs reduced the value of imports. One possible explanation is that import quantities did not change too much, while import prices decreased with input tariff liberalisation. However, the import values turned out not to significantly affect the air pollution index (Table 3.5). On the other hand, we found that due to the reduction in input tariffs, export share increased and dirty exports decreased (Table 3.4).

[66] We define dirty industries by the conventional approach in the literature (Robinson, 1988; Tobey, 1990; Mani, 1996). There are five sectors categorized as dirty industries by this approach: iron and steel, nonferrous metal, industrial chemicals, pulp and paper, and non-metallic mineral products.
[67] Explanations of the variables are available in the appendix.

Furthermore, the export share is significantly associated with air pollution: increasing export share is associated with decreases in the air pollution index, though the significance is lost once we add regional-time dummies. The increasing export shares explain that in general, input tariff liberalisation promotes exports. Input tariff reduction means cheaper intermediate factors for industries. Consequently, the industries have more funds to invest in additional factor production (e.g., capital) and new technologies to increase productivity and increase foreign market shares by promoting exports. Adapting new technologies can also bring benefits to the environment since newer technologies are relatively cleaner.

In contrast, reduction in input tariffs is significantly reducing the share of dirty exports, and dirty exports significantly affect air pollution: decreasing dirty exports is associated with a reduction in air pollution measures. Trade liberalisation has made Indonesia specialise in relatively labour-intensive sectors, as labour is an abundant factor of production. The industrial structure has moved from dirty, heavy industries to labour-intensive industries which are relatively cleaner. However, the reduction in dirty exports as a consequence of decreasing input tariffs may be the result of decreasing export prices for dirty industrial products, or because of lower foreign demand for dirty products. Likewise, it may also be the result of less competitiveness in the dirty sectors. For various reasons, air pollution will be decreasing. Thus, overall, analysis of all potential channels supports the positive impact of tariff reform on air pollution through composition and technical effects. Moreover, the results in Table 3.5 underpin the fact that our main results are robust to different additional controls.[68]

[68] That is, if we consider the potential mediators as alternative additional control variables. The tariff coefficients in any specification stay significant and show similar magnitudes.

Table 3.4. Potential channels in predicting air pollution.

Dependent	Potential channels		
	Dirty outputs	Output over input	Capacity utilisation
Manuf. input tariffs	-0.137	0.029	-4.130**
	(0.106)	(0.046)	(1.416)
N observations	691	691	691
Time-variant controls	Yes	Yes	Yes
Year-island dummies	Yes	Yes	Yes
Dependent	**Potential channels**		
	Import values	Export shares	Dirty export values
Manuf. input tariffs	0.311*	-1.618*	0.130*
	(0.178)	(0.891)	(0.078)
N observations	691	691	691
Time-variant controls	Yes	Yes	Yes
Year-island dummies	Yes	Yes	Yes

Table 3.5. Mediation test for potential channels.

Specifications	Δ Aerosol Index							
	(1)		(2)		(3)		(4)	
	a	b	a	b	a	b	a	b
Input tariffs	0.095**	0.041**	0.093**	0.041**	0.072**	0.036**	0.094**	0.041**
	(0.004)	(0.005)	(0.004)	(0.005)	(0.006)	(0.007)	(0.004)	(0.005)
Capacity utilisation	0.000*	0.000						
	(0.000)	(0.000)						
Import values			-0.000	-0.000				
			(0.000)	(0.000)				
Export shares					-0.017*	-0.002		
					(0.007)	(0.007)		
Dirty export values							0.001*	0.001**
							(0.000)	(0.000)
N observations	691	691	691	691	691	691	691	691
Time-variant controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-island dummies	No	Yes	No	Yes	No	Yes	No	Yes

Note: Each block of the table reports separate weighted tariff coefficients, generated by first difference estimates of the change of aerosol index on tariffs and further controls. Time-variant controls include the first difference of precipitation, temperature, expenditure per capita, household access to electricity and population. Robust standard errors are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% level.

3.6 Sensitivity analysis

3.1.6 Robustness to confounding trends

The exogeneity assumption is violated if omitted factors exist that can endogenously influence tariff reform exposure and which are related to the initial structure of the district-level labour market. Our results are found to be robust to including the effect of initial conditions and initial levels of the dependent variable, as shown in column 3 and column 4 of Table 3.3. However, it could be argued that districts with large environmental problems lobby for industry relocation or creation that may benefit regional growth or the environment so that the regional exposure is endogenous with air quality. But any political lobbying could only happen at a national or industrial level which is again already taken out by our within regional estimations.

Moreover, if the political economy power is relatively persistent and does not change over time, it will be eliminated by the first difference approach. Finally, Mobarak and Purbasari (2006) argue that political lobbying for trade protection is difficult in the case of a developing country like Indonesia where trade reform is closely overseen by an international organisation.[69] Therefore, we do not consider that endogeneity is a big issue in this study. Nevertheless, we conduct placebo tests to check whether future tariff changes have significant effects on current outcomes.

The placebo test results suggest that our results are not biased by parallel trends that drive aerosol index and are insufficiently controlled for by the initial conditions. Table 3.6 presents the results of the changes in air pollution measure regression on future changes in tariff measures. We can see from the table that future tariffs are not related to the

[69] They empirically proved that there is no relationship between a political economy connection variable and tariffs.

current change in air pollution measure. All in all, the placebo test in general shows that tariffs are exogenous and suggest that the positive relationships between tariff reduction and air pollution are not driven by omitted variables, or differential growth trajectories of regional economies, irrespective of the specifications.

3.1.7 Spatial spillovers

We ran regressions on equation (3.5) and (3.6) for the spatial autoregressive model (SAM) and spatial Durbin model, respectively. The results in Table 3.7, in general, show that controlling for spatial dependence does not change our main results[70] of tariff reduction impact on air pollution. The tariff coefficient still significant and relatively has the same magnitude. From the SAR regression, the spatial lag term of pollution is significant which indicates that spatial dependence inherent in our sample data. The results show that neighbours' average pollution influence local pollution. Meanwhile, the spatial panel fixed effects regression for SDM shows no significant effects of neighbourhood's tariff exposure to a district's air pollution condition. It is only the district's own exposure to import tariffs which matters.

Nevertheless, the spatial error model is also captured by the SDM model. Thus, we next investigate the diagnostic test for SDM. The Moran's I score of SDM model turns out to be highly significant, indicating a strong spatial autocorrelation of the residuals. The LM test for spatial error and spatial lag are also significant. The robust LM tests for both spatial types are not significant, which means that when lagged dependent variable is present, both the error and lag dependence disappears. Thus, the SDM model is more preferred than the SAR model. However, since the coefficients of SDM model is

[70] See appendix for explanations on the spatial method and spatial regression results.

relatively similar with our main result, and the neighbours' weight shows no significant effects on the results, the spatial dependency test, in general, supports our main estimation results.

Table 3.6. Placebo test: past changes in the aerosol index on changes in tariffs.

	Manuf. output tariff	Manuf. input tariff	N
	(2)	(2)	
Pollution (1 period lag)	0.270	0.072	
s.e.	(1.034)	(0.488)	232
Pollution (2 period lag)	2.220	-0.402	
s.e.	(2.010)	(0.594)	464
Time-variant controls	Yes	Yes	
year-island dummies	Yes	Yes	

Notes: Each block of the table reports separate tariff coefficients, generated by first difference estimates of the change of past pollution index on future tariffs and further controls. Time-variant controls include the first difference of precipitation, temperature, expenditure per capita, household access to electricity and population. Robust standard errors are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% levels.

Table 3.7. Spatial regression of tariff effects on the aerosol index.

Aerosol Index		
Specifications	Model	
	SAR	SDM
<u>SAR</u>		
Manuf. Input tariff	0.040***	0.043***
	(0.000)	(0.000)
W_pollution	0.024***	
	(0.000)	
W_input tariff		-0.002
		(0.590)
N observations	696	696
N districts	232	232
Year-island dummies	Yes	Yes
Time-variant controls	No	Yes

Note: The results generated by spatial panel fixed effect estimates of the change of aerosol index on tariffs and further controls. Time-variant controls include first difference of precipitation, temperature, expenditure per capita, household access to electricity and population. Robust standard errors are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% levels.

3.1.8 Robustness to different tariff measures

The positive relationship between tariffs and the aerosol index also holds for alternative tariff measures. We calculate labour-weighted output and input tariffs by replacing the weight in equation (3.1) and (3.2). The labour-weighted output and input tariff regression results are presented in Table 3.8. The evidence shows a similar relationship with the aerosol index as the labour-weighted ones, but with higher magnitudes. These relations support our main results that tariff reforms have contributed to a decrease in air pollution in Indonesia.

Table 3.8. Air pollution effects of tariff reforms, labour-weighted tariffs.

Aerosol Index				
Specifications	Model			
	(1)	(2)	(3)	(4)
Panel A				
Labour weighted output tariffs	0.027**	0.028**	0.033**	0.034**
	(0.007)	(0.006)	(0.006)	(0.006)
Panel B				
Labour weighted input tariffs	0.041**	0.041**	0.042**	0.042**
	(0.006)	(0.005)	(0.005)	(0.005)
Panel C				
Labour weighted output tariffs	-0.010	-0.005	-0.005	-0.005
	(0.008)	(0.008)	(0.009)	(0.009)
Labour weighted input tariffs	0.048**	0.044**	0.045**	0.045**
	(0.009)	(0.008)	(0.008)	(0.008)
N observations	696	696	696	696
N districts	232	232	232	232
Year-island dummies	Yes	Yes	Yes	Yes
Time-variant controls	No	Yes	Yes	Yes
Initial labour force and rural population shares	No	No	Yes	Yes
Dependent variable 1993	No	No	No	Yes

Note: Each block of the table reports separate weighted tariff coefficients, generated by first difference estimates of the change of aerosol index on tariffs and further controls. Time-variant controls include the first difference of precipitation, temperature, expenditure per capita, household access to electricity and population. Robust standard errors are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% levels.

3.7 Conclusions

This study tries to examine the effects of reducing input tariffs on air pollution in 232 Indonesian districts from 1993 to 2002. During this period, Indonesia reformed its trade policy by reducing barriers to trade in the form of import tariffs across sectors, with average import tariffs decreasing from 14.9% in 1993 to 6.2% in 2002. Meanwhile, this period also saw increased air pollution, measured by the aerosol index, in almost all Indonesian districts.

We combine tariff data with labour structure and industrial data to investigate the effects of changes in tariffs on air pollution. Our results suggest that reductions in industrial input tariffs have contributed to a decreasing air pollution index in Indonesia. One percent reduction in the manufacturing-weighted input tariff corresponds to a 0.017 decline in the aerosol index over a three-year period. Cheaper industrial input tariffs seem to have contributed to mitigating the increasing air pollution in Indonesia. On the other hand, we found no evidence of correlation of the tariff reduction for output markets with air pollution in Indonesia. Our results are robust to alternating tariff measures and potential spatial spillover effects as well as to controlling for initial conditions and regional-year dummies. The placebo regressions show no evidence of confounding trends, which supports our empirical specification.

We also consider a variety of potential causal channels that may change with tariff reforms and whose change may help to explain the observed relationships. The results indicate that the potential channels are through composition and technical effects. Trade liberalisation seems to have moved industries away from relatively dirty sectors to relatively cleaner sectors. Cheaper intermediate inputs have also helped industries to be able to invest in new and cleaner technology as well as to improve industrial efficiency.

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Appendix 3

Appendix 3-A: List of districts

Aceh Selatan
Aceh Tenggara
Aceh Timur
Aceh Tengah
Aceh Barat
Aceh Besar
Pidie
Aceh Utara
Kota Banda Aceh
Tapanuli Selatan
Tapanuli Tengah
Tapanuli Utara
Labuhan Batu
Asahan
Simalungun
Dairi
Karo
Deli Serdang
Langkat
Kota Sibolga
Kota Tanjung Balai
Kota Pematang Siantar
Kota Tebing Tinggi
Kota Medan
Kota Binjai
Pesisir Selatan
Solok
Sawahlunto/Sijunjung
Tanah Datar
Padang Pariaman
Agam
Lima Puluh Koto
Pasaman
Kota Padang
Kota Solok
Kota Sawah Lunto
Kota Padang Panjang
Kota Bukittinggi
Kota Payakumbuh
Indragiri Hulu
Indragiri Hilir
Kampar
Bengkalis
Bogor
Sukabumi
Cianjur
Bandung
Garut
Tasikmalaya
Ciamis
Kuningan
Cirebon
Majalengka
Sumedang
Indramayu
Subang
Purwakarta
Karawang
Bekasi
Bogor
Sukabumi
Bandung
Cirebon
Pandeglang
Lebak
Tangerang
Serang
Cilacap
Banyumas
Purbalingga
Banjarnegara
Kebumen
Purworejo
Wonosobo
Magelang
Boyolali
Klaten
Sukoharjo
Wonogiri
Karanganyar
Sragen
Grobogan
Blora
Rembang
Pati
Kudus
Situbondo
Kab. Probolinggo
Kab. Pasuruan
Sidoarjo
Kab. Mojokerto
Jombang
Nganjuk
Kab. Madiun
Magetan
Ngawi
Bojonegoro
Tuban
Lamongan
Gresik
Bangkalan
Sampang
Pamekasan
Sumenep
Kota Kediri
Kota Blitar
Kota Malang
Kota Probolinggo
Kota Pasuruan
Kota Mojokerto
Kota Madiun
Surabaya
Jembrana
Tabanan
Badung
Gianyar
Klungkung
Bangli
Karangasem
Buleleng
Lombok Barat
Lombok Tengah
Lombok Timur
Sumbawa
Dompu
Bima
Sumba Barat
Sumba Timur
Kupang
Pasir
Kutai Kartanegara
Berau
Bulongan
Balikpapan
Samarinda
Bolaang Mongondow
Minahasa
Kepulauan Sangihe
Manado
Boalemo
Kodya. Gorontalo
Banggai Kepulauan
Poso
Donggala
Toli-Toli
Selayar
Bulukumba
Bantaeng
Jeneponto
Takalar
Gowa
Sinjai
Maros
Pangkajene Kepulauan
Barru
Bone
Soppeng
Wajo
Sidenreng Rappang
Pinrang
Enrekang
Luwu
Tana Toraja
Polewali Mamasa
Majene
Mamuju
Ujung Pandang
Pare-Pare
Buton
Muna
Konawe
Kolaka

Pekan Baru	Jepara	Timor Tengah Selatan	Maluku Tenggara
Batam	Demak	Timor Tengah Utara	Maluku Tengah
Kepulauan Riau	Semarang	Belu	Ambon
Kerinci	Temanggung	Alor	Halmahera Tengah
Sarolangun	Kendal	Flores Timur	Maluku Utara
Batanghari	Batang	Sikka	Fakfak
Tanjung Jabung Timur	Pekalongan	Ende	Manokwari
Tebo	Pemalang	Ngada	Sorong and Tambrauw
Jambi	Tegal	Manggarai	Merauke
Oku	Brebes	Sambas	Jayawijaya
Oki	Magelang	Pontianak	Jayapura
Muara Enim	Surakarta	Sanggau	Nabire
Lahat	Salatiga	Ketapang	Yapen Waropen
Musi Rawas	Semarang	Sintang	Biak Numfor
Musi Banyu Asin	Pekalongan	Kapuas Hulu	
Palembang	Tegal	Pontianak city	
Bangka	Kulon Progo	Kotawaringin Barat	
Belitung	Bantul	Kotawaringin Timur	
Pangkal Pinang	Gunung Kidul	Kapuas	
Bengkulu Selatan	Sleman	Barito Selatan	
Rejang Lebong	Yogyakarta	Barito Utara	
Bengkulu Utara	Pacitan	Palangka Raya	
Bengkulu	Ponorogo	Tanah Laut	
Lampung Selatan	Trenggalek	Kotabaru	
Lampung Tengah	Tulungagung	Banjar	
Lampung Utara	Kab. Blitar	Barito Kuala	
Bandar Lampung	Kab. Kediri	Tapin	
Jakarta Selatan	Kab. Malang	Hulu Sungai Selatan	
Jakarta Timur	Lumajang	Hulu Sungai Tengah	
Jakarta Pusat	Jember	Hulu Sungai Utara	
Jakarta Barat	Banyuwangi	Tabalong	
Jakarta Utara	Bondowoso	Banjarmasin	

Appendix 3-B: Variables' definitions and data sources.

Tariff rate [*T_MFN*]: Simple average of most favoured nation (MFN) tariff rates. Source: Author's calculation based on UNCTAD-TRAIN database.

Aerosol Index *[pollution]*: a measure of how much the wavelength dependence of backscattered UV radiation from an atmosphere containing aerosols (Mie scattering, Rayleigh scattering, and absorption) differs from that of a pure molecular atmosphere (pure Rayleigh scattering). Source: http://disc.sci.gsfc.nasa.gov/aerosols/data-access

Precipitation [*precip*]: any product of the condensation of atmospheric water vapour that falls quickly out of a cloud. Measured in yearly Total Precipitation units (mm). Source: http://climate.geog.udel.edu

Temperature *[temper]*: Average yearly temperature in a district. Source: http://climate.geog.udel.edu

Expenditure per capita [*expcap*]: Average nominal expenditure percapita. Source: Author's calculation based on Susenas.

Electricity [elec]: Households' access to electricity (%) in district level. Source: INDO-DAPOER, The World Bank.

Population[*pop*] : Number of population in a district. Source: INDO-DAPOER, The World Bank.

Initial labour force [*agrishare, manushare, miningshare*]: The share of agriculture, manufacture, and mining labour at the district level in 1990. Source: 1990 Census, Statistics Indonesia.

Initial rural share *[ruralshare*]: the share of the rural population at the district level in 1990. Source: 1990 Census, Statistics Indonesia.

Dirty output [*dirtyoutput*] : total values of output from dirty industries in a year. Source: Statistic Industry.

Pollution intensity [*polin*]: average yearly pollution index per total output in a district. Source: http://disc.sci.gsfc.nasa.gov/aerosols/data-access and Statistic Industry.

Output over input [*OI*]: the ratio of total output over the total input of all industries in a district. Source: Statistic Industry.

Capacity Utilisation [*caputil*]: the rate at which technical potential output levels are being met or used. Source: Statistic Industry.

Import values [*dimport*]: total intermediate import values of all industries in a district. Source: Statistic Industry.

Export shares [*Xshare*]: the average shares of exported products of all industries in a district. Source: Statistic Industry.

Dirty Export shares [*dirtyX*]: the average shares of exported products of dirty industries in a district. Source: Statistic Industry.

Appendix 3-C: Descriptive statistics of main variables

Table 3-C1. Descriptive statistics of main variables

Variable	Obs.	Mean	Std. Dev.	Min	Max
Aerosol index	928	0.760	0.150	0.468	1.188
Output tariff (labour weighted)	928	10.758	3.878	4.300	20.638
Input tariff (labour weighted)	928	9.714	2.771	4.493	17.124
Output tariff (manuf. weighted)	928	13.422	5.314	0.629	40.913
Input tariff (manuf. weighted)	928	9.168	3.326	3.043	29.196
Input tariff (labour weighted, AHS)	928	10.993	3.585	5.874	18.748
Precipitation	928	1.934	0.675	0.407	3.787
Temperature	928	25.073	2.453	16.966	29.075
Expenditure per capita (in 10^3)	928	101.847	71.260	22.794	606.236
HH's access to electricity	928	74.346	24.405	0.020	100
Population	928	711282	616161	39900	5021000
Initial agricultural labour share	928	72.540	27.108	0	100
Initial mining labour share	928	2.418	6.012	0	70.79935
Initial manufacturing labour share	928	8.313	10.550	0	64.70589
Initial rural share	928	68.309	34.412	0	100
Dirty output	928	2.00E+08	1.73E+09	0	4.86E+10
Pollution intensity	923	4.88E-07	6.01E-06	1.51E-11	1.696-4
Capacity utilisation	924	60.590	20.581	0	100
Import values	924	1.87E+08	8.78E+08	0	1.23E+10
Export share	923	2.327	1.022	0	4.537961
Dirty export share	923	0.189	2.377	0	70.535

Appendix 3-D: Complete results of air pollution effects of tariff reforms, labour weighted tariffs.

Table 3-D1. Complete results of air pollution effects of tariff reforms, labour weighted tariffs.

Tariff Measures	Δ Aerosol Index											
	Model 1				Model2				Model 3			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Output labour weighted tariff	0.027**	0.028**	0.033**	0.034**					-0.010	-0.005	-0.005	-0.005
s.e.	(0.007)	(0.006)	(0.006)	(0.006)					(0.008)	(0.008)	(0.009)	(0.009)
Input labour weighted tariff					0.041**	0.041**	0.042**	0.042**	0.048**	0.044**	0.045**	0.045**
s.e.					(0.006)	(0.005)	(0.005)	(0.005)	(0.009)	(0.008)	(0.008)	(0.008)
Precipitation		-0.064**	-0.065**	-0.065**		-0.060**	-0.061**	-0.061**		-0.059**	-0.060**	-0.061**
s.e.		(0.010)	(0.010)	(0.010)		(0.009)	(0.009)	(0.009)		(0.009)	(0.009)	(0.009)
Temper		0.043**	0.046**	0.048**		0.049**	0.049**	0.051**		0.048**	0.048**	0.050**
s.e.		(0.015)	(0.015)	(0.014)		(0.014)	(0.014)	(0.013)		(0.014)	(0.014)	(0.013)
Expcap		0.124**	0.117**	0.116**		0.099**	0.098**	0.097**		0.101**	0.100**	0.100**
s.e.		(0.028)	(0.028)	(0.028)		(0.026)	(0.026)	(0.026)		(0.026)	(0.026)	(0.026)
Electric		-0.048	-0.020	-0.015		-0.018	0.010	0.014		-0.016	0.009	0.013
s.e.		(0.043)	(0.049)	(0.049)		(0.040)	(0.046)	(0.047)		(0.040)	(0.047)	(0.047)
Population		-0.006	-0.007	-0.008		-0.006	-0.009	-0.010		-0.006	-0.009	-0.010
s.e.		(0.020)	(0.020)	(0.021)		(0.018)	(0.018)	(0.018)		(0.018)	(0.018)	(0.018)
N observations	696	696	696	696	696	696	696	696	696	696	696	696
N districts	232	232	232	232	232	232	232	232	232	232	232	232
Year-island dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Initial labour force and rural population shares	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Dependent variable 1993	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes

Note: Each block of the table reports separate weighted tariff coefficients, generated by first difference estimates of the change of aerosol index on tariffs and further controls. Initial labour forces including the manufacturing, mining and agricultural shares of labour. Robust standard errors are reported in parentheses. ***,**,* mark statistical significance at the 1, 5 and 10% levels.

Appendix 3-E: Spatial Spillover

Appendix 3-E.1: Spatial Regression

There is spatial autocorrelation in a variable if observations that are closer to each other in space have related values (Tobler's Law). One of the regression assumptions is the independence of observations. If this does not hold, we obtain inaccurate estimates of the ρ coefficients, and the error term ρ contains spatial dependencies (i.e., meaningful information), whereas we want the error not to be distinguishable from random noise. Spatial dependence may occur when the spatial dimension of social and economic exist. There are two primary spatial dependence types: spatial error and spatial lag. Spatial error model is considered when the error terms across different spatial units are correlated. Spatial lag model is for the case which the dependent variable is affected by the independent variables in its own place and its neighbour's place.

Spatial autocorrelation is the correlation of a variable with itself in space. Spatial Autoregressive Model (SAR) is also known as Spatial Lag Model. Positive spatial autocorrelation exists when high values correlate with high neighbouring values or when low values correlate with loweighboring values. Negative spatial autocorrelation exists when high values correlate with low neighbouring values and vice versa. Presence of spatial autocorrelation results in a loss of information, which is related to greater uncertainty, less precision, and larger standard errors.

Different types of spatial dependency models:

- Spatial Lag Model: Y = BX + rWy + e ; e = lWe+u
- Spatial Error Model: Y = BX + e ; e = lWe+u
- Spatial Durbin Model: Y = BX + aWX* + rWy + e ; e = lWe+u
- General Spatial Model: Y = BX + rWy + LW1y + e ; e = lW1e+u

Spatial regression models are statistical models that account for the presence of spatial effects, i.e., spatial autocorrelation (or more generally spatial dependence) and/or spatial heterogeneity. if LM test for spatial lag is more significant than LM test for spatial error, and robust LM test for spatial lag is significant but robust LM test for spatial error is not, then the appropriate model is spatial lag model. Conversely, if LM test for spatial error is more significant than LM test for spatial lag and robust LM test for spatial error is significant but robust LM test for spatial lag is not, then the appropriate specification is spatial error model, [Anselin & Griffith, 1998; Anselin, 2013].

Robust versions of Spatial LM tests are considered only when standard versions (LM-Lag or LM-Error) are significant. General Spatial Model is used to deal with both types of spatial dependence, namely spatial lag dependence and spatial error dependence. Spatial Error Model is used to handle spatial dependence due to omitted variables or errors in measurement through the error term. Spatial Autoregressive Model (SAR) is also known as Spatial Lag Model. SDM model adds average-neighbour values of the independent variables to the specification. Example: the level of crime in region j depends on the intensity of policing in j as well as on the intensity in neighbouring jurisdictions.

Appendix 3-E.2: Spatial Regression Results

Table 3-E.2.A. Spatial Panel Fixed-Effects Lag Regression (SAR)

dpol	coef.	std.Err.	t	P>ItI
wly_dpol	0.0245805	0.0073785	3.33	0.001
dTLI	0.0395519	0.0064225	6.16	0.000
dprecip	-0.0665431	0.0127247	-5.23	0.000
dtemper	0.0465791	0.0164391	2.83	0.005
dexpcap	1.76E-07	1.81E-07	0.97	0.331
delectric	-0.0757924	0.081683	-0.93	0.354
dpop	-2.02E-08	2.97E-08	-0.68	0.497
javay1	-0.2303872	0.0311883	-7.39	0.000
javay2	0	(omitted)		
javay3	0.0110306	0.0259401	0.43	0.671
sumaterayl	-0.3975911	0.0289317	-13.74	0.000
sumateray2	-0.1522623	0.0271653	-5.61	0.000
sumateray3	0	(omitted)		
kalimantanyl	0	(omitted)		
kalimantany2	0.0824789	0.0392728	2.10	0.036
kalimantany3	0.336714	0.0337705	9.97	0.000
sulawesiy1	0	(omitted)		
sulawesiy2	-0.1645504	0.0394083	-4.18	0.000
sulawesiy3	0.0917123	0.0374095	2.45	0.015
_cons	0.2184709	0.0263103	8.30	0.000

Spatial Panel Autocorrelation Tests

Ho: Spatial Lagged Dependent Variable has No Spatial Autocorrelation
Ha: Spatial Lagged Dependent Variable has Spatial Autocorrelation

- LM Lag (Anselin)	=	0.0000	P-Value > Chi2 (1)	1.0000
- LM Lag (Robust)	=	5.0995	P-Value > Chi2 (1)	0.0239

Ho: No General Spatial Autocorrelation
Ha: General Spatial Autocorrelation

- LM SAC (LMErr+LMLag_R)	=	14.7430	P-Value > Chi2 (1)	0.0006
- LM SAC (LMLag+LMErr_R)	=	14.7430	P-Value > Chi2 (1)	0.0006

Table 3-E.2.B. Spatial Panel Fixed-Effects Durbin Regression (SDM)

dpol	coef.	std.Err.	t	P>ItI
dTLI	0.0426762	0.0071037	6.01	0.000
dprecip	-0.0760528	0.0134872	-5.64	0.000
dtemper	0.0525934	0.0171536	3.07	0.002
dexpcap	1.73E-07	1.84E-07	0.94	0.348
delectric	-0.0912378	0.0845115	-1.08	0.281
dpop	-9.78E-09	3.08E-08	-0.32	0.751
javay1	-0.2326028	0.0328103	-7.09	0.000
javay2	0	(omitted)		
javay3	0.0054835	0.0292878	0.19	0.852
sumateray1	0	(omitted)		
sumateray2	0.2871063	0.0416249	6.90	0.000
sumateray3	0.4088924	0.0367277	11.13	0.000
kalimantany1	0	(omitted)		
kalimantany2	0.1095205	0.0470998	2.33	0.021
kalimantany3	0.3880171	0.0402435	9.64	0.000
sulawesiy1	0	(omitted)		
sulawesiy2	-0.1329499	0.0524551	-2.53	0.012
sulawesiy3	0.160773	0.0464912	3.46	0.001
wlx_dTLI	-0.0016405	0.0030436	-0.54	0.590
wlx_dprecip	0.000915	0.0058106	0.16	0.875
wlx_dtemper	0.0053803	0.006941	0.78	0.439
wlx_dexpcap	-6.54E-08	1.05E-07	-0.62	0.535
wlx_delectric	0.0599832	0.0452398	1.33	0.186
wlx_dpop	-2.91E-08	1.86E-08	-1.56	0.120
wlx_javay1	-0.018269	0.0093089	-1.96	0.050
wlx_javay2	0.0025911	0.0118692	0.22	0.827
wlx_javay3	0	(omitted)		
wlx_sumatera-1	-0.0072888	0.014806	-0.49	0.623
wlx_sumatera-2	0	(omitted)		
wlx_sumatera-3	0.007476	0.0122324	0.61	0.541
wlx_kalimantan-1	0	(omitted)		
wlx_kalimantan-2	0.0037501	0.0153445	0.24	0.807
wlx_kalimantan-3	-0.0258037	0.0149483	-1.73	0.085
_cons	0.1154202	0.053649	2.15	0.032

Panel Heteroscedasticity Tests

Ho: Spatial Lagged Dependent Variable has No Spatial Autocorrelation
Ha: Spatial Lagged Dependent Variable has Spatial Autocorrelation

- LM Lag (Anselin)	=	25.8708	P-Value > Chi2 (1)	0.0000
- LM Lag (Robust)	=	0.6855	P-Value > Chi2 (1)	0.4077

Ho: No General Spatial Autocorrelation
Ha: General Spatial Autocorrelation

- LM SAC (LMErr+LMLag_R)	=	26.5378	P-Value > Chi2 (1)	0.0000
- LM SAC (LMLag+LMErr_R)	=	26.5378	P-Value > Chi2 (1)	0.0000

4. CHAPTER 4

Tariff Reform and Child Mortality in Indonesia

4.1 Introduction

Many developing countries, including Indonesia, are becoming more open to international trade. The question of whether expanding international trade brings benefits that outweigh the potential risks is still contested. One of the emerging debates is on the health impacts of trade liberalisation. The impacts can be both positive and negative. On one hand, health might improve with economic growth (Pritchett and Summers, 1996; Frankel and Romers, 1999) and income of workers from sectors with comparative advantage (Krueger, 1974) as well as with increasing living standards (Dollar and Kraay, 2001). Trade liberalisation might also lower the price of health products and services, thus improving people's access to better health (Blouin et al., 2006). On the other hand, health conditions might degrade for workers in import-competing sectors because of temporary or permanent unemployment or decreasing wages (Ruhm, 2000). Furthermore, trade might lead to numerous health concerns through environmental degradation as a result of rising industrialisation, along with trade expansion (Rock, 1996; Federman and Levine, 2010).

The human health condition is not only important in itself (Sen, 1999), but also for long-run economic growth (Levine and Rothman, 2006). Trade policy cannot stand alone, and we cannot ignore the effects of increasing trade flows on health. It is important to understand trade-health relationships so that international trade policies can maximise potential health benefits and minimise potential risks and threats, especially for poor people (Blouin and Drager, 2015). The interconnections between international trade and public health deserve more consideration than they have been given to date (Shaffer et al., 2005).

Despite the importance of the issue, empirical studies on the impact of trade liberalisation on health are still limited, and the results are mixed. Using cross-country analysis, Levine and Rothman (2006) find that trade significantly improves health outcomes, despite weaker effects which were sometimes not significant after controlling for income. They argue that the main channel to improve health is through enhanced income. Since trade can be endogenous to income and health, they follow Frankel and Romer's (1999) method, using an exogenous proxy of trade predicted by a gravity model. Similarly, Owen and Wu (2007), using fixed effect panel data analysis and controlling for incomes and other variables, show that trade openness improves child mortality and life expectancy in a panel of 210 developed and developing countries. They argue that knowledge spillover is one of the channels, supporting Deaton (2004). However, the positive impact is not robust when the sample is limited to developing countries where the impact of child mortality is no longer significant. However, Winters et al. (2004) argue that the effect of trade liberalisation on health outcomes can be heterogeneous and specific to each country. Similarly, the channels could vary across countries, since each country may have different economic and institutional conditions. Thus, it is important to investigate the effect of trade liberalisation on health outcomes at a national or regional level to understand the impact and mechanism as well as to strengthen policy responses.

We attempt to contribute to the issue by providing empirical evidence on the trade-health relation in the context of Indonesia. Given its unique geographic and economic characteristics, Indonesia offers an intriguing case study. Over several decades, Indonesia has experienced vast trade liberalisation by reducing import tariffs and participating in many trade agreements (Basri and Hill, 2004). Indonesia's simple average of applied most favoured nation (MFN) tariff decreased from around 6% in late 1990 to around 1.4% in 2012. Table 4.1 summarises the detailed evolution of Indonesia's simple average of applied most favored nation (MFN) tariff of 20 tradable sectors during the period 1993-2007. In general, industries with higher initial tariffs experienced the largest tariff reductions relative to initial levels. This correlation shows that tariff reductions were not discriminatory across sectors and did not favour any possibly protected sectors.

Table 4.1. Evolution of average most favoured nation tariff rates by sector.

Sector	Tariff rates (%)		
	1993	1999	2007
Agriculture			
Plants and Animals	16.62	10.6	5.11
Forestry	7.56	3.3	2.44
Hunting	8.5	3.17	1.5
Sea Fishery	25.4	14.08	5.4
Fresh-water fishery	10	0	0
Mining			
Coal Mining	5	5	5
Metal ores mining	3.96	4.05	3.67
Stones & sand mining	7.66	3.98	3.83
Salt mining	20	15	8
Minerals and chemical mining	3.16	3.04	3.08
Other mining	4.09	3.75	3.24
Manufacturing			
Food, beverages & tobacco	22.91	18.99	10.73
Textiles, apparel, leather	27.59	17.7	10.75
Wood & products	27.8	14.22	7.55
paper and products	19.99	7.42	4.38
Chemicals and products	11.11	8.04	5.73
Nonmetallic-mineral products	21.1	7.78	8.12
Basic metals	9.42	7.2	5.75
Metal products	16.41	9.01	5.38
Other manufacturing	32.57	18.26	10.77

Note: Sectors are constructed based on a concordance between tariff and census labour market data.
Source: Indonesia Customs Book and UNCTAD-TRAINS database.

At the same time, similar to many developing countries, improving health conditions of the people is one of Indonesia's objectives. Health outcomes have significantly improved in Indonesia since the 1970s. Based on Ministry of Health reports,[71] the infant mortality rate declined from 145 per 1,000 live births in 1970 to 68 per 1,000 live births in 1990 and was down to 34 in 2012. Likewise, the under-five mortality rate has lowered from 98 in 1990 to around 40 per 1,000 live births. Nutrition status had shown steady progress from almost 11 percent case of malnutrition of children in 1990 to around 5 percent in 2013. The Maternal Mortality Ratio (MMR) decreased from 390 per 100,000 in 1990 to 228 per 100,000 in 2007 but rose to 359 in 2012. These factors had contributed to an improvement in life expectancy from 44 in the 1970s to 70.7 in 2013.

Despite the above progress, improvement in the infant and under-five mortality rate had slowed down, even stagnated, around 2007 to 2012. Looking at the sub-national level, the average numbers show obvious geographic differences in health progress including substantial variations in child mortality measures and malnutrition across regions. These disparities are also shown in the coverage of various health programmes and health facilities.[72]

In this study, we examine the relationship between regional tariff exposures and child mortality in Indonesian districts in 2007. We focus on two measures of mortality: infant mortality and under-five mortality rates. We find that districts' higher exposures to intermediate input tariffs were associated with lower infant and under-five mortality rates and that the relationships were stronger in rural compared to urban regions. Our results imply that being one percentage point more exposed to international trade is associated with 2.3 fewer infant deaths per 1000 births and 2.7 fewer deaths before age 5 per 1000

[71] Profil Kesehatan Indonesia (Indonesian Health Profiles), various years.
[72] Complete figures can be seen in Peta Kesehatan Indonesia (Indonesian Health Map) published by Indonesia Ministry of Health, various years.

births, approximately. In addition, we also explore the potential mechanisms underlying the observed relationships. We find that higher trade exposure was associated with higher per capita income, more health facilities, and a higher share of manufacturing employment as well as lower total fertility rates.

Our study extends the literature on the health effects of trade exposure by focusing on the effect of one particular health measure: child mortality. We also enhance the literature by developing district exposure to tariffs and investigating the mechanisms behind the results. However, following Edmonds et al. (2010) and Kis-Katos and Sparrow (2015), we focus only on the effects of tariff reductions and ignore changes in non-tariff barriers (NTBs). This is primarily due to data availability. Removal of NTBs is unarguably an important part of Indonesian trade liberalisation. Our study measures the effect of another dimension of the reforms, namely tariff cuts. We should admit that the exclusion of NTBs is potentially harmful to our empirical strategy, especially if the trends in NTBs were in the opposite direction as those for tariffs. But as previously acknowledged by Edmonds et al. (2010), the existing literature suggests that tariffs and NTBs have a positive correlation.

Nevertheless, our results might be biased if they are to represent the impact of trade liberalisation on child mortality since some of the effects should be assigned to the NTBs. Thus, we limit the discussion to the extent that our results represent the correlations of tariff reform (only) on child mortality measures. Moreover, even though based on our placebo test we find no evidence of reverse causality, our empirical model is still prone to omitted variable bias. Therefore, the association between trade exposure and child mortality cannot be interpreted to imply causality.

The rest of the paper proceeds as follow. In section 4.2 we describe data sources for the analysis while in section 4.3 we outline our measurement and identification strategy. The results and discussion follow in section 4.4, while section 4.5 provides sensitivity analysis. Section 4.6 shows potential mechanisms, and the last section concludes.

4.2 Data

We measure trade exposure as the relative importance of average national most favoured nation (MFN) tariffs across districts in the year 2007. The tariff data are derived from the UNCTAD-TRAIN database[73] and were cross-checked using the Indonesian Customs Tariff Book series.[74] We combine tariff data with district-level labour market structure characteristics in the pre-analysis period, based on the 1990 Indonesian Census.[75] The census has information on main sectoral occupations at the two-digit level. We examine the concordance between sectoral information in tariff data and the census; we are thus able to construct 20 sectoral tariff lines: 5 different sectors in agriculture, six sectors in mining and nine sectors in manufacturing.[76]

Our primary source of child mortality measurement is Riskesdas (Riset Kesehatan Dasar) or Indonesia Basic Health Research data 2007, a community-based Basic Health Research survey performed by the Ministry of Health which enrolled more than 98.000 subjects from almost 260,000 households in 33 provinces. Riskesdas 2007 is the sixth in

[73] Downloaded through the WITS system of the World Bank.
[74] 'Buku Tarip Bea Masuk', various years was collected in the form of books (hard copy). We thus calculated the sectoral tariff by first manually inputting data from the tariff books into a computer to further analyse it with concordance of the UNCTAD-TRAIN database. We found similar results using either set of data, so in the analysis we use the series of tariffs from the UNCTAD-TRAIN database.
[75] The census is available in the IPUMS database system (Minnesota Population Center, 2013).
[76] The 20 sectors are: plants and animals; forestry; hunting; sea fishery; fresh-water fishery; coal; metal ore; stones; salt; minerals and chemicals; other mining; food, beverages and tobacco; textile, apparel and leather; wood and products; paper and products; chemicals; non-metallic products; other manufacturing.

a series of surveys undertaken as part of the International Demographic and Health Surveys (IDHS) project. The first survey was the National Indonesia Contraceptive Prevalence Survey carried out in 1987. Subsequent surveys were conducted in 1991, 1994, 1997, and 2002-2003. The 2007 IDHS was designed together with Badan Pusat Statistik (BPS)-Statistics Indonesia, the National Family Planning Coordinating Board (NFPCB), and the Ministry of Health (MOH). The main objective of the 2007 IDHS was to provide detailed information on population, family planning, and health for policymakers and programme managers.[77] We also include several control variables in our specification, including the district's average number of individual health-related variables, household characteristics, district demographics, and facilities, as well as geographical factors. All but geographical control variables were derived from Riskesdas and Susenas (national socio-economic survey) 2007.

We include three geographical factors as control variables: air pollution, rainfall, and temperature. Data on precipitation and temperature were taken from the Center for Climate Research (CCR), Dept. of Geography, University of Delaware.[78] Besides extracting child mortality data, we also sourced some control and potential channel variables from Riskesdas 2007 as will be described in the methodology section. Furthermore, we sourced some information at the district level for constructing additional control variables (percentage of poor people in a district, poverty gap, and literacy rate) from the Indonesian Database for Policy and Economic Research (INDO-DAPOER) which is available on the World Bank website. Finally, we used the 1990 national input-output (IO) table[79] to draw a set of information on sectoral input-output structure. We then combined this information with the regional economic structure as well as the

[77] Demographic and Health Survey Report 2007, Ministry of Health, Indonesia.
[78] http://climate.geog.udel.edu/~climate/html_pages/download.html#ghcn_T_P2
[79] We use an IO table with 66 sectors based on the 1990 economic census which was published by Statistics Indonesia (BPS).

associated tariffs to construct regional input and output tariffs, similar to Kis-Katos and Sparrow (2015).

Our dataset covers 282 districts from 26 provinces. Indonesia actually had more than 300 districts in 1993 and grew to more than 400 districts in 2002. Unfortunately, our data sets do not cover all existing districts in the corresponding year. After combining different datasets and dealing with district splits[80] we are left with a balanced panel of 282 districts, comprised of rural (*kabupaten*) and urban districts (*kota*). The descriptive statistics of the changes in our main variables are presented in Table 4.2, while the district list and descriptive statistics for all variables are presented in the appendix to this chapter.

4.3 Empirical strategy

4.3.1 Measurement of tariff exposure

To examine the effects of tariff reform on child mortality, we consider using average nominal tariffs weighted by initial labour market structure of the region, as constructed by Topalova (2007) and Edmonds et al. (2010) and further modified by many recent papers.[81] We adopt the method by Kis-katos and Sparrow (2015) in constructing regional tariff exposures, by incorporating labour weighted and manufacturing weighted tariffs approach. This method exploits Indonesia's geographic diversity in how households are affected by national tariff changes.

Table 4.2. Descriptive statistics of main variables.

[80] We deal with district splits by grouping the new districts back into their original 1993 district.
[81] This method has been further modified and used by Kovak (2010), Kis-Katos & Sparrow (2011), McCaig (2011), Fukase (2013), Castilho et al. (2012), and Kis-Katos & Sparrow (2015).

Variable	Mean	Std. Dev.	Obs.
Infant mortality rates	11.47	12.06	282
Under-five mortality rates	15.99	15.15	282
Change of output tariffs 2007-1993	-10.67	4.18	282
Change of input tariffs 2007-1993	-6.93	2.51	282

For each sector s in district d, we calculate the relative importance of a sector in a district as a weight, $L_{s,d}/L_d$, where $L_{s,d}$ is the district sectoral labour and L_d is total labour in a district in the initial year, based on Industrial Statistic data 1990.[82] The district tariff at time t is then calculated according to:

$$Output\ Tariff_{d,t} = \sum_{s=1}^{23} \left[\frac{L_{s,d}}{L_d}\ x\ T_{s,t} \right] \tag{4.1}$$

where $T_{s,t}$ is the national tariff in sector s at time t. The use of time-invariant, pre-sample period employment weight is to control for then unobserved counterfactuals of what would have been the evolution of child mortality rates across Indonesian district in the absence of tariff reform. Thus, changes in child mortality rates that are not a consequence of trade reform should not be included in the calculation of regional tariffs. Therefore, district exposure to tariff reforms is based only on the tariff cuts and the pre-existing structure of employment within a district.[83] According to McCaig (2011), the use of pre-reform time-invariant weights is common in many empirical micro literatures, such as Bernard and Jensen (2004) and Lemieux (2002).

[82] After taking concordance between input and output data in 1975 into account, we managed to distinguish between 23 different industrial tradable outputs.
[83] This is apparently not a perfect method for controlling for the unobserved confounder as employment weights might change even without changes in tariffs.

Following Amiti and Konings (2007), Amiti and Cameron (2012) and Kis-Katos and Sparrow (2015), we construct labour-weighted input tariffs in order to identify the separate effects of reducing output and input tariffs on child mortality rates. District exposure to input tariffs is measured by first weighing the tariff by input share of each sector computed from the 1990 national input-output table, ($M_{j,s}/M_s$), and then further weighted by the industry's initial (t=1990) labour share as the measure of relative regional importance, $L_{s,d}/L_d$.

$$InputTariff_{d,t} = \sum_{s=1}^{23} \left[\frac{L_{s,d}}{L_d} \; x \left(\sum_{j=1}^{20} \frac{M_{j,s}}{M_s} \; x \; T_{j,t} \right) \right] \qquad (4.12)$$

The input specific weight, $M_{j,s}/M_s$, is the initial share of j industry over all inputs of any sector s in 1990 and $T_{j,t}$ is the corresponding national tariff of each input j in year t. The input weight is based on total input purchases, including domestic and import inputs. If otherwise, only imported inputs were used, it would lead to endogeneity bias as argued by Amiti and Cameron (2012). Since the 1990 input-output table that we have is only available at the national level, we have to assume that the district level structure of inputs is similar to the national structure.

4.3.2 Estimation methods

Previous empirical work investigating the impact of district tariff exposure in Indonesia use the following specification (Amiti and Cameron, 2012; Kis-Katos and Sparrow, 2015):

$$y_{d,t} = \alpha + T'_{d,t}.\beta + X'_{d,t}.\gamma + \lambda_{r,t} + \varepsilon_{d,t} \qquad (4.3)$$

where $y_{d,t}$ is the outcome observed in district d at year t, $T'_{d,t}$ is a vector of district input and output tariff exposures in district d at year t. $X'_{d,t}$ is a vector of district d characteristics at year t and λ_r is to control for common shocks across all districts within major Indonesian island groups.[84] The coefficient of interest, β, captures the effect of regional tariff exposure on the outcome of interest.

To reduce unobserved variable bias, it is common to conduct a fixed effect estimation of equation (1) or to estimate the first difference model as:

$$\Delta y_{d,t} = \alpha + \Delta T'_{d,t}.\beta + \Delta X'_{d,t}.\gamma + \lambda_{r,t} + \varepsilon_{d,t} \tag{4.4}$$

This method removes district fixed effects and eliminates the unobserved heterogeneity that might be instigated by the initial district structure.

The reason for the implementation of the specification in equation (4.4) is that information on child mortality indicators—or for any other health indicators—at the district level is not available for 1993; i.e., the initial period of our analysis. Health indicators at district level are typically available after 2000. Therefore, we manipulate equation (4.4) as follows.

$$y_{d,t} - y_{d,t-1} = \alpha_1 + \Delta T'_{d,t}.\beta_1 + \Delta X'_{d,t}.\gamma_1 + \lambda_{1r,t} + \varepsilon_{1d,t} \tag{4.5}$$

and assume that vector $X_{d,t-1}$ is a good prediction of $y_{d,t-1}$ such that

$$y_{d,t-1} = \alpha_0 - X'_{d,t-1}.\gamma_0 + \lambda_{0r,t} + \varepsilon_{0d,t} \tag{4.6}$$

[84] There are five main island dummies: Sumatera, Java, Kalimantan, Sulawesi and the outer islands.

Substituting (4.5) into (4.6) produces

$$y_{d,t} = \alpha + \Delta T'_{d,t}.\beta_1 + \Delta X'_{d,t}.\gamma_1 + X'_{d,t-1}.\gamma_0 + \lambda_{r,t} + \varepsilon_{d,t} \tag{4.7}$$

Equation (4.7) was adopted as the main estimation model, in which $y_{d,t}$ is the infant or child under-five mortality rates for district d in 2007, $\Delta T'_{d,t}$ consists of $TO_{d,2007} - TO_{d,1993}$ and $TI_{d,2007} - TI_{d,1993}$, $\Delta X'_{d,t}$ is $X'_{d,2007} - X'_{d,1993}$, $X'_{d,t-1}$ is $X'_{d,1993}$ and X'_d is a vector of all control variables utilised at district level, namely size of population, share of female population, average household expenditure per capita, family size, average household's monthly protein and calorie intake, average breastfeeding period, average age at which first married, percentage of married people, percentage of divorced, total fertility rate, average cases of skilled birth assistance attendance during labour, , average mother's education, immunisation rate, literacy rate, average completion rate per education level, diarrhoea prevalence, employment rate, sectoral labour share, average number of households with electricity access, air pollution, temperature and precipitation.

As mentioned before, β_1 is the coefficient of interest. The interpretation of β_1 is as follows. A positive β_1 means a higher reduction of tariff exposure will reduce the child mortality rate, and a negative β_1 means a higher reduction of tariff exposure will increase child mortality (Amiti and Cameron, 2012; Kis-Katos and Sparrow, 2015).

4.4 Results and discussions

The general effects of tariff reductions on infant and under-five mortality rates for equation (4.7) are shown in Table 4.3 and Table 4.4 (see columns 1a to 4a for the infant mortality rate and columns 1b to 4b for the under-five mortality rate).[85] Overall, there is

[85] Complete results of the regressions are available in the appendix.

a negative correlation between both child mortality rate measures and input tariff exposure, implying that tariff reform for input markets is associated with higher child mortality rates. The relationship persists after controlling for time-variant controls, island dummies, and initial sectoral labour and rural shares. By contrast, output tariffs have a positive association with under-five mortality rates, which implies that output tariff reform is associated with lower under-five mortality rates. However, the significance disappears after controlling for the initial structure of the economy and society. Furthermore, we find no significant relationships between output tariff reforms and infant mortality rates.

We refer to column 4a and column 4b as our preferred specification for interpreting the effects. We find that a one percentage point more reduction in input tariff corresponds to 2.8 infant deaths per 1000 births and 3.7 deaths of children under-five per 1000 births. Tariff reductions for intermediate inputs are associated with higher infant and under-five mortality rates in Indonesian districts while reducing output tariffs has no statistically significant effect on child mortality rates.

A one percentage decrease in input tariff is associated with an additional 2.8 infant deaths per 1000 births and 3.7 under-five children deaths per 1000 births. Kis-Katos and Sparrow (2015) argue that import tariff reduction seems to increase firm competitiveness which then contributes to an increase in work participation and wages for medium and low skilled labour. Furthermore, they are convinced that input tariff liberalisation has increased the incomes of the poor.

It has been suggested that increased income in developing countries would lower annual child death rates (Pritchett and Summers, 1996). From this perspective, trade liberalisation is ‘good for the poor’ and ‘good for health’ (Dollar and Kraay, 2002). But this does not appear to be the case in this study. The results of this study indicate that districts which are more exposed to input tariff reductions experience higher child mortality rates. It seems that the income benefits of intermediate tariff liberalisation do not appear to improve health conditions in Indonesia. The possible reasons might lie in the doubtful nutrition transition impact of trade liberalisation as suggested by previous studies (Hawkes, 2006; Schmidhuber and Shetty, 2005; Popkin, 2006). However, the exact paths are not clear, and there are very few studies that attempt to check the links. We try to explore the possible partial mechanism behind our main results and present the findings in section 4.6.

Next, we examine the variation in the correlation between tariff exposure and child mortality rates in rural and urban areas. We split our samples into rural and urban and run a similar regression as equation (4.7). The results are presented in Table 4.5. The results are similar to the full sample. Input tariffs seem to have significant correlations with both infant and under-five mortality rates while output tariffs show no significant relationships with mortality measures, except for infant mortality rates in urban districts. Based on columns 2 and 4, the correlations of tariffs and infant mortality rates are higher in magnitude and significance for urban region sample regressions.

In contrast, the association coefficients between input tariffs and under-five mortality rates are higher for rural regions as shown in columns 6 and 8. Overall, the conclusion remains. Districts with higher exposure to tariff reform experienced higher child mortality rates.

4.5 Robustness checks

4.5.1 Robustness to alternative specifications

Equation (4.7) is derived from a first difference assuming that $X'_{d,1993}$ is a good prediction of $y_{d,1993}$. Since numerous variables are included for 1993 and 2007 so that one can generate information from the available datasets for Indonesia, estimating equation (4.7) should in theory greatly reduce the time-invariant missing confounding variables.

However, there are several potential omitted confounders that might affect or change our results. First, migration. Differential migration patterns could result from different demand for labour in different sectors facing tariff cuts. Over our period of analysis, the change in child mortality rates might only represent migration across districts, and not the effects of tariff reform.

Second, initial child mortality rate. Districts that initially had higher child mortality rates are more likely to have higher levels of child mortality rates now compared to other districts, assuming that tariff cuts give the same decreasing rate across districts. Thus, the association between tariff cuts and child mortality rates might be overestimated since part of the effect should be assigned to initial child mortality rates.

Next, one could argue that it is not tariff cuts that matter, but initial tariffs. The argument is based on the fact that sectors which initially had high tariff rates experienced larger cuts[86] so that the effect of tariff cuts is merely the effect of initial tariffs.

[86] As described in chapter 1 on Indonesian tariff cuts.

Lastly, because of data limitations, we mentioned that we had to merge back split districts to their parent districts in 1990. This cross-walked method might induce problems since any cross-walked districts' variables do not fully represent the true conditions in 2007. Furthermore, splitting might affect socio-economic conditions both to parents and new districts.

We deal with these potential confounding factors by adding related control variables in our main model: in-migration rates, initial levels of dependent variables, initial tariff levels and splitting dummies. The results are presented in columns 5a to 7a in Table 4.3 and columns 5b to 7b in Table 4.4.[87] For both infant and under-five mortality rates, all input tariff cut variables show significant relationships, regardless of alternative control variables and specifications. The coefficients' signs show the consistency of our main results that districts with higher exposure to tariff cuts experienced higher rates of infant and under-five mortality. Thus, the results for both infant and under-five mortality rates are relatively robust to any specifications.

[87] Complete results for infant and under-five mortality rates are in the appendix.

Table 4.3. Regional tariff exposure for infant mortality rates, as equation (4.7).

	Model 1a	Model 2a	Model 3a	Model 4a	Model 5a	Model 6a	Model 7a
Δ Output Tariff	0.566	0.752	0.774	0.575	1.807	1.817	1.003
	(0.386)	(0.533)	(0.572)	(.255)	(1.975)	(2.017)	(1.923)
Δ Input Tariff	- 0.468	- 2.325**	- 2.353**	- 2.817*	- 2.963*	- 2.949*	- 2.570*
	(0.621)	(0.803)	(0.880)	(1.061)	(1. 36)	(1.152)	(1.93)
Control variables	No	Yes	Yes	Yes	Yes	Yes	Yes
Island dummies	No	No	Yes	Yes	Yes	Yes	Yes
Initial structure of the economy and society	No	No	No	Yes	Yes	Yes	Yes
Initial input and output tariff exposures	No	No	No	No	Yes	Yes	Yes
Split district dummies	No	No	No	No	No	Yes	Yes
Proxy for in-migration	No	No	No	No	No	No	Yes
N observations	221	221	221	221	221	221	221
Adjusted R-square	0.015	0.595	0.602	0.616	0.622	0.622	0.643

Note: The table reports weighted tariff coefficients, generated by first difference estimates of district infant mortality levels on changes of tariffs and further controls. Time-variant controls include the general welfare of the society, geophysics characteristics, female characteristics, general health status, marriage and fertility characteristics (complete list in the appendix to this chapter). Robust standard errors are reported in parentheses. **,*, + mark statistical significance at the 1, 5 and 10% levels.

Table 4.4. Regional tariff exposure for under-five mortality rates, as equation (4.7).

	Model 1b	Model 2b	Model 3b	Model 4b	Model 5b	Model 6b	Model 7b
Δ Output Tariff 2007- 1993	0.554	1.547*	1.385*	2.081	4.747*	4.689*	3.559+
	(0.400)	(0.641)	(0.686)	(1.486)	(2.162)	(2.205)	(2.081)
Δ Input Tariff 2007- 1993	- 0.243	- 2.810**	- 2.903**	- 3.752**	- 4.052**	- 4.133**	-3.629**
	(0.616)	(0.911)	(0.989)	(1.123)	(.199)	(1.231)	(1.246)
Control variables	No	Yes	Yes	Yes	Yes	Yes	Yes
Island dummies	No	No	Yes	Yes	Yes	Yes	Yes
Initial structure of the economy and society	No	No	No	Yes	Yes	Yes	Yes
Initial input and output tariff exposures	No	No	No	No	Yes	Yes	Yes
Split district dummies	No	No	No	No	No	Yes	Yes
Proxy for in-Migration	No	No	No	No	No	No	Yes
N observations	221	221	221	221	221	221	221
Adjusted R-square	0.015	0.592	0.599	0.630	0.649	0.649	0.660

Note: The table reports weighted tariff coefficients, generated by OLS estimates of district under-five mortality levels on changes of tariffs and further controls. Time-variant controls include the general welfare of the society, geophysics characteristics, female characteristics, general health status, marriage and fertility characteristics (complete list in the appendix to this chapter). Robust standard errors are reported in parentheses. **,*, + mark statistical significance at the 1, 5 and 10% levels.

Table 4.5. Regional tariff exposure and child mortality rates in urban and rural regions.

Specification	Infant Mortality				Under-five mortality			
	Urban		Rural		Urban		Rural	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Output Tariff	0.989	1.604+	0.846	1.289	1.024	1.355	0.919	1.008
	(0.868)	(0.915)	(0.892)	(0.992)	(0.904)	(0.950)	(0.884)	(0.990)
Input Tariffs	- 2.558*	- 2.498*	- 2.489+	- 2.225+	- 2.761*	- 2.925*	- 3.061*	- 2.994*
	(1.140)	(1.183)	(1.352)	(1.305)	(1.199)	(1.242)	(1.395)	(1.365)
N observations	263	263	242	242	263	263	242	242
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Island dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Initial sectoral share	No	Yes	No	Yes	No	Yes	No	Yes

Note: The table reports separate weighted tariff coefficients, generated by OLS estimates of district child mortality levels on tariffs and further controls. Time-variant controls include the general welfare of the society, geophysics characteristics, female characteristics, general health status, marriage and fertility characteristics (complete list in the appendix to this chapter). Robust standard errors are reported in parentheses. **,*, + mark statistical significance at the 1, 5 and 10% levels.

4.5.2 Robustness to any confounding trends

The exogeneity assumption is violated if the variations in tariff reform across districts are correlated with pre-existing trends. It could be argued that districts with high health problems lobby for industry relocation or creation that may benefit regional growth or the environment so that regional exposure is endogenous with child mortality. However, any political lobbying could only happen at a national level, which is again already taken out by regional estimations. Moreover, Mobarak and Purbasari (2006) argue that political lobbying for trade protection is not likely to be the case in developing countries.[88] Nevertheless, we conduct placebo tests to check whether future tariff changes have significant effects on current outcomes.

The placebo test results suggest that our results are not biased by parallel trends that drive child mortality and are insufficiently controlled for by the initial conditions. Table 4.6 presents the results of infant and under-five mortality rate regression on future tariff measures.

Table 4.6. Placebo test: past changes in child mortality on changes in tariffs.

	Infant mortality rate		Under-five mortality rate	
Output Tariff	- 1.183	- 1.358	- 2.070	- 2.089
	(1.202)	(1.420)	(1.444)	(1.776)
Input Tariff	2.009	2.148	2.482	2.735
	(1.811)	(2.085)	(2.260)	(2.647)
Control variables	Yes	Yes	Yes	Yes
Island dummies	No	Yes	No	Yes
N observations	221	221	221	221
Adjusted R-square	0.564	0.573	0.560	0.568

Note: The table reports weighted tariff coefficients, generated by OLS estimates of district child mortality levels on changes of tariffs and further controls. Time-variant controls include the general welfare of society, geophysical characteristics, female characteristics, general health status, marriage and fertility characteristics (complete list in the appendix to this chapter). Robust standard errors are reported in parentheses. **,*, + mark statistical significance at the 1, 5 and 10% levels.

[88] They empirically proved that there is no relationship between a political economy connection variable and tariffs.

We can see from the table that future tariffs are not related to current child mortality. These suggest that the relationships between tariff reduction and child mortality are not driven by omitted variables, or differential growth trajectories of regional economies, irrespective of the specifications.

4.6 Potential mechanisms

Trade can affect health through various mechanisms. First, trade might affect income and economic growth (Frankel and Romer, 1999; Levine and Rothman, 2006; Billmeier and Nannicini, 2013). Then, trade might affect poverty and inequality (Topalova, 2010, Kis-Katos and Sparrow, 2015) and through public expenditure on public goods such as education and health services (Conway, 2004). Next, in the labour market, trade liberalisation in the short term might create unemployment. Unemployed people might lose their health coverage, impeding access to health assistance or treatment and forgoing medication due to cost (Sullivan and Wachter, 2009). However, trade liberalisation might induce increasing wage in sectors with comparative advantage and decreasing wages in other sectors such as in import-competing sectors. Decreased wages in the short term reduce the opportunity cost of having children and thereby increases the birth rate. On the other hand, decreasing income may affect whether households can afford to raise children which may push the birth rate down (Dettling and Kearney, 2014). Furthermore, trade can affect babies' development, as indicated by the fetal origins hypothesis (Barker et al., 1990; Barker, 1995).

Another potential mechanism is through environmental quality degradation which in turn affects human health (Pearce, 1996). In addition, Cutler et al. (2006) argue that urbanisation is an alternative channel for the trade-health relationship. Urbanisation is not good for health, at least initially, since unsanitary conditions are larger and the spread of disease is easier in bigger, more crowded, newly enlarged cities. On the other hand, trade can generate revenue to develop medical interventions and medical technology and inventions. Freeze-dried serums can be transported to remote areas without refrigeration; oral dehydration therapy can prevent children dying from diarrhoea.

Trade liberalisation might also affect nutrition by affecting the food chain through exports, imports, food supply chain dynamics and foreign direct investment (FDI) in food processing, retail, and marketing. Reduced import tariffs increase imports of food, widen the choices of food and lower prices. The effects on health depend on how it affects the diet. Nutrition can change because of dietary changes due to the impact of trade liberalisation, which in turn induces diet-related chronic disease. Local short food chains might be shifted because of rising investment in value-added processed food. Investment also pushes marketing and stimulates the spread of modern retailers which in turn increase the sales of packaged food and change cultural expectations via advertising and product marketing, e.g., soft drinks. Moreover, trade can affect health via accidents, crimes, war and conflicts (Carneiro et al., 2015), knowledge spillover in health product and service development, and cultural influence.

In this chapter, we consider total fertility rates, average breastfeeding length, average expenditure per capita, average food expenditure per capita, the share of agricultural workers and share of manufacturing workers at the district level as possible channels as to how district tariff exposures affect child mortality rates. We investigate whether tariff reforms predict changes in these potentially mediating variables at the district level (step 1). Then we examine whether these potential channels affect infant and under-five mortality rates (step 2). The results of step 1 are shown in Table 4.7, while those for step 2 are in Table 4.8 and Table 4.9.

From the results, we find that greater exposure to tariff cuts is correlated with lower average food expenditure per capita and a lower agricultural share in labour. However, after examining step 2, we find that not all of these potential channels are correlated with child mortality rates. Tables 4.8 and 4.9 show that only average food expenditure per capita is significantly associated with infant and under-five mortality rates. Lower average food expenditure per capita is associated with higher infant and under-five mortality rates. Thus, higher exposure to tariff reduction is associated with lower average food expenditure per capita and lower food expenditure per capita is correlated with higher infant and under-five mortality rates.

Further explanation of our result could be as follows. Lower food expenditure could be due to dietary changes in favour of cheaper, fancy but unhealthy food. This implies that the mechanism behind our main findings might lie on the nexus between tariff reform, food, and nutrition. Thow and Hawkes (2009) suggest that tariff reform is one factor facilitating the nutrition transition. Tariff reform may increase people's income, but the increasing income might not directly translate into increased nutrition and health status. People may choose different diets, some of which could create health concerns (Popkin, 2006). For example, if pregnant mothers choose a 'bad diet' which causes malnutrition, over-nutrition or chronic disease, their health problems can contribute to child early mortality.[89]

[89] See, for example: Puffer & Serrano (1973), Black et al, (2008), Zu Et al., (2015).

Table 4.7. Potential channels -step 1, from tariffs to potential channels.

	Δ Total fertility rate	Average breastfeeding length	Δ Average expenditure per capita	Δ Average food expenditure per capita	Δ Share of agricultural worker	Δ Share of manufacturing worker
Δ Output Tariff 2007-1993	-0.051	0.062	-0.004*	-0.018*	-0.280	0.231
	(0.032)	(0.098)	(0.002)	(0.008)	(0.442)	(0.276)
Δ Input Tariff 2007-1993	0.038	0.067	0.004	0.021+	1.452*	-0.682
	(0.047)	(0.161)	(0.003)	(0.011)	(0.671)	(0.453)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Island dummies	Yes	Yes	Yes	Yes	Yes	Yes
N observations	221	221	221	221	221	221
Adjusted R-square	0.790	0.423	0.952	0.951	0.935	0.784

Note: The table reports weighted tariff coefficients, generated by first difference estimates of potential channels on weighted tariffs and further controls. Time-variant controls include the general welfare of society, geophysical characteristics, female characteristics, general health status, marriage and fertility characteristics (complete list in the appendix to this chapter). Robust standard errors are reported in parentheses. **,*, + mark statistical significance at the 1, 5 and 10% levels.

Table 4.8. Potential channels -step 2, from channels to infant mortality rates.

Potential Channels	Infant mortality rate in 2007					
	Model c1a	Model c2a	Model c3a	Model c4a	Model c5a	Model c6a
Δ Total fertility rate	1.436					
	(2.297)					
Δ Average breastfeeding length		-1.283+				
		(0.702)				
Δ Average expenditure per capita			-3.904			
			(14.752)			
Δ Average food expenditure per capita				-29.489*		
				(14.488)		
Δ Share of agricultural worker					-0.225	
					(0.174)	
Δ Share of manufacturing worker						0.307
						(0.264)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Island dummies	Yes	Yes	Yes	Yes	Yes	Yes
N observations	221	221	221	221	221	221
Adjusted R-square	0.573	0.584	0.565	0.589	0.577	0.573

Note: The table reports weighted tariff coefficients, generated by OLS estimates of district infant mortality levels on changes of tariffs and further controls. Time-variant controls include the general welfare of society, geophysical characteristics, female characteristics, general health status, marriage and fertility characteristics (complete list in the appendix to this chapter). Robust standard errors are reported in parentheses. **,*, + mark statistical significance at the 1, 5 and 10% levels.

Table 4.9. Potential channels -step 2, from channels to under-five mortality rates.

Potential Channels	Child under five-mortality rate in 2007					
	Model c1a	Model c2a	Model c3a	Model c4a	Model c5a	Model c6a
Δ Total fertility rate	1.964					
	(2.922)					
Δ Average breastfeeding length		-0.807				
		(0.808)				
Δ Average expenditure per capita			-10.774			
			(18.148)			
Δ Average food expenditure per capita				-41.216*		
				(18.614)		
Δ Share of agricultural worker					-0.225	
					(0.209)	
Δ Share of manufacturing worker						0.300
						(0.339)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Island dummies	Yes	Yes	Yes	Yes	Yes	Yes
N observations	221	221	221	221	221	221
Adjusted R-square	0.574	0.563	0.56	0.591	0.566	0.563

Note: The table reports weighted tariff coefficients, generated by OLS estimates of district under-five mortality levels on changes of tariffs and further controls. Time-variant controls include the general welfare of society, geophysical characteristics, female characteristics, general health status, marriage and fertility characteristics (complete list in the appendix to this chapter). Robust standard errors are reported in parentheses. **,*, + mark statistical significance at the 1, 5 and 10% levels

4.7 Conclusions

In this study, we try to examine the correlations between tariff exposure and child mortality rates in 282 Indonesian districts in 2007. We combined tariff data with labour structure and industrial data to construct tariff exposure at district levels. We then constructed infant and under-five mortality as our main outcome variables from the National Basic Health Survey (Riskesdas) 2007, a cross-sectional, district representative survey of the Indonesian population.

We find that the reduction in intermediate input tariffs is associated with a higher number of infant and under-five deaths per 1000 births. Thus, districts with higher exposure to input tariff cuts are correlated with higher child mortality rates in 2007. Our results are mostly robust to including alternative controls and initial conditions as well as to different specifications. Furthermore, placebo regressions show no evidence of confounding trends, which supports the validity of our empirical methods.

We also consider a variety of potential causal channels that may change with tariff reforms and whose change may help to explain the observed relationships. The channels investigation results indicate that the potential channels of such associations are through lower average food expenditure. Our findings support other studies which show that tariff reform might induce a diet and nutrition transition which could have a negative impact on health outcomes. Therefore, interventions are needed to mitigate potential negative impacts of trade liberalisation on diet and nutrition which could be harmful to people's health status. Trade policies should, therefore, be accompanied by sectoral derivative policies such as supporting macro and health policies to gain the optimal benefit of trade and development (Hawkes, 2006; Thow and Hawkes, 2009).

However, this study poses several caveats. First is the inability to examine within-district effects over the years, since child mortality data at the district level is very limited. Second caveat is that our study, due to data limitation, is only comparing the end points of data (the 2007 data), so we cannot exhibit any causal interpretations of the results. Nevertheless, this paper is one of the very first studies examining the issue of trade and child mortality in Indonesia. Therefore, despite the methodological limitations, we believe the findings presented here are still informative and important. Future studies should explore the issue using district panel data analysis and investigate the pathways through which trade reform exposure affects child mortality in more detail

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Appendix 4

Appendix 4-A: List of districts

Aceh Selatan	Bogor	Situbondo	Pasir
Aceh Tenggara	Sukabumi	Kab. Probolinggo	Kutai Kartanegara
Aceh Timur	Cianjur	Kab. Pasuruan	Berau
Aceh Tengah	Bandung	Sidoarjo	Bulongan
Aceh Barat	Garut	Kab. Mojokerto	Balikpapan
Aceh Besar	Tasikmalaya	Jombang	Samarinda
Pidie	Ciamis	Nganjuk	Bolaang Mongondow
Aceh Utara	Kuningan	Kab. Madiun	Minahasa
Kota Banda Aceh	Cirebon	Magetan	Kepulauan Sangihe
Tapanuli Selatan	Majalengka	Ngawi	Manado
Tapanuli Tengah	Sumedang	Bojonegoro	Boalemo
Tapanuli Utara	Indramayu	Tuban	Kodya. Gorontalo
Labuhan Batu	Subang	Lamongan	Banggai Kepulauan
Asahan	Purwakarta	Gresik	Poso
Simalungun	Karawang	Bangkalan	Donggala
Dairi	Bekasi	Sampang	Toli-Toli
Karo	Bogor	Pamekasan	Selayar
Deli Serdang	Sukabumi	Sumenep	Bulukumba
Langkat	Bandung	Kota Kediri	Bantaeng
Kota Sibolga	Cirebon	Kota Blitar	Jeneponto
Kota Tanjung Balai	Pandeglang	Kota Malang	Takalar
Kota Pematang Siantar	Lebak	Kota Probolinggo	Gowa
Kota Tebing Tinggi	Tangerang	Kota Pasuruan	Sinjai
Kota Medan	Serang	Kota Mojokerto	Maros
Kota Binjai	Cilacap	Kota Madiun	Pangkajene Kepulauan
Pesisir Selatan	Banyumas	Surabaya	Barru
Solok	Purbalingga	Jembrana	Bone
Sawahlunto/Sijunjung	Banjarnegara	Tabanan	Soppeng
Tanah Datar	Kebumen	Badung	Wajo
Padang Pariaman	Purworejo	Gianyar	Sidenreng Rappang
Agam	Wonosobo	Klungkung	Pinrang
Lima Puluh Koto	Magelang	Bangli	Enrekang
Pasaman	Boyolali	Karangasem	Luwu
Kota Padang	Klaten	Buleleng	Tana Toraja
Kota Solok	Sukoharjo	Lombok Barat	Polewali Mamasa
Kota Sawah Lunto	Wonogiri	Lombok Tengah	Majene
Kota Padang Panjang	Karanganyar	Lombok Timur	Mamuju
Kota Bukittinggi	Sragen	Sumbawa	Ujung Pandang
Kota Payakumbuh	Grobogan	Dompu	Pare-Pare
Indragiri Hulu	Blora	Bima	Buton

Indragiri Hilir
Kampar
Bengkalis
Pekan Baru
Batam
Kepulauan Riau
Kerinci
Sarolangun
Batanghari
Tanjung Jabung Timur
Tebo
Jambi
Oku
Oki
Muara Enim
Lahat
Musi Rawas
Musi Banyu Asin
Palembang
Bangka
Belitung
Pangkal Pinang
Bengkulu Selatan
Rejang Lebong
Bengkulu Utara
Bengkulu
Lampung Selatan
Lampung Tengah
Lampung Utara
Bandar Lampung
Jakarta Selatan
Jakarta Timur
Jakarta Pusat
Jakarta Barat
Jakarta Utara

Rembang
Pati
Kudus
Jepara
Demak
Semarang
Temanggung
Kendal
Batang
Pekalongan
Pemalang
Tegal
Brebes
Magelang
Surakarta
Salatiga
Semarang
Pekalongan
Tegal
Kulon Progo
Bantul
Gunung Kidul
Sleman
Yogyakarta
Pacitan
Ponorogo
Trenggalek
Tulungagung
Kab. Blitar
Kab. Kediri
Kab. Malang
Lumajang
Jember
Banyuwangi
Bondowoso

Sumba Barat
Sumba Timur
Kupang
Timor Tengah Selatan
Timor Tengah Utara
Belu
Alor
Flores Timur
Sikka
Ende
Ngada
Manggarai
Sambas
Pontianak
Sanggau
Ketapang
Sintang
Kapuas Hulu
Pontianak city
Kotawaringin Barat
Kotawaringin Timur
Kapuas
Barito Selatan
Barito Utara
Palangka Raya
Tanah Laut
Kotabaru
Banjar
Barito Kuala
Tapin
Hulu Sungai Selatan
Hulu Sungai Tengah
Hulu Sungai Utara
Tabalong
Banjarmasin

Muna
Konawe
Kolaka
Maluku Tenggara
Maluku Tengah
Ambon
Halmahera Tengah
Maluku Utara
Fakfak
Manokwari
Sorong and Tambrauw
Merauke
Jayawijaya
Jayapura
Nabire
Yapen Waropen
Biak Numfor

Appendix 4-B: Descriptive statistics

Table 4-B1. Descriptive statistics of all variables.

Variables	# of observation	1993		2007	
		Mean	Standard deviation	Mean	Standard deviation
General welfare of the society					
Population (number of people)	221	6.51.E+05	5.57.E+05	1.37.E+07	1.48.E+07
Proportion of formal workers (%)	221	28.57	16.03	34.93	15.70
Proportion of no school experience (%)	221	37.61	12.15	32.40	7.42
Proportion of primary school graduates (%)	221	33.94	7.32	29.52	6.85
Proportion of junior high school graduates (%)	221	10.97	4.68	17.52	4.40
Proportion of high school graduates (%)	221	14.40	7.43	17.96	8.56
Proportion of college graduates (%)	221	1.52	1.63	4.78	2.81
Proportion of households with electricity access (%)	221	49.85	25.64	0.57	0.29
General health status					
Average household size (number of people)	221	4.49	0.43	4.09	0.41
Average protein consumption (gram)	221	51.08	9.77	59.68	10.05
Average calorie consumption (kcal)	221	1819.32	303.47	2236.63	299.95
Average population age (years)	221	25.49	2.41	28.50	2.88
Diarrhoea prevalence (%)	221	0.70	0.46	2.07	1.12
Marriage and fertility characteristics					
Average age at first Marriage (years)	221	19.27	1.58	19.99	1.15
Proportion of married couples (%)	221	40.80	4.41	48.97	4.25
Proportion of divorced and not remarried (%)	221	1.33	0.63	2.36	0.98
Proportion of maternities assisted by professional midwife (%)	221	42.86	25.23	65.13	23.70
Proportion of complete immunisation (%)	221	41.63	16.90	53.63	17.65
Female characteristics					
Female population share (%)	221	50.27	1.54	50.14	1.54

Proportion of mothers- no school experience (%)	221	40.29	11.90	32.40	7.42
Proportion of mothers-primary school graduates (%)	221	36.34	7.95	31.33	7.14
Proportion of mothers-junior high school graduates (%)	221	11.02	4.90	16.23	3.22
Proportion of mothers-high school graduates (%)	221	10.82	6.46	15.37	6.95
Proportion of mothers-higher education graduates (%)	221	1.52	1.63	4.68	2.83
Proportion of full time housewives (%)	221	57.77	13.85	77.42	6.52
Proportion of female unemployment rate (%)	221	72.56	14.95	50.08	12.55
Geophysical characteristics					
Level of air pollution (aerosol index)	221	0.84	0.10	0.86	0.07
Average annual precipitation rate (mm)	221	1653.58	599.68	2117.97	663.74
Average annual temperature (°C)	221	25.02	2.25	25.05	2.29
Child mortality rate					
Infant mortality rate (death number per 1000 births)	221	-	-	14.64	11.79
Child under-five mortality rate (death number per 1000 births)	221	-	-	20.41	14.24
Tariff exposures					
Input tariff exposure (%)	221	14.10	0.75	5.73	2.33
Output tariff exposure (%)	221	16.24	1.49	3.66	3.93

Appendix 4-C: Main results -infant mortality rate regressions

Table 4-C1. Main results for infant mortality rate regressions.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	1a	2a	3a	4a	5a	6a	7a
Δ Output Tariff	0.566	0.752	0.774	0.575	1.807	1.817	1.003
	(0.386)	(0.533)	(0.572)	(1.255)	(1.975)	(2.017)	(1.923)
Δ Input Tariff	-0.468	-2.325**	-2.353**	-2.817*	-2.963*	-2.949*	-2.570*
	(0.621)	(0.803)	(0.880)	(1.061)	(1.136)	(1.152)	(1.193)
Δ Population		-0.427	-0.629	-0.648	-0.256	-0.213	1.561
		(1.781)	(1.900)	(1.945)	(1.996)	(2.105)	(2.071)
Δ Proportion of formal workers		-0.214	-0.143	-0.036	-0.052	-0.056	-0.055
		(0.218)	(0.232)	(0.246)	(0.251)	(0.255)	(0.243)
Δ Proportion of primary school graduates		-0.548	-0.481	-0.471	-0.500	-0.502	-0.283
		(0.335)	(0.346)	(0.351)	(0.367)	(0.374)	(0.376)
Δ Proportion of junior high school graduates		0.115	0.077	0.158	0.099	0.100	0.001
		(0.410)	(0.434)	(0.445)	(0.440)	(0.444)	(0.400)
Δ Proportion of high school graduates		-1.192*	-1.301*	-1.363*	-1.296*	-1.295*	-1.063+
		(0.514)	(0.542)	(0.588)	(0.610)	(0.613)	(0.597)
Δ Proportion of college graduates		1.884	1.666	1.586	1.522	1.525	-0.265
		(1.454)	(1.581)	(1.555)	(1.537)	(1.550)	(1.599)
Δ Proportion of household with electricity access		7.960	7.794	6.835	6.765	6.795	5.815
		(8.277)	(8.926)	(9.363)	(9.525)	(9.545)	(10.151)
Δ Average household size		14.669*	14.936*	16.710*	16.321*	16.215+	18.601*
		(6.805)	(7.143)	(7.749)	(7.707)	(8.305)	(8.001)
Δ Average protein consumption		0.899*	0.900*	0.970*	0.860*	0.855+	0.755+
		(0.363)	(0.375)	(0.385)	(0.427)	(0.451)	(0.442)
Δ Average calorie consumption		-9.112**	-8.893*	-9.454*	-8.462*	-8.429+	-5.866
		(3.275)	(3.414)	(3.787)	(4.104)	(4.247)	(4.135)
Δ Average population age		0.755	0.784	0.898	0.875	0.879	0.319
		(1.571)	(1.688)	(1.826)	(1.926)	(1.947)	(1.845)

Δ Diarrhoea prevalence	2.438	1.970	1.649	1.812	1.808	0.337
	(1.758)	(1.906)	(2.008)	(2.063)	(2.068)	(2.337)
Δ Average age at first Marriage	2.266	2.327	2.334	2.357	2.350	3.712
	(2.144)	(2.434)	(2.635)	(2.674)	(2.702)	(2.795)
Δ Proportion of married couples	0.615	0.652	0.809+	0.729	0.728	0.915+
	(0.428)	(0.432)	(0.467)	(0.517)	(0.524)	(0.485)
Δ Proportion of divorced and not remarried	1.795	2.110	1.799	1.452	1.455	2.608
	(1.420)	(1.497)	(1.643)	(1.623)	(1.637)	(1.645)
Δ Proportion of maternities assisted by professional midwife	-0.110	-0.156	-0.186	-0.162	-0.160	-0.213
	(0.133)	(0.146)	(0.152)	(0.163)	(0.167)	(0.183)
Δ Proportion of complete immunisation	-0.096	-0.110	-0.177	-0.223	-0.223	-0.120
	(0.353)	(0.365)	(0.361)	(0.359)	(0.362)	(0.339)
Δ Female population share	-1.483	-1.526	-1.312	-1.389	-1.379	-1.414
	(0.934)	(1.026)	(1.022)	(1.009)	(1.022)	(1.107)
Δ Proportion of mothers-primary school graduates	-0.586	-0.589	-0.577	-0.525	-0.530	-0.126
	(0.549)	(0.608)	(0.648)	(0.638)	(0.649)	(0.638)
Δ Proportion of mothers-junior high school graduates	0.380	0.522	0.847	0.868	0.860	1.070+
	(0.580)	(0.631)	(0.661)	(0.647)	(0.663)	(0.564)
Δ Proportion of mothers-high school graduates	-0.170	0.017	-0.052	0.087	0.081	0.852
	(0.727)	(0.881)	(0.910)	(0.910)	(0.909)	(0.931)
Δ Proportion of mother-higher education graduates	0.433	0.422	0.404	0.288	0.289	1.468
	(1.489)	(1.566)	(1.590)	(1.604)	(1.617)	(1.566)
Δ Proportion of full time housewives	-0.136	-0.135	-0.097	-0.107	-0.106	-0.186
	(0.252)	(0.260)	(0.267)	(0.279)	(0.281)	(0.279)
Δ Proportion of female unemployment rate	0.049	0.046	-0.002	0.006	0.011	-0.036
	(0.127)	(0.138)	(0.134)	(0.131)	(0.146)	(0.146)
Δ Level of air pollution	9.007	9.734	10.058	10.008	9.778	26.889
	(28.966)	(35.180)	(35.928)	(36.445)	(36.896)	(42.503)
Δ Average annual precipitation rate	3.266*	3.931*	3.880*	3.603+	3.613+	5.716**

	(1.558)	(1.635)	(1.721)	(1.817)	(1.827)	(1.898)
Δ Average annual temperature	1.590*	1.425	1.483	1.421	1.429	1.100
	(0.743)	(0.915)	(0.897)	(0.937)	(0.963)	(0.979)
Population in 1993	-0.420	-0.277	1.344	1.125	1.031	-0.785
	(2.415)	(2.684)	(2.955)	(2.919)	(3.147)	(2.949)
Proportion of formal workers in 1993	0.319	0.318	0.339	0.324	0.322	0.198
	(0.212)	(0.238)	(0.239)	(0.246)	(0.246)	(0.238)
Proportion of primary school graduates in 1993	-1.195	-1.135	-1.141	-1.109	-1.113	-0.432
	(0.753)	(0.765)	(0.815)	(0.821)	(0.831)	(0.847)
Proportion of junior high school graduates in 1993	1.331	1.221	1.206	1.357	1.364	1.536
	(0.811)	(0.854)	(0.983)	(0.987)	(1.005)	(0.936)
Proportion of high school graduates in 1993	0.513	0.560	0.560	0.592	0.602	0.432
	(0.920)	(0.938)	(0.953)	(0.989)	(0.999)	(1.007)
Proportion of college graduates in 1993	2.889	3.313	3.501	3.550	3.528	2.627
	(2.063)	(2.148)	(2.171)	(2.131)	(2.195)	(2.472)
Proportion of households with electricity access in 1993	7.873	7.730	6.734	6.652	6.683	5.734
	(8.212)	(8.855)	(9.287)	(9.458)	(9.475)	(10.092)
Average household size in 1993	21.336**	20.657**	19.522**	18.166**	18.120**	18.933**
	(5.875)	(6.231)	(6.253)	(6.382)	(6.511)	(6.633)
Average protein consumption in 1993	-0.725	-0.603	-0.491	-0.440	-0.433	-0.725
	(0.557)	(0.640)	(0.667)	(0.685)	(0.708)	(0.725)
Average calorie consumption in 1993	35.948	29.027	25.102	20.770	20.279	40.714
	(31.812)	(33.565)	(34.671)	(35.910)	(37.362)	(37.649)
Average population age in 1993	1.718	1.702	2.071	1.776	1.763	0.354
	(1.240)	(1.380)	(1.439)	(1.524)	(1.537)	(1.631)
Diarrhoea prevalence in 1993	3.016	2.692	1.293	1.619	1.579	4.929
	(3.706)	(4.320)	(5.188)	(5.254)	(5.434)	(4.960)
Average age at first Marriage in 1993	1.232	2.109	1.821	1.883	1.900	2.327
	(1.803)	(2.495)	(2.570)	(2.616)	(2.642)	(2.645)
Proportion of married couples in 1993	1.706*	1.769*	1.511+	1.494	1.506	1.923*
	(0.833)	(0.828)	(0.885)	(0.904)	(0.905)	(0.880)

Proportion of divorced and not remarried in 1993	6.917**	7.168**	6.902*	6.793*	6.807*	5.864*
	(2.405)	(2.617)	(2.678)	(2.742)	(2.764)	(2.906)
Proportion of maternities assisted by professional midwife in 1993	-0.037	-0.108	-0.104	-0.098	-0.095	-0.196
	(0.129)	(0.164)	(0.175)	(0.185)	(0.191)	(0.225)
Proportion of complete immunisation in 1993	-0.170	-0.155	-0.198	-0.223	-0.223	-0.040
	(0.310)	(0.318)	(0.325)	(0.321)	(0.323)	(0.308)
Female population share in 1993	-1.482	-1.547	-1.343	-1.235	-1.232	-0.636
	(1.053)	(1.115)	(1.111)	(1.073)	(1.084)	(1.137)
Proportion of mothers-primary school graduates in 1993	0.405	0.390	0.387	0.412	0.406	0.287
	(0.738)	(0.766)	(0.816)	(0.800)	(0.813)	(0.804)
Proportion of mothers-junior high school graduates in 1993	-1.479	-1.372	-1.186	-1.308	-1.321	-1.230
	(1.023)	(1.081)	(1.169)	(1.182)	(1.213)	(1.131)
Proportion of mothers-high school graduates in 1993	-1.628	-1.647	-1.635	-1.583	-1.598	-0.727
	(1.193)	(1.335)	(1.385)	(1.373)	(1.380)	(1.359)
Proportion of mothers-higher education graduates in 1993	-0.698	-1.387	-2.347	-2.480	-2.467	-1.165
	(2.392)	(2.562)	(2.848)	(2.780)	(2.806)	(3.050)
Proportion of full-time housewives in 1993	-0.352	-0.329	-0.288	-0.256	-0.255	-0.223
	(0.276)	(0.304)	(0.295)	(0.314)	(0.317)	(0.333)
Proportion of female unemployment rate in 1993	-0.023	-0.014	-0.050	-0.022	-0.017	-0.108
	(0.170)	(0.183)	(0.190)	(0.187)	(0.202)	(0.197)
Level of air pollution in 1993	22.843	18.487	17.490	15.423	15.585	12.576
	(21.670)	(26.513)	(27.219)	(27.909)	(28.155)	(31.321)
Average annual precipitation rate in 1993	13.434**	12.486*	11.492+	10.874+	10.901+	9.455
	(4.535)	(5.524)	(5.870)	(5.867)	(5.921)	(6.193)
Average annual temperature in 1993	2.775**	2.652*	2.552*	2.441*	2.444*	1.893
	(0.805)	(1.087)	(1.155)	(1.177)	(1.189)	(1.294)
Java island dummy			1.372			
			(9.413)			
Sumatera island dummy		3.573	5.729	5.936	5.766	3.289
		(8.164)	(10.382)	(9.330)	(9.699)	(10.461)

Kalimantan island dummy			-1.672	0.077	2.109	1.946	1.715
			(10.353)	(11.795)	(11.052)	(11.438)	(11.270)
Sulawesi island dummy			-3.567	-1.082	-1.465	-1.588	-10.431
			(7.549)	(6.319)	(8.924)	(9.271)	(9.814)
Small islands dummy			-2.678		-0.632	-0.693	-9.298
			(8.462)		(9.290)	(9.389)	(9.615)
Agricultural sector share 1990				0.080	0.197	0.197	0.236
				(0.113)	(0.207)	(0.209)	(0.194)
Mining sector share 1990				0.216	0.672	0.672	0.705
				(0.350)	(0.596)	(0.602)	(0.564)
Manufacturing sector share 1990				0.119	-0.080	-0.084	0.169
				(0.464)	(0.532)	(0.551)	(0.525)
Rural share 1990				-0.109	-0.113	-0.111	-0.109
				(0.099)	(0.097)	(0.099)	(0.101)
Initial output tariff exposures					2.735	2.761	2.166
					(3.112)	(3.177)	(3.022)
Initial input tariff exposures					-1.141	-1.150	-0.959
					(1.512)	(1.520)	(1.499)
Split district dummies						0.248	0.553
						(3.593)	(3.732)
Proxy for in-Migration 2007							-0.271
							(0.306)
Constant	17.477**	-494.990*	-455.141+	-441.991+	-438.336	-435.711	-631.224*
	(1.999)	(228.121)	(248.564)	(257.386)	(264.670)	(271.594)	(274.918)
Observations	221	221	221	221	221	221	221
R-squared	0.015	0.595	0.602	0.616	0.622	0.622	0.643

Robust standard errors in parentheses

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

Appendix 4-D: Main results – under-five mortality rate regressions

Table 4-D1. Main results for under-five children mortality rate regressions.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	1b	2b	3b	4b	5b	6b	7b
Δ Output Tariff	0.554	1.547*	1.385*	2.081	4.747*	4.689*	3.559+
	(0.400)	(0.641)	(0.686)	(1.486)	(2.162)	(2.205)	(2.081)
Δ Input Tariff	-0.243	-2.810**	-2.903**	-3.752**	-4.052**	-4.133**	-3.629**
	(0.616)	(0.911)	(0.989)	(1.123)	(1.199)	(1.231)	(1.246)
Δ Population		-1.577	-1.586	-1.494	-0.647	-0.904	0.696
		(2.350)	(2.460)	(2.366)	(2.371)	(2.536)	(2.439)
Δ Proportion of formal workers		-0.098	-0.073	0.059	0.024	0.046	0.050
		(0.232)	(0.250)	(0.256)	(0.259)	(0.270)	(0.241)
Δ Proportion of primary school graduates		-0.398	-0.351	-0.350	-0.408	-0.396	-0.198
		(0.408)	(0.430)	(0.429)	(0.412)	(0.425)	(0.425)
Δ Proportion of junior high school graduates		0.497	0.600	0.717	0.587	0.582	0.458
		(0.483)	(0.522)	(0.513)	(0.495)	(0.488)	(0.462)
Δ Proportion of high school graduates		-1.351*	-1.350*	-1.546*	-1.401*	-1.409*	-1.092
		(0.637)	(0.661)	(0.684)	(0.694)	(0.696)	(0.663)
Δ Proportion of college graduates		2.384	2.425	2.312	2.163	2.147	0.568
		(1.845)	(2.052)	(1.888)	(1.855)	(1.859)	(1.867)
Δ Proportion of households with electricity access		20.016*	18.704+	17.379	17.219	17.041	14.575
		(9.250)	(10.030)	(10.433)	(10.564)	(10.507)	(10.975)
Δ Average household size		7.338	6.320	7.004	6.079	6.705	8.249
		(9.592)	(9.872)	(10.222)	(10.164)	(11.169)	(10.531)
Δ Average protein consumption		0.370	0.460	0.487	0.246	0.277	0.158
		(0.485)	(0.509)	(0.506)	(0.552)	(0.595)	(0.560)
Δ Average calorie consumption		-9.621*	-9.652*	-9.573*	-7.427	-7.618	-3.907
		(4.255)	(4.477)	(4.786)	(4.714)	(5.012)	(4.858)
Δ Average population age		1.338	1.054	1.341	1.289	1.263	0.261
		(2.012)	(2.162)	(2.298)	(2.489)	(2.504)	(2.320)
Δ Diarrhoea prevalence		3.383	3.195	2.836	3.189	3.213	1.464

	(2.106)	(2.291)	(2.364)	(2.437)	(2.465)	(2.839)
Δ Average age at first Marriage	-1.719	-1.200	-1.398	-1.365	-1.323	0.057
	(2.491)	(2.899)	(3.098)	(3.107)	(3.138)	(3.230)
Δ Proportion of married couples	0.869+	0.899+	1.027+	0.846	0.852	1.044+
	(0.470)	(0.506)	(0.522)	(0.576)	(0.589)	(0.527)
Δ Proportion of divorced and not remarried	1.783	2.204	1.342	0.582	0.568	1.726
	(1.542)	(1.573)	(1.730)	(1.682)	(1.678)	(1.684)
Δ Proportion of maternities assisted by professional midwife	-0.073	-0.112	-0.172	-0.118	-0.130	-0.162
	(0.159)	(0.169)	(0.173)	(0.187)	(0.197)	(0.209)
Δ Proportion of complete immunisation	-0.339	-0.313	-0.448	-0.550	-0.550	-0.387
	(0.378)	(0.415)	(0.396)	(0.370)	(0.374)	(0.328)
Δ Female population share	-1.309	-1.455	-1.228	-1.402	-1.458	-1.423
	(1.257)	(1.379)	(1.316)	(1.219)	(1.225)	(1.268)
Δ Proportion of mother-primary school graduates	-1.022	-1.085	-1.109	-1.000	-0.968	-0.511
	(0.615)	(0.712)	(0.729)	(0.692)	(0.702)	(0.645)
Δ Proportion of mothers-junior high school graduates	-0.808	-0.770	-0.194	-0.145	-0.101	0.123
	(0.677)	(0.767)	(0.780)	(0.748)	(0.780)	(0.676)
Δ Proportion of mothers-high school graduates	-0.012	-0.098	-0.209	0.097	0.133	0.915
	(0.880)	(1.122)	(1.122)	(1.107)	(1.098)	(1.107)
Δ Proportion of mothers-higher education graduates	1.042	0.757	0.853	0.611	0.606	1.771
	(1.958)	(1.944)	(1.854)	(1.805)	(1.814)	(1.786)
Δ Proportion of full time housewives	-0.073	-0.114	-0.051	-0.069	-0.072	-0.100
	(0.335)	(0.352)	(0.340)	(0.352)	(0.356)	(0.344)
Δ Proportion of female unemployment rate	0.171	0.173	0.121	0.141	0.115	0.101
	(0.157)	(0.168)	(0.163)	(0.156)	(0.182)	(0.171)
Δ Level of air pollution	-20.714	-16.255	-14.931	-14.941	-13.584	-2.229
	(35.689)	(41.675)	(41.717)	(43.570)	(44.936)	(50.779)
Δ Average annual precipitation rate	5.779**	6.235**	6.294**	5.692**	5.635**	7.446**
	(1.666)	(1.712)	(1.796)	(1.939)	(1.948)	(2.178)
Δ Average annual temperature	1.913*	1.901+	1.997*	1.858+	1.812+	1.390
	(0.864)	(1.044)	(0.987)	(1.016)	(1.027)	(1.104)

Population in 1993	-0.679	-1.626	1.559	1.093	1.644	-1.204
	(2.936)	(3.312)	(3.316)	(3.105)	(3.520)	(3.391)
Proportion of formal workers in 1993	0.169	0.170	0.179	0.147	0.155	0.042
	(0.237)	(0.266)	(0.260)	(0.259)	(0.256)	(0.238)
Proportion of primary school graduates in 1993	-2.031*	-2.033*	-2.199*	-2.127+	-2.103+	-1.287
	(0.941)	(0.995)	(1.050)	(1.074)	(1.100)	(1.105)
Proportion of junior high school graduates in 1993	1.524	1.489	1.358	1.681	1.636	1.840+
	(0.973)	(1.000)	(1.133)	(1.102)	(1.116)	(1.090)
Proportion of high school graduates in 1993	0.852	1.137	1.165	1.236	1.178	1.294
	(1.166)	(1.218)	(1.218)	(1.210)	(1.192)	(1.163)
Proportion of college graduates in 1993	2.945	3.203	3.691	3.803	3.932	3.466
	(2.396)	(2.475)	(2.456)	(2.366)	(2.494)	(2.770)
Proportion of households with electricity access in 1993	19.987*	18.682+	17.300+	17.114	16.933	14.482
	(9.173)	(9.941)	(10.338)	(10.483)	(10.421)	(10.907)
Average household size in 1993	20.226*	19.548*	16.681+	13.663	13.936	16.347+
	(8.412)	(8.533)	(8.549)	(8.687)	(8.916)	(8.465)
Average protein consumption in 1993	-1.458**	-1.151+	-1.047	-0.934	-0.977	-1.164
	(0.527)	(0.613)	(0.642)	(0.655)	(0.682)	(0.713)
Average calorie consumption in 1993	60.452+	53.446	51.234	41.727	44.623	61.476
	(30.508)	(32.304)	(32.743)	(34.254)	(36.421)	(37.357)
Average population age in 1993	0.572	0.336	1.078	0.439	0.517	-1.178
	(1.654)	(1.798)	(1.779)	(1.844)	(1.876)	(1.940)
Diarrhoea prevalence in 1993	3.987	2.750	-1.075	-0.381	-0.146	4.009
	(4.629)	(5.318)	(6.112)	(6.078)	(6.340)	(5.479)
Average age at first Marriage in 1993	1.100	2.360	2.061	2.174	2.075	2.346
	(2.318)	(3.023)	(2.957)	(2.962)	(3.033)	(3.002)
Proportion of married couples in 1993	2.286*	2.268*	1.776	1.732	1.664	2.219*
	(1.058)	(1.060)	(1.107)	(1.064)	(1.037)	(1.009)
Proportion of divorced and not remarried in 1993	8.670**	9.838**	9.724**	9.472**	9.390**	7.883*
	(2.912)	(3.205)	(3.199)	(3.142)	(3.157)	(3.115)
Proportion of maternities assisted by	0.097	0.061	0.058	0.072	0.057	-0.030

professional midwife in 1993						
	(0.167)	(0.204)	(0.209)	(0.225)	(0.234)	(0.274)
Proportion of complete immunisation in 1993	-0.472	-0.406	-0.508	-0.566+	-0.564+	-0.298
	(0.349)	(0.377)	(0.372)	(0.333)	(0.336)	(0.316)
Female population share in 1993	-1.701	-1.937	-1.692	-1.461	-1.481	-0.799
	(1.339)	(1.433)	(1.320)	(1.230)	(1.245)	(1.265)
Proportion of mothers-primary school graduates in 1993	0.890	0.810	0.917	0.970	1.004	0.803
	(0.838)	(0.845)	(0.910)	(0.872)	(0.853)	(0.827)
Proportion of mothers-junior high school graduates in 1993	-2.821*	-2.924*	-2.488+	-2.749*	-2.673+	-2.608*
	(1.143)	(1.244)	(1.310)	(1.289)	(1.344)	(1.261)
Proportion of mothers-high school graduates in 1993	-2.278	-2.589	-2.673	-2.560	-2.473	-1.788
	(1.491)	(1.686)	(1.700)	(1.644)	(1.605)	(1.483)
Proportion of mothers-higher education graduates in 1993	-1.015	-1.694	-3.781	-4.089	-4.167	-2.528
	(2.812)	(2.944)	(3.288)	(3.130)	(3.141)	(3.394)
Proportion of full-time housewives in 1993	-0.260	-0.297	-0.241	-0.166	-0.168	-0.052
	(0.356)	(0.404)	(0.373)	(0.396)	(0.401)	(0.415)
Proportion of female unemployment rate in 1993	0.109	0.099	0.077	0.139	0.112	0.054
	(0.219)	(0.235)	(0.248)	(0.240)	(0.276)	(0.253)
Level of air pollution in 1993	28.904	27.691	25.483	21.045	20.089	14.692
	(25.847)	(32.073)	(32.777)	(34.362)	(34.373)	(37.300)
Average annual precipitation rate in 1993	15.237**	15.828*	14.591*	13.195*	13.036+	11.428+
	(5.373)	(6.516)	(6.723)	(6.578)	(6.641)	(6.793)
Average annual temperature in 1993	3.551**	3.622**	3.471**	3.224*	3.204*	2.502+
	(0.854)	(1.202)	(1.243)	(1.262)	(1.277)	(1.376)
Java island dummy			4.795			
			(11.100)			
Sumatera island dummy		-5.007	1.557	0.132	1.132	-1.286
		(9.711)	(12.008)	(10.544)	(10.880)	(11.946)
Kalimantan island dummy		-11.047	-6.361	-3.777	-2.822	-2.779
		(11.400)	(13.593)	(12.285)	(12.568)	(12.508)
Sulawesi island dummy		-7.250	-0.891	-3.561	-2.836	-13.942

			(8.588)	(7.587)	(9.817)	(10.115)	(11.173)
Small islands dummy			-7.900		-3.183	-2.823	-14.326
			(10.113)		(10.752)	(10.788)	(11.531)
Agricultural sector share 1990				0.055	0.308	0.307	0.326
				(0.140)	(0.239)	(0.239)	(0.212)
Mining sector share 1990				0.100	1.091	1.091	1.035
				(0.432)	(0.739)	(0.742)	(0.676)
Manufacturing sector share 1990				-0.298	-0.732	-0.710	-0.390
				(0.546)	(0.570)	(0.598)	(0.580)
Rural share 1990				-0.207	-0.217+	-0.227+	-0.205
				(0.127)	(0.120)	(0.122)	(0.123)
Initial output tariff exposures					5.967	5.818	5.096
					(3.736)	(3.816)	(3.636)
Initial input tariff exposures					-2.444	-2.389	-2.022
					(1.743)	(1.741)	(1.652)
Split district dummies						-1.461	-0.330
						(4.911)	(4.981)
Proxy for in-Migration 2007							-0.593
							(0.363)
Constant	24.674**	-609.439**	-564.642*	-556.799*	-545.855*	-561.315*	-741.390**
	(2.926)	(216.305)	(235.210)	(242.925)	(240.587)	(251.976)	(268.449)
Observations	221	127	127	127	127	127	123
R-squared	0.015	0.592	0.599	0.630	0.649	0.649	0.660

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

5. CHAPTER 5

Conclusions

5.1 Key Findings and Contributions

This dissertation set out to determine the impacts of Indonesian tariff reform on different aspects of welfare: socio-economics, environment, and health. In this investigation, the aim was to contribute to the existing literature on the impacts of trade liberalisation, as an important aspect of economic globalisation, on welfare. The research provides an empirical analysis in the case of Indonesia, where limited evidence has been shown for the welfare impacts of trade liberalisation so far. Furthermore, this dissertation also considers the environmental and health impacts of trade liberalisation which have previously had little attention in the literature.

Three empirical analyses are carried out to provide welfare evidence of liberalisation in Indonesia. Trade liberalisation is measured by import tariff reform which, in the model, is further specified by regional exposure to tariff reductions. The identification strategy of this paper exploits variation in sectoral composition across regions in Indonesia in the initial, pre-reform period. Regional exposure to tariff reductions is a measurement of regional trade liberalisation, calculated by weighting nominal national tariffs by the relative importance of a sector in a region which is constructed either from relative sectoral labour share or relative share of sectoral-industrial output. Meanwhile, in this dissertation, welfare is defined and measured in three different dimensions of socio-economics, environment, and health. The socio-economic aspect of welfare is measured by income inequality and poverty rates, while environment and health are measured by an air pollution indicator and child mortality rates, consecutively. Then a first difference econometric model is used to investigate the effect of tariff cuts on each measure of welfare. The results are then supported by several sensitivity analyses including a placebo test, and in most cases, potential channels are explored

The first study exploits a long series of tariff information, regional household and industrial data, which covers 26 provinces over 36 years, to investigate the effects of changes in tariffs on inequality and poverty using different types of tariff measurement. The results show that tariff reforms have partially contributed to lower income inequality in Indonesia, as well as contributing to poverty reduction. Provinces with higher exposure to tariff reductions experienced lower inequality and lower poverty rates. The results are robust to alternative tariff measures and different model specifications as well as to controlling for initial conditions. Furthermore, placebo tests confirm that the findings were not altered by confounding trends, which supports our identification strategy. The main finding is broadly consistent with the conclusions of Kis-Katos and Sparrow (2015) who find poverty reductions in regions with more exposure to input tariff liberalisation. The results, however, are counter to some papers which examine the impacts of trade liberalisation on income inequality, such as Barro (2000) and Lundberg and Squire (2003).

The second analysis examines the effects of reducing import tariffs on air pollution in 232 Indonesian districts from 1993 to 2002. The aerosol index is constructed as a measure of air pollution by utilising the wealth of atmospheric composition satellite data for air quality applications collected by the National Aeronautics and Space Administration (NASA). The aerosol index is a measure of air clarity in the atmosphere. A higher index figure indicates more air pollution. The results show that tariff reform has contributed to a lower air pollution measure. Districts that were more exposed to intermediate input tariff reductions had a lower aerosol index. We also consider a variety of potential causal channels that may change with tariff reforms and whose change may help to explain the observed relationships. The results indicate that the potential channels are through composition and technical effects. Trade liberalisation seems to have moved industries away from relatively dirty sectors to relatively cleaner sectors. Cheaper intermediate inputs have also helped industries to be able to invest in new and cleaner technology as well as to improve industrial efficiency. These results are robust to different tariff measures and potential spatial spill-over effects as well as to any confounding trends, which supports our empirical specification. These findings further support the idea of the positive impact of trade liberalisation on the environment as argued by, among others, Copeland and Taylor (2003), Frankel and Rose (2005), and Faiz-Ur-Rehman et al. (2007).

The last paper investigates the effects of tariff exposure on child mortality rates in 282 Indonesian districts in 2007. In this dissertation, we constructed infant and under-five mortality as our main outcome variables from National Basic Health Survey (Riskesdas) 2007, a cross-sectional, district representative survey of the Indonesian population. We find that a reduction in intermediate input tariff exposure is associated with more infant and under-five deaths per 1000 births. Our results are mostly robust to including alternate controls and initial conditions as well as to different specifications. Furthermore, placebo regressions show no evidence of confounding trends, which supports the validity of our empirical methods. The results suggest that tariff reform was associated with higher child mortality rates. This finding is somewhat surprising as we expected to have the reverse result. However, by investigating the potential channels, we found that the potential partial channel is through lower average food expenditure. Thus, the evidence supports other studies which show that tariff reform might induce a diet and nutrition transition which could have a negative impact on health outcomes. In this case, interventions are needed to mitigate the unfavourable impacts of trade liberalisation on diet and nutrition which could be harmful to people's health status.

5.2 Concluding Remarks and Policy Implications

Taken together, the overall results suggest that tariff reforms partially contributed to better income equality and alleviating poverty, as well as mitigating air pollution, but were also related to increased child mortality rates.

Our findings for better income inequality and lower poverty rates are consistent with many studies that support trade liberalisation in the sense that it will increase global income, promote growth, equalise wages and advance poverty reduction (Dollar and Kraay, 2001; Bhagwati, 2004; Amiti and Cameron, 2012; Borjas, 2015; Kis-Katos and Sparrow, 2015). However, our findings are contra to a number of economists who have shown that trade liberalisation can lead to rising inequality and marginalise the poor in developing countries (Davis, 1996; Sala-i-Martin, 2002; Kremer, 2006; Millanovic, 2016).

The most common measure of inequality is the Gini coefficient. The World Bank (2013) argues that within-country inequality for an average person in the world was higher in 2013 compared to the previous half decade. The study also suggests that relative inequality was increasing between 1988 and 2008. Our study finds that manufacturing tariff reform significantly reduces Gini coefficients, but there is no evidence that tariff cuts lead to more equal income shares between the richest and the poorest. This may indicate that the decrease in Gini coefficients (as a result of manufacturing tariff reform) mainly comes from the narrowing gap in the middle quintiles. It seems that while there have been benefits from liberalisation, the benefits might not have been equally spread out. This is not the responsibility of the trade liberalisation per se; we may need to explore complementary policies to ensure the more equal distribution of the benefits of trade liberalisation, including well-targeted policies to reduce inequality. We need a comprehensive policy, including education and labour market policies that enable workers to get job and equip them with requisite skills, and of course, a better tax system with progressive impacts.

On the environment side, reduction of input tariffs seems to have contributed to mitigating the increasing trend of air pollution in Indonesia. This finds against the argument that trade has a detrimental effect on the environment, particularly on air pollution. It also supports existing large literature about the effect of trade liberalisation on the environment (Antweiler et al., 2001; Dean, 2002; Harbaugh et al., 2002; Copeland and Taylor, 2003; Frankel and Rose, 2005; and Faiz-Ur-Rehman et al. 2007). However, this finding is subject to some limitations. For instance, this dissertation only focuses on air pollution and does not account for other types of pollution, so the results should be interpreted with caution. Nevertheless, the main message is there: trade liberalisation is not the (sole) actor causing an environmental problem. If any unexpected effects on environment present, again, complementary policies are needed, including environmental policies that best suit the Indonesian context.

The positive effects on socio-economic and environment, however, are not clearly translated into the health outcomes. More exposure to tariff reform is associated with higher rate of child mortality rates. Our findings support other studies which show that trade liberalisation can lead to a diet and nutrition transition which could have a negative impact on health outcomes. Some sectoral derivative policies should, therefore, be needed to complement trade policies. Health and macro policies might be needed to ensure the optimal benefit of trade and development as argued by Hawkes (2006) and Thow and Hawkes (2009).

This dissertation, in general, supports the welfare enhancing effects of tariff liberalisation. This does not mean that trade liberalisation is unconditionally good for everyone, or every country. Trade liberalisation is a current trade regime that should be faced. It comes with many potential effects which could be positive and negative at the same time. Therefore, good policies are needed to get the best benefit from it and minimise any potential harmful effects. As suggested by Bhagwati (2007), trade liberalisation, as the heart of globalisation, requires domestic institutional and policy adjustments to reveal its human face. National policies development to meet international standard might also be needed to make sure that globalisation works for everyone (Stiglitz, 2006). As causal factors might be different across countries, specific policy interventions should be explored for the case of Indonesia.

The findings in this dissertation add to a growing body of literature on the impact of trade liberalisation and contribute to the debate on the issue. Despite its exploratory nature, this dissertation also offers some new insights into the relatively unexplored impacts of trade liberalisation on the environment and health.

5.3 Limitations and Future Research

Overall, this dissertation is limited by the lack of sectoral analysis on the impacts of tariff reform. Deeper sectoral analysis may bring a better understanding of how tariff reforms in various sectors impact differently to the welfare of the people. For example, Gonzales Gordon and Resosudarmo (2018) find that in Indonesia, different sector growth leads to different impact of development. They argue that agriculture sector growth is more inclusive than in other sectors.

Data availability issues also did not allow the same regional levels of analysis in all empirical chapters. Moreover, this dissertation cannot take in to account the impact of non-tariff measures (NTMs). This is primarily due to data availability. Removal of NTMs is unarguably an important part of Indonesian trade liberalisation, and its exclusion is potentially harmful for our empirical strategy, especially if the trends of NTMs were in the opposite direction as compared to tariffs. Several studies have suggested that tariff reductions may be accompanied by the rise in NTMs (Moore and Sanardi, 2011; Aisbett and Pearson, 2012, Beverelli et al., 2014). Nevertheless, we limit our results to the extent that they address only the partial impact of trade liberalisation contributed by tariff reform, not representing the whole impact since some of the effects should be assigned to NTMs.

In observing the impact of tariff reform on society's welfare, this dissertation has utilised first difference econometric methods to examine the impact of tariff reform on different aspects of welfare. The first difference specification controls for unobserved regional-level heterogeneity and addresses potential bias of time-invariant unobservables. We include interactive island-year fixed effects to control for shocks over time that affect trade across all regions but may vary across different islands. We also incorporate a vector of initial conditions of sectoral labour and rural population shares to deal with any potential confounders. Furthermore, several sensitivity analyses are considered for robustness checks, and placebo tests are conducted for potential endogeneity checks to support our identification strategy.

However, this thesis may still have some weaknesses both in terms of the results arising from the database and *caveats* arising from the model. The first study lacks empirical evidence for the mechanism in which tariff reduction brings down poverty and inequality.

We have also not been able to control for migration due to the data limitations. In addition, the findings in the last empirical study might still be prone to possible bias in the analysis due to the inability to examine within district effects over years, since child mortality data at district levels has been very limited.

Admittedly, as with all other research, the scarcity of data is a major hindrance, but efforts should still be made to obtain it. Future research using larger datasets is needed to better understand the impacts of tariff reform in different sectors and to establish more accuracy on the analysis. Moreover, efforts should also include the possibility of expanding the analysis to include NTMs. Non-tariff measures are any measure that reduces potential world income by the non-optimal allocation of goods and services or resources devoted to these goods and services (Baldwin, 1970). There has been a rise in the quest of quantifying NTM as an instrument of trade policy to better understand their impact on trade flows and welfare. The need is in line with rising trade restrictive measures following declining tariffs as the result of international and regional trade commitments (Evenett and Frits, 2017). There have been extensive studies trying to provide quantitative instruments for NTMs.[90] However, quantifying NTMs is challenging, and up to now, there has been no consensus on the best quantitative measure for NTMs. Each NTM study has different a methodology and approach, which has its merits and challenges (Berden and Francois, 2015). The complexity of measuring NTMs comes not only from quantifying but also from the classification of NTMs itself. UNCTAD (1994) uses a classification of over 100 trade measures, while OECD (1994) lists 150 measures covering only the agriculture sector (Bora and Lairds, 2002). Obviously, there are a

[90] See, for instance: Baldwin, 1970; Corden, 1974; Laird and Yeats, 1990; Feenstra, 1988, Helpman and Krugman, 1989; OECD, 1994; Anderson and Neary, 1994; Kee et al., 2009; BV et al., 2009; Fontagné et al., 2013; Francois et al., 2013; Egger et al., 2015; Ing and Cadot, 2017.

number of complications and limitations with the measurement and collection of NTM data. There is a need to be more creative in developing a quantitative measure of NTMs.

In addition, it is important to have a better understanding about how trade liberalisation may affect welfare by investigating the channels. Thus, further studies need to examine more closely the precise mechanisms of the impact of trade liberalisation on socio-economics, environment and health, and on other unexplored dimensions. Understanding the causal channels may help to ensure that trade liberalisation benefits everyone, and to ensure that the benefits are better distributed. Furthermore, by knowing the path of trade liberalisation in country-specific cases, we may be able to formulate specific policy interventions that should be in place to complement trade liberalisation, so that trade liberalisation and globalisation leave no one as losers. To ensure that globalisation does have a human face.

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