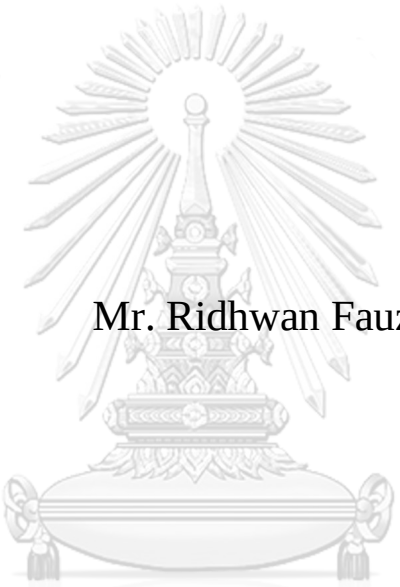
A POLICY SIMULATION IMPACT OF TOBACCO EXCISE TAX INCREASE ON CIGARETTE CONSUMPTION, MORTALITY, MEDICAL TREATMENT COST, LIFE-YEARS GAINED, AND GOVERNMENT REVENUE IN INDONESIA

Mr. Ridhwan Fauzi



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การประเมินผลกระทบนโยบายการเพิ่มของภาษีสรรพสามิตบุหรี่ต่อปริมาณการสูบบุหรี่ อัตราตาย ค่าใช้จ่ายในการรักษาการเพิ่มขึ้นของปีสุขภาวะ และรายได้ของรัฐบาลในประเทศอินโดนีเซีย

นายริดวาน เฟาว์ซิ

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาสาธารณสุขศาสตรดุษฎีบัณฑิต
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ริดวาน เฟาว์ซี : การประเมินผลกระทบนโยบายการเพิ่มของภาษีสรรพสามิตบุหรี่ต่อปริมาณการสูบบุหรี่ อัตราตาย ค่าใช้จ่ายในการรักษา การเพิ่มขึ้นของปีสุขภาวะและรายได้ของรัฐบาลในประเทศอินโดนีเซีย. (A POLICY SIMULATION IMPACT OF TOBACCO EXCISE TAX INCREASE ON CIGARETTE CONSUMPTION, MORTALITY, MEDICAL TREATMENT COST, LIFE-YEARS GAINED, AND GOVERNMENT REVENUE IN INDONESIA) อ.ที่ปรึกษาหลัก : สถิรกร พงศ์พานิช

งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาผลของการขึ้นภาษีสรรพสามิตยาสูบต่อการบริโภคยาสูบ, อัตราการตาย, ค่ารักษาพยาบาล, จำนวนปีที่ชีวิตยืนยาวขึ้น และรายได้ของรัฐบาลในประเทศอินโดนีเซีย

งานวิจัยนี้ประกอบด้วยสองระยะ โดยระยะแรก คือศึกษาความต้องการยาสูบซึ่งวิเคราะห์โดย *two-part econometrics model* ฐานข้อมูลมาจากการสำรวจภาวะเศรษฐกิจและสังคมแห่งชาติ ปีพุทธศักราช 2558, 2559, 2560, 2562 และ 2563 ข้อมูลของผู้เข้าร่วมวิจัยถูกวิเคราะห์โดยใช้ *logit specification* ส่วนที่สอง (จำนวนของการสูบบุหรี่) วิเคราะห์โดยใช้โมเดลเชิงเส้นโดยนัยทั่วไป ระยะที่สอง คือ ใช้ *compartmental model* ในผู้ที่สูบบุหรี่จำนวน 65 ล้านคน เพื่อประเมินผลของความแตกต่างในการขึ้นภาษีสรรพสามิตยาสูบในแต่ละสถานการณ์ต่อการบริโภคยาสูบ, อัตราการตายจากการสูบบุหรี่, ค่ารักษาพยาบาล, จำนวนปีที่ชีวิตยืนยาวขึ้น และรายได้ของรัฐบาลในประเทศอินโดนีเซีย

ราคามีความสัมพันธ์ทางลบกับการตัดสินใจสูบบุหรี่และจำนวนของการสูบบุหรี่ การประมาณค่าความยืดหยุ่นของราคายาสูบทั้งหมด คือ ระหว่าง -0.4933 ถึง -0.4277 การวิเคราะห์ในแต่ละกลุ่มย่อย พบว่าวัยรุ่นมีการตอบสนองกับการเปลี่ยนแปลงของราคามากกว่าผู้ใหญ่ นอกจากนี้ผลการทดลองพบว่าร้อยละ 12.5 ถึง 200 ของการขึ้นภาษีสรรพสามิตยาสูบจะลดจำนวนผู้สูบบุหรี่ลง 0.5 ถึง 8.0 ล้านคน, ลดการบริโภคยาสูบ 5.7 ถึง 90.4 พันล้านมวน, ลดอัตราการตายจากการสูบบุหรี่ 0.2 ถึง 3.3 ล้าน, เพิ่มจำนวนปีที่ชีวิตยืนยาวขึ้น 4.2 ถึง 68, ลดค่ารักษาพยาบาล 1.4 ถึง 22.7 ล้านล้านรูเปีย และสร้างรายได้ให้รัฐบาล 16.7 ถึง 176.6 ล้านล้านรูเปีย

การเพิ่มภาษียาสูบมีความสำคัญต่อระบบสาธารณสุขและเศรษฐศาสตร์ ดังนั้นจึงจำเป็นที่จะต้องมีการเพิ่มภาษีสรรพสามิตยาสูบประจำปี อย่างน้อยร้อยละ 30 และลดความซับซ้อนของโครงสร้างภาษี เพื่อป้องกันผู้สูบบุหรี่เปลี่ยนมาบริโภคยี่ห้อที่มีราคาถูกลง

สาขาวิชา	สาธารณสุขศาสตร์	ลายมือชื่อนิสิต .....
ปีการศึกษา	2564	ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

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The study aimed to examine the impact of tobacco excise tax increase on cigarette consumption, mortality, medical treatment cost, life-years gained, and government revenue in Indonesia.

The study consisted of two phases. First, the demand for cigarettes was analyzed using the two-part econometrics model. Data were retrieved from the National Socioeconomic Survey (SUSENAS) 2015, 2016, 2017, 2019, and 2020. The smoking participation was examined using logit specification, while the second part (smoking intensity) used the Generalized Linear Model (GLMs). Second, a compartmental model involving 65 million smokers was employed to assess the impact of different tobacco excise tax increased scenarios on cigarette consumption, tobacco-attributed mortality, tobacco-attributed medical treatment cost, life-years gained, and government revenue in Indonesia

Price was negatively associated with the decision to smoke and smoking intensity. The estimated overall cigarettes price elasticity was approximately between -0.4933 to -0.4277. Subgroups analysis found that youth were more sensitive to price change than adults. Furthermore, The results revealed that a 12.5-200% increase in tobacco excise taxes would reduce the number of smokers by 0.5 to 8.0 million smokers, decrease cigarette consumption by 5.7 to 90.4 billion sticks, avert tobacco attributed mortalities by 0.2 to 3.3 million, produce additional life-years by 4.2 to 68.0, reduce tobacco-attributed medical treatment costs by 1.4 to 22.7 trillion rupiahs, and generate additional government revenue by 16.7 to 176.6 trillion rupiahs.

Raising the tobacco taxes has significant benefits to public health and economics. Therefore, It is necessary to significantly increase the cigarette taxes annually by at least 30% and simplify the taxes structure to prevent smokers from switching to the cheaper brand.

Field of Study:	Public Health	Student's Signature .....
Academic Year:	2021	Advisor's Signature .....

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Ridhwan Fauzi

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CHAPTER I INTRODUCTION

1.1. Background and Rationale

Since the past century, tobacco use has been a pandemic (Warner and MacKay, 2006). World Health Organization (WHO) reported that around 1 billion people used tobacco globally in 2019, consisting of 847 million males and 153 million females (WHO, 2021). Although the total number of smokers was slightly lower than in 2007, the number of active smokers was still exceedingly high (WHO, 2021). About 80% of active smokers are living in Low and Middle-Income Countries (LMICs) (Lian and Dorotheo, 2021).

Indonesia is the world's second-largest tobacco market after China (Lian and Dorotheo, 2021). The smoking rates among males are considered the world's highest, while the smoking prevalence among females has increased multiple times in the past decade (Soerojo et al., 2020). In 2018, the prevalence of tobacco use among adults is about 33.8% in Indonesia, including 62.9% of males and 4.8% of females (Kemenkes-Ministry of Health, 2019). Moreover, most smokers in Indonesia (WHO, 2019). do not have a intention to quit smoking. The Global Adult Tobacco Survey (GATS) reported that less than half of current smokers have an intention for smoking cessation (WHO, 2019). Therefore, the prevalence of tobacco use has been relatively unchanging since the last decade.

Smoking causes adverse effects on nearly all body organs (USDHHS, 2014). Tobacco use is also a major risk factor for Non-Communicable Diseases (NCD)

(USDHHS, 2014). Tobacco smoke contains at least 7,000 chemicals and chemical compounds, and almost 70 of them are known as a carcinogen (USDHHS, 2010). Tobacco smoke can impair DNA, which causes cells to grow abnormally (USDHHS, 2010). Afterward, toxic chemicals from cigarettes prevent the body from releasing the cells to destroy the abnormal cell (USDHHS, 2010). Almost 90% of lung cancers are related to smoking (USDHHS, 2010). The evidence is sufficient to infer that smoking caused two additional cancers, liver and colorectal cancer (USDHHS, 2010).

Cigarette smoking also damages lung tissue causing Chronic Obstruct Pulmonary Diseases (COPD), asthma and increasing the risk of acquiring tuberculosis (USDHHS, 2010). Moreover, tobacco use contributes to plaque formation in the arteries' walls, thickens the blood, and causes clots inside the veins and arteries (USDHHS, 2010). These trigger Cardiovascular Diseases (CVD) such as Peripheral Arterial Disease (PAD), Coronary Heart Disease (CHD), and stroke (USDHHS, 2010). There is also sufficient evidence that smoking increases the risk of developing diabetes by 30-40% (USDHHS, 2010). Diabetic patients who smoke tobacco are more likely to have kidney failure, blindness, and a higher risk of amputation than non-smokers (USDHHS, 2010).

Tobacco is the biggest single preventable cause of morbidity and mortality (WHO, 2017). It kills at least eight million people a year worldwide in 2018 (IHME, 2020). A majority (76%) of these death occurs in developing countries (IHME, 2020). WHO estimated one billion deaths related to tobacco use in the 21st century (WHO, 2008). In Indonesia, tobacco causes approximately 290,444 deaths, which equals 17.1% of the total death in 2019 (IHME, 2020). Smoking is also the third-highest risk factor of the loss of years due to premature death, disability, and morbidity or

Disability Adjusted Life Years (DALYs), which caused 9.95% of total DALYs in 2019 (IHME, 2020).

High smoking prevalence increases medical expenditure, reduces productivity, and induces additional costs to society (WHO, 2019). A previous study found that tobacco use incurred massive macroeconomic costs in Indonesia, estimating 45.9 billion US Dollars a year in 2015 (Kosen et al., 2017). The costs included loss of productive years due to premature death, disability, and morbidity (Kosen et al., 2017). At the micro-level, expenditure on tobacco among poorest households is considerably higher than basic needs, which is fourteen times higher than the average expenditure on meat, six times on milk and egg, two times on fish and vegetables, almost seven times on education, eleven times on health, and two times on clothing (Lian and Dorotheo, 2018).

World Health Organization has proposed the Framework Convention on Tobacco Control (FCTC), which is the first global public health treaty adopted in the World Health Assembly (WHA) in 2003. The WHO FCTC was entered to force in 2005 (WHO, 2003). There have been 182 countries signed or ratified the WHO FCTC as of November 2020 (UN, 2020). The treaty consists of 38 articles that provide a comprehensive strategy to combat the tobacco epidemic, including supply and demand-side reduction (WHO, 2003). In 2008, the WHO introduced the MPOWER package as the follow-up of WHO FCTC enactment (WHO, 2008). The MPOWER package consists of six evidence-based policy options, specifically: (1). Monitoring tobacco use and prevention policies; (2). Protecting people from tobacco smoke; (3) Offering help to quit tobacco use; (4). Warning about the danger of tobacco use; (5).

Enforcing the ban on tobacco advertising, promotion, and sponsorship, and (6) Raising the tax on tobacco (WHO, 2008).

Raising tobacco tax is one of the most cost-effective measures for reducing tobacco consumption (Chaloupka et al., 2012). At the same time, tobacco tax increase generate a source of revenue for the government (Chaloupka et al., 2012). A significant tax increase will discourage potential smokers from starting, motivating current smokers to stop, reducing the number of cigarettes used among those who remain to smoke (Chaloupka et al., 2012). Consequently, raising tobacco tax will reduce tobacco-related morbidity and mortality (WHO, 2008). A multi countries study showed that cigarette price elasticity ranged from -0.2 to -0.8 in developing world, meaning a percent increase in cigarette price would reduce cigarette consumption from 0.2 to 0.8% (IARC, 2011). The large body of evidence shows that tax intervention will have a greater impact on vulnerable groups such as youth, low educated and the poor (IARC, 2011, Hill et al., 2014). Therefore, raising the tobacco tax also improves equity (Hill et al., 2014).

Indonesia's current tobacco excise tax system is quite complicated (Ahsan et al., 2016). The system use multi tiers with a different tariff based on cigarette type, production volumes, and retail prices (Ahsan et al., 2016). This complex system creates an opportunity for the tobacco industry to sell cigarettes with a more affordable and wide range of prices (Ahsan et al., 2016). Moreover, the excise tax law number 39 the year 2007 sets the maximum allowable excise tax rate at 57% (Ahsan et al., 2016). This regulation prevents the government from significantly increasing the annual tobacco excise tax tariff. In 2019, the government decided not to increase the excise tax tariff making the rate stable around 44% (Kemenkeu-Ministry of

Finance, 2018). Thus, the total tobacco taxes, including tobacco excise taxes, value-added taxes, and local taxes, are about 57% of the retail price. This rate still bellows the best practice of the WHO at 75% of the retail price (WHO, 2019). In addition, Although the government has increased the tobacco excise tax tariff several times during the past decade, the real price change is still lower than income growth (Zheng et al., 2018). A previous study from the World Bank found that the Relative Income Price (RIP) of cigarettes was 6.03% in 2002 and 4.02% in 2016, meaning the price is more affordable in 2016 than in 2002 (Zheng et al., 2018).

The tobacco industry persistently undermines tobacco tax policy advocacy through various channels (Ross and Tesche, 2016). They use media to build public support and pressure the government not to increase the excise tax (Bigwanto, 2019). For instance, a discourse media analysis study found that news media coverage was dominated by the pro-industry statements to reject tax increase and delay tax simplification policy during October 2018 or one month before annual state budgeting negotiation in parliament (Bigwanto, 2019). The industry also mobilizes farmers, labor and consumer associations, and religious groups to create public pressure (Bigwanto, 2019). They even sponsored the academician to generate misleading evidence on tax policy (Bigwanto, 2019). Moreover, the industry successfully engages national and local politicians and senior government officials to fight against excise tax reform (Bigwanto, 2019).

Despite the fact that the Indonesian government is facing intense challenges from the tobacco industry in developing an effective tobacco tax policy, the public demands a stronger regulation on tobacco control. A phone-based survey reported that most secondhand smokers (86.7%) supported the government to increase cigarette tax

(Nurhasana et al., 2020). They also believed that raising taxes could prevent children from buying cigarettes (86.70%) and help family members to stop smoking (86.69%) (Nurhasana et al., 2020). Furthermore, increasing the tobacco tax would generate additional revenue to correct negative externalities of smoking, such as increasing the health promotion budget, financing Universal Health Coverage (UHC), and building healthcare infrastructure in the least developed region. Unfortunately, there is insufficient evidence on the benefit of the tobacco tax increase on the Indonesian health system and state revenue. This study provides substantial evidence to support the policymakers in increasing the tobacco tax as an effective measure to reduce smoking prevalence and attributable burden as well as expand fiscal space to improve the health sector's funding.

1.2. Objectives

1.2.1. General Objective

The study aimed to examine the impact of increasing tobacco excise tax on cigarette consumption, tobacco-attributed mortality, tobacco-attributed medical treatment cost, life-years gained, and government revenue in Indonesia.

1.2.2. Specific Objectives

1. To estimate smoking participation elasticity in the period of 2015-2020 in Indonesia.
2. To estimate smoking participation elasticity among smokers in the period of 2015-2020 in Indonesia.
3. To assess the impact of 12.5%, 25%, 50%, 100%, and 200% increase of tobacco excise tax on cigarette consumption, tobacco-attributed mortality, tobacco-

attributed medical treatment cost, life-years gained, and government revenue in Indonesia.

1.3. Research Questions

1. What is the coefficient of smoking participation elasticity in the period of 2015-2020 in Indonesia?
2. What is the coefficient of smoking intensity elasticity among smokers in the period of 2015-2020. in Indonesia?
3. What is the impact of 12.5%, 25%, 50%, 100%, and 200% increase of tobacco excise tax on cigarette consumption, tobacco-attributed mortality, tobacco-attributed medical treatment cost, life-years gained, and government revenue in Indonesia?

1.4. Research Hypothesis

1). The smoking participation is inelastic in the period of 2015-2020 in Indonesia.

2). The smoking intensity is inelastic in the period of 2015-2020 in Indonesia.

3). The 12.5%, 25%, 50%, 100%, and 200% increase in tobacco excise tax rate reduce cigarettes cigarette consumption, tobacco-attributed mortality, tobacco-attributed medical treatment cost, life-years gained, and government revenue in Indonesia.

1.5. Conceptual Framework

The study consists of two phases. Phase 1 analyzed the demand for cigarette smoking and estimated cigarette price elasticity. The second phase simulated the impact of tobacco tax increase on health and economic outcomes. Table 1 presents the research flow and the outcomes of each phase.

Table 1. Research flow

Phase	Type of Study	Outcome
I	Pooled cross sectional from 2015 to 2020	• Smoking participation elasticity • Smoking intensity elasticity
II	Modelling	• Cigarette consumption; • Mortality; • Life-years gained. • Treatment cost; and • Government revenue.

The conceptual framework of each phase is shown in the following figures:

Figure 1. Conceptual framework of phase I

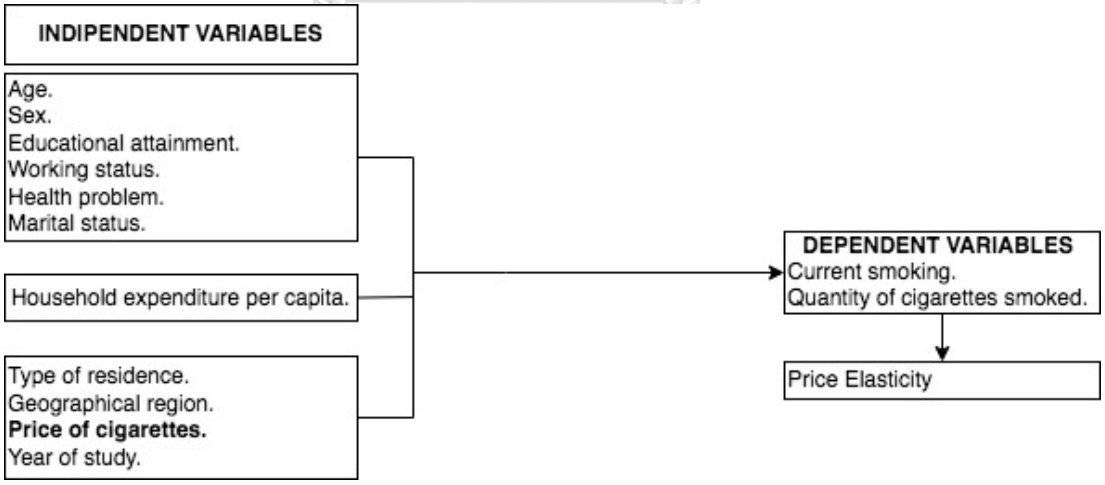
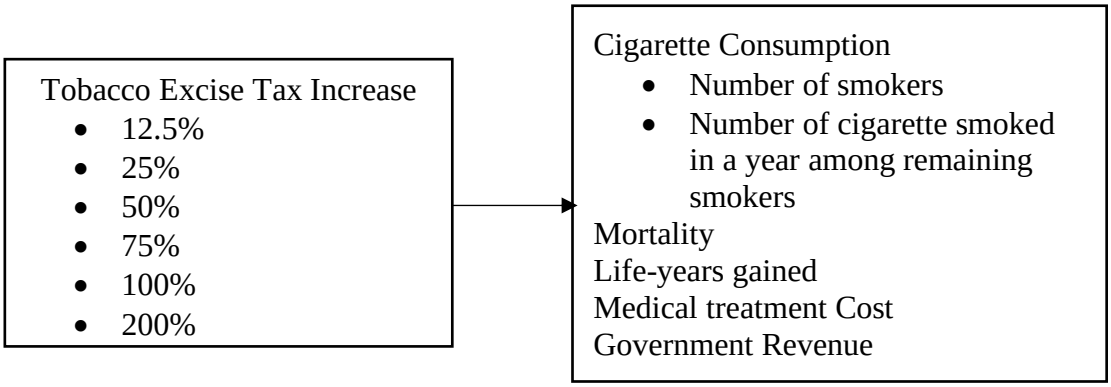


Figure 2. Conceptual framework of phase II



1.6. Operational Definitions

1. Cigarette price elasticity refers to the degree of a change in demand for cigarettes in response to a change in the prices.

1a. Smoking participation elasticity refers to a change in smoking participation (current smoking status) in response to the price change.

1b. Smoking intensity elasticity refers to a change in the number of cigarettes smoked among smokers relative to the price change.

2. Current smoking refers to the intentional inhalation of cigarettes smoked in the past month.

3. Number of cigarettes smoked refers to the average number of cigarettes consumed in a week by smokers.

4. Cigarette price is the average cigarette consumption price per stick among all smokers in the district and type of residence. The price is adjusted with the Consumer Price Index (CPI) for the base year 2020.

5. Age is defined by the date of birth collected during the survey and counted from the last birthday in years.

6. Sex means the sex of the participants, either male or female.

7. Education attainment is the number of years of formal education completed.
8. Marital status is the legally defined marital state classified as single, married, separated, divorced, and widowed.
9. Working status is the main income-earning activity in the past week that classified as student, worker, and unemployed.
10. Health problem is a self-report of having a physical health problem or symptom in the past 30 days.
11. Per capita household expenditure is the total amount of final consumption expenditure made by the household member to meet daily needs per month divided by the number of household member. The number was then classified into 5 quintiles. The expenditure was also adjusted with the inflation for the base year 2020.
12. Type of residence refers to the type of village in which participants live, either urban or rural.
13. Geographical region is the regional classification where participants were residing during the data collection.
14. Year refers to the year of survey conducted.
15. Tobacco excise taxes refers to unique taxes imposed on tobacco products regulated by the Ministry of Finance.
16. Mortality refers to an estimated number of deaths attributable to tobacco use.
17. Medical treatment cost is an estimated cost of medical care for treating tobacco-related diseases.
18. Life-years gained is the additional number of years of life by person who quit smoking cigarettes.

19. Government revenue is an estimated total government revenue from tobacco excise taxes, value-added taxes of cigarette product, and local tobacco taxes.

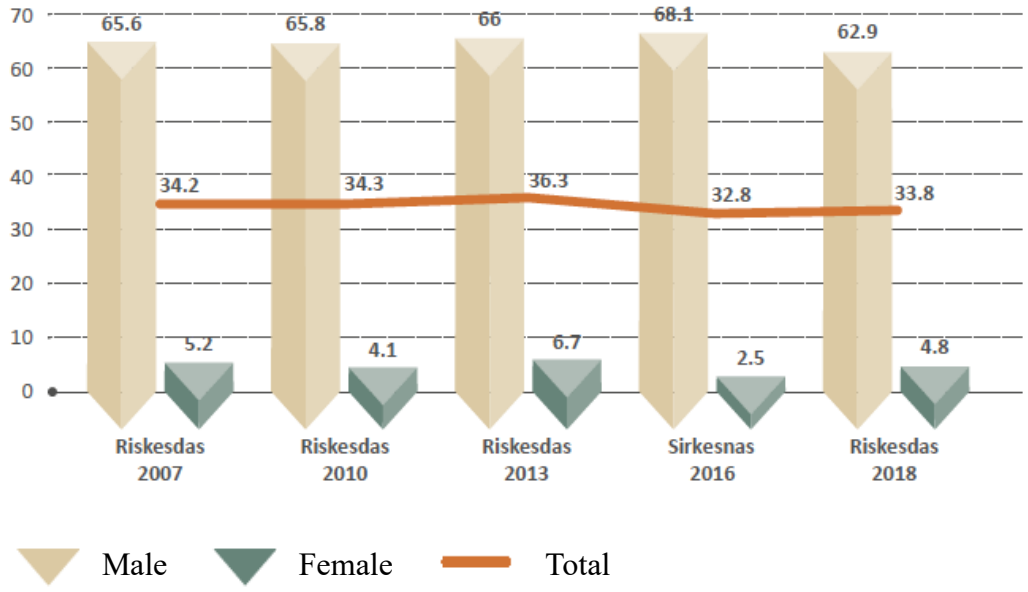
CHAPTER II LITERATURE REVIEW

2.1. Tobacco Epidemic

2.1.1. Prevalence of Tobacco Use

A total of 17.5% of adults aged 15 years and above or 1.4 billion people currently use tobacco worldwide in 2019, including 847 million males and 153 million females (WHO, 2021). This rate is declining by 23% or 23 million fewer than in 2007 (WHO, 2021). The global reduction of smoking rates occurs in all countries income groups (WHO, 2019). However, About 80% of smokers live in Low and Middle-Income Countries (Lian and Dorotheo, 2021).

Figure 3 Prevalence of current smokers among adults in Indonesia, 2007-2018



Source: (TCSC-IPHA, 2020)

About 550 billion cigarettes sticks were sold and consumed by 122 million smokers from ASEAN in 2016 (Lian and Dorotheo, 2018). Most of them (316.1

billion) were consumed by Indonesian (Lian and Dorotheo, 2018). Basic health research 2018 reported that a total of one-third (33.8%) of adults currently smoked tobacco in 2018, 62.9% of males and4.8% of females (Kemenkes-Ministry of Health, 2019). This rate is the highest among neighboring countries in ASEAN, such as Vietnam (22.5%), Thailand (19.1%), Malaysia (22.8%), and Singapore (12%) (Lian and Dorotheo, 2018).

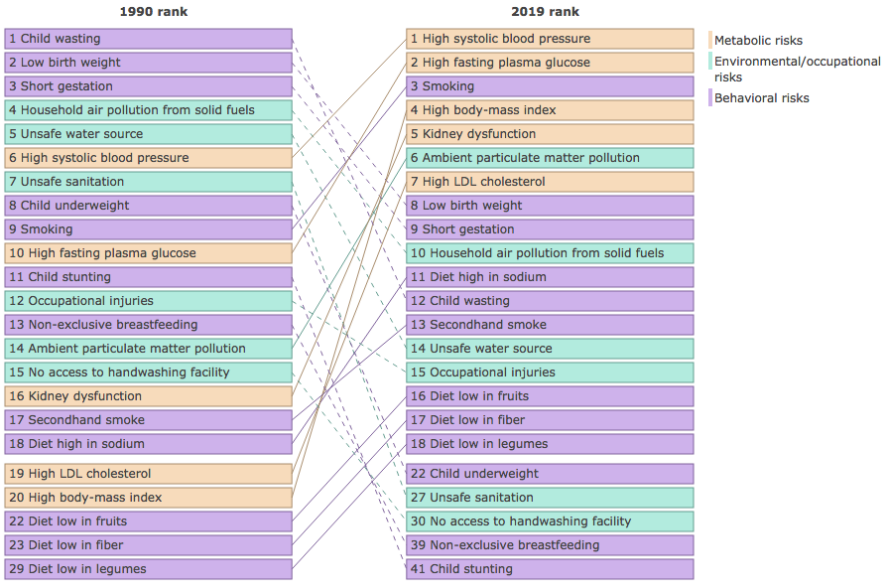
Figure 3 presents the smoking prevalence among adults in Indonesia from 2007 to 2018. The smoking prevalence has been fluctuating in the past decades. A total of 34.2% currently smoked tobacco in 2007 and increased to 36.3% in 2013. Then, the rate slightly declined to 33.8% in 2018. However, the smoking prevalence is still stubbornly high, particularly among males. About one-third (62.9%) of Indonesian males smoke cigarettes, which is the world's highest (WHO, 2019). Despite the smoking prevalence among females being lower than in developed countries, the rate is the highest among ASEAN Countries but Myanmar (Lian and Dorotheo, 2018, WHO, 2019).

2.1.2. The Burden of Tobacco-Related Illness and Death

Tobacco is the most significant preventable cause of morbidity and mortality (WHO, 2019). An epidemiological study in the United States found that about 60% of smokers would die attributed to tobacco use (Jha et al., 2013). Institute for Health Metrics and Evaluation (IHME) estimated that more than eight million people died a year worldwide related to smoking in 2019, which accounted for 13.61% of total deaths. The majority (76%) of these death occurs in LMICs (GBD 2019 Risk Factors Collaborators, 2020). Moreover, smoking is the leading risk factor of DALYs in

males and sixth in females, which accounted for 7.89% of the total DALY in 2019 (GBD 2019 Risk Factors Collaborators, 2020).

Figure 4. Leading Risk Factors of DALYs in Indonesia for 1990 and 2019



Source: (IHME, 2020)

Figure 4 depicts the change in the risk factors in Indonesia, 1990-2019. The burden of tobacco use elevates over the years from the ninth in 1990 to the third-highest in 2019. It is the highest among behavioral risks and higher than any environmental or occupational risk factors, including air pollution and unsafe water sources. About 290,444 people died a year associated with tobacco (IHME, 2020). It also caused 1.2 million Years Lost due to Disability (YLDs) and 7.6 million premature deaths or Years of Life Lost (YLLs). Thus, the total DALYs attributed to tobacco use were approximately 8,851,100.65 in 2019 (IHME, 2020).

2.1.3. Cancer

Tobacco smoke contains more than 7,000 chemicals, and at least 69 of these are carcinogens and many other toxicants causing adverse health effects (USDHHS, 2010). These cancer-causing substances include Polycyclic Aromatic Hydrocarbon

(PAH), heterocyclic compounds, N-nitrosamines, aromatic amines, heterocyclic aromatic amines, Aldehydes, Phenolic compounds, volatile hydrocarbons, nitrohydrocarbons, miscellaneous organic compounds, and metals and inorganic compounds (USDHHS, 2010). These carcinogens exposure causes DNA damage that lead to cells growing out of control (USDHHS, 2014). In normal circumstances, the body releases special cells to annihilate the irregular cells (USDHHS, 2014). However, cigarette smoke toxicants impair this process resulting in these abnormal cells proliferating (USDHHS, 2014).

Some cancers are directly related to tobacco, such as lung, larynx, pharynx, nasopharynx, lip and oral cavity, esophageal, kidney, pancreas, bladder, stomach, leukemia, prostate, breast, and cervical cancer (USDHHS, 2010). Afterward, recent evidence is sufficient to infer the causal effect between smoking and liver and colorectal cancer (USDHHS, 2014). Those are the top 5 deadliest cancer in both males and females globally (IHME, 2020). A meta-analysis of a longitudinal study in Asia found that the hazard ratio of all cancer mortality comparing current smokers with non-smokers is 1.44 (95% C.I. = 1.32 to 1.57) in males and 1.61 (95% C.I. = 1.29 to 2.00) in females (Barzi et al., 2008). A recent epidemiological study in ASEAN found that smoking was attributed to 121,849 new cancer cases in 2018, consisting of 106,858 males and 14,991 female cases (Kristina et al., 2019).

Almost 90% of lung cancer is related to smoking (USDHHS, 2014). A meta-analysis shows that the relative risk of developing cancer comparing smokers and non-smokers in males and females yields a similar magnitude, 7.33 (95% C.I. = 4.90-10.96) in males and 6.99 (95% C.I. = 5.09-9.59) in females, respectively (O'Keeffe et al., 2018). Tobacco smoking does not only increase the risk of lung cancer among

smokers but also among secondhand smokers. A prior meta-analysis in Japan revealed that lung cancer's relative risk associated with exposure to environmental tobacco smoke in the house during adulthood is approximately 1.28 (95% C.I. = 1.10–1.48) (Hori et al., 2016). Furthermore, a cohort study in the United States found that the relative risk of death from lung cancer compared to non-smokers is 25.66 (95% C.I. = 23.17–28.40) for the current smokers and 6.70 (95% C.I. = 6.09–7.36) for former smokers (Thun et al., 2013).

Lung cancer is the highest cancer death in males and females (IHME, 2020). More than 2 million people died a year globally due to lung cancer in 2019 (IHME, 2020). In Indonesia, lung cancer is the top 10 cause of death and the most among cancer, contributing 2.9% of the total death in 2019 (IHME, 2020). Tobacco attributed to 59.55% of these deaths, totaling 29,357 cases in 2009 (IHME, 2020). Afterward, it also yielded 720.161.51 of YLLs, and 6,313.38 of YLDs, contributing to 56.88% of total lung cancer DALYs (IHME, 2020).

2.1.4. Respiratory Disease

Tobacco smoke contains very strong toxicants such as Acrolein, Formaldehyde, Nitrogen oxides, Cadmium, and Hydrogen cyanide (USDHHS, 2014). Exposure to those chemicals can damage cells and tissue in the air path from the nose and mouth to the lung’s air sac (USDHHS, 2014). The body has no chance to heal the damage if continuously exposed to these toxicants in large amounts (USDHHS, 2014). Long-term exposure to cigarette smoke chemicals causes severe lung injury (USDHHS, 2014).

Respiratory diseases attributed to tobacco use include COPD and Asthma (USDHHS, 2014). A meta-analysis involving 129 studies found that the relative risk

of COPD comparing current and ex-smokers with smokers are 3.51 (95% C.I. = 3.08-3.99) and 2.35 (95% C.I. = 2.11-2.63), respectively (Forey et al., 2011). Another meta-analysis among the Japanese population showed that the relative risk of developing COPD is 3.57 (95% C.I. = 2.72–4.70) for current smokers and 3.03 (95% C.I. = 2.00–4.57) for former smokers compared to non-smokers (Lee et al., 2018).

There is a strong association between smoking and Asthma incidences and exacerbation (USDHHS, 2014). A repeated cross-sectional study in Korea revealed that current smokers and formers smokers have a significantly higher adjusted odds ratio of experiencing wheezing and exercise wheezing, ever diagnosed and current asthma, and experiencing asthma aggravation within the past year than non-smokers (Kim et al., 2018). Besides, secondhand smoke may induce asthma exacerbation in children. A meta-analysis also suggested that a positive association was found between secondhand smoke exposure with ever diagnosed asthma (OR = 1.24; 95% C.I. = 1.20-1.28), asthma-like syndrome (OR = 1.34; 95% CI = 1.34-1.64), and wheezing (OR = 1.27; 95% CI = 1.23-1.32) (He et al., 2020).

Active and passive smoking increase the risk of getting Tuberculosis (USDHHS, 2014). A meta-analysis of the study from 2014 to 2020 revealed that there was an increased risk of acquiring TB among active smokers (RR = 2.67; 95% C.I. = 2.02–3.53) and secondhand smokers (RR = 2.15; 95% C.I. = 1.419–3.242) (Obore et al., 2020). Another multicounty study found that TB incidence risk ratios attributed to smoking are approximately 17.6% (95% C.I. = 8.4–21.4) (Amere et al., 2018). Furthermore, smoking also affects the treatment outcome of TB. A prior meta-analysis involving 47,770 TB patients suggested that those who smoked tobacco were

more likely (OR= 1.51; 95% C.I. = 1.30-1.75) to have a poor treatment outcome (Burusie et al., 2020).

Lower Respiratory Infections (LRI) is the second highest burden of diseases (12.55% of total DALYs) in children under the age of 5 (IHME, 2020). Exposure to environmental tobacco smoke has a major attributions to these burden. A meta-analysis suggests that exposure to secondhand smoke by any households members increased the risk of lower respiratory infections (OR = 1.54; 95% C.I.= 1.40 - 1.69) (Jones et al., 2011). Furthermore, sub-group analysis by type of LRI found that exposure to passive smoke are more likely to develop acute respiratory infections (OR =1.27; 95% C.I. = 1.07-1.51), Bronchiolitis (OR = 2.51; 95% C.I. = 1.96-3.21), Bronchitis (OR = 1.58; 95% C.I. = 1.27-1.98), Pneumonia (OR = 1.43; 95% C.I. = 0.93-2.21), and unspecific lower respiratory infection (OR = 1.49; 95% C.I.= 1.33-1.68) compared to those who unexposed (Jones et al., 2011). Besides, the risk of getting LRI is also higher among those who actively smoke tobacco. A meta-analysis shows that the risk of developing community acquired pneumonia is higher among current smokers (OR = 2.17; 95% C.I. = 1.70–2.76, n = 13 studies; HR = 1.52; 95% C.I. = 1.13–2.04, n = 7 studies) and former smokers (OR = 1.49; 95% C.I. = 1.26–1.75, n = 8 studies; HR = 1.18; 95% C.I. = 0.91–1.52, n = 6 studies) than non-smokers (Baskaran et al., 2019).

More than 200 thousand people die a year due to chronic reparatory, tuberculosis, and respiratory infection in Indonesia in 2019 (IHME, 2020). Drug susceptible Tuberculosis, COPD, and Asthma are ranked fifth, sixth, tenth, and thirteen of the cause of death, respectively (IHME, 2020). In addition, tobacco is attributed to more than half (59.32%) of the death caused by COPD (IHME, 2020).

For Asthma, tobacco is associated with approximately 17.39% of mortality (IHME, 2020). Afterward, tobacco attribution of tuberculosis and Lower Respiratory Infections (LRI) mortality is 22.96% and 24.98%, respectively (IHME, 2020).

2.1.5. Cardiovascular Diseases

Tobacco smoke contains many dangerous constituents such as oxidizing chemicals, nicotine, carbon monoxide, and particulate matter (USDHHS, 2010). The toxicants were known as s major cause of endothelial dysfunction, increase the risk of thrombosis, yield a chronic inflammation that causes atherogenic diseases process, escalate triglycerides, and reduce high-density lipoprotein cholesterol (USDHHS, 2010). This damage leads to Cardiovascular Diseases (CVD) such as coronary heart disease, peripheral arterial disease, stroke, atrial fibrillation, aortic aneurysm, hypertension, myocardial infarction, and sudden death (USDHHS, 2014).

U.S. Surgeon general report concluded that the risk of cardiovascular diseases increases in active and passive smokers (USDHHS, 2010). The degree of risk elevates with the number of cigarettes smoked daily and the duration of smoking (USDHHS, 2010). Nevertheless, The risk of cardiovascular diseases attributed to tobacco is significantly increased even for people who smoked fewer than five cigarettes a day or were exposed to cigarette smoke at a minimum level (USDHHS, 2010). A repeated longitudinal study in America found that the relative risk of death from ischemic heart disease, stroke, and other heath diseases comparing current smokers and non-smokers were 2.50 (95% C.I. = 2.34-2.66), 1.92 (95% C.I. = 1.66-2.21), and 2.15 (95% C.I. = 1.92-2.41) respectively (Thun et al., 2013). Afterward, a meta-analysis involving the Japanese population revealed that the relative risk of current

smokers developing ischemic heart disease was 2.21 (95% C.I. = 1.96-2.50) compared to non-smokers, while stroke was 1.40-(95% C.I. = 1.25-1.57) (Lee et al., 2018).

Cardiovascular diseases have been the highest cause of death in Indonesia since 1990 (IHME, 2020). It contributes to 38.19% of all causes of mortality in 2019, which raised from 20.26% in 1990 (IHME, 2020). A total of 137,195 or 21.04% of total cardiovascular death associated with tobacco use (IHME, 2020). Furthermore, cardiovascular diseases attributed to tobacco generated 3,800,127.41 of YLLs and 252,533.63 of YLDs in 2019 (IHME, 2020).

2.1.6. Diabetes

There is convincing evidence to support the relationship between smoking and developing type 2 diabetes (USDHHS, 2014). Tobacco smoke increases inflammatory markers and oxidative stress and leads to endothelial dysfunction (USDHHS, 2014). Besides, nicotine can impair pancreatic islet ß cell function, which reduces the release of insulin (USDHHS, 2014). Nicotine exposure also increases the insulin resistance status in people with type 2 diabetes (USDHHS, 2014). These multiple mechanisms lead to insulin resistance, change glucose homeostasis, and impair pancreatic cell function, which is important to developing diabetes and its comorbidities (USDHHS, 2014).

U.S. Surgeon General concluded that the risk of incidence of type 2 diabetes is 30-40% higher for smokers than non-smokers (IHME, 2020). Another meta-analysis included 88 studies with 5,898,795 participants found that the relative risk of developing type 2 diabetes was 1.37 (95% C.I. = 1.33-1.42, n = 8 studies) for current smokers and 1.14 (95% C.I. = 1.10-1.18, n = 47 studies) for former smokers compare to those who never smoked (Pan et al., 2015). In addition, this study also yields a

dose-response relationship between the degree of smoking and the risk of incidences of diabetes (Pan et al., 2015). The Relative Risk of getting Type 2 Diabetes was 1·21 (1·10-1·33) for light smokers, 1·34 (1·27-1·41) for moderate smokers, and 1·57 (1·47-1·66) for heavy smokers compared to non-smokers (Pan et al., 2015). Similarly, a study in Japan found that the risk of getting type 2 diabetes increased 16% for each increment of 10 sticks of cigarettes smoked a day (Akter et al., 2017).

Diabetes mortality has increased by 157.66% during the past decade in Indonesia (IHME, 2020). In 1990, the diabetes mortality rate was 17.92 per 100,000 deaths (IHME, 2020). The rate was then elevated to 40.98 per 100,00 deaths in 2019 (IHME, 2020). smoking and exposure to environmental tobacco smoke ranked third and fifth risk factors for diabetes mortality in 2019 (IHME, 2020). It attributed 12.84% of diabetes mortality or equals 21,879 deaths a year (IHME, 2020). Furthermore, smoking contributes to 615,945.96 YLLs and 201,858.07 YLDs in diabetes (IHME, 2020).

2.1.7. Medical Service Utilization

There is convincing evidence that cigarette use and exposure to cigarette smoke increase medical care services and healthcare costs (USDHHS, 2014). A national representative survey found that current and former smokers were more likely to be hospitalized than non-smokers with the odds ratio of 2.09 (95% C.I.= 1.26-3.44) and 1.35 (95% C.I. = 1.12-1.63), respectively (Sibai et al., 2016). Furthermore, the study also found a dose-response relationship between the number of cigarette packs consumed a year with the odds of hospitalization ($p<0.001$) (Sibai et al., 2016). Afterward, a previous longitudinal study among U.S. navy female recruits revealed a significant difference ($P<0.001$) found in days hospitalized between daily

smokers and never and other smokers (Woodruff et al., 2010). For secondhand smokers, maternal smoking was associated with higher odds of infant hospitalization due to infectious disease (Metzger et al., 2013).

Outpatient visits include routine medical check-ups, preventive care, follow-up of chronic health issues, and treating new symptoms or diseases (USDHHS, 2014). Smoking has a mixed effect on outpatient care utilization (USDHHS, 2014). Evidence shows that current smokers are less likely to have outpatient visits and adherence to attending routine medical treatment than non-smokers (USDHHS, 2014). On the other hand, former smokers are more likely to visit outpatients care (Baskaran et al., 2019). Most smokers quit smoking after being diagnosed with severe illness or diseases (Westmaas et al., 2015). Thus, they need more intense outpatient care visits to manage their ongoing disease.

A systematic review examining smoking and cardiac rehabilitation participation revealed that smoking increase the probability of being referred to a cardiac rehabilitation program (Gaalema et al., 2015). Nevertheless, they are less likely to attend one session of the program and more likely to drop out (Gaalema et al., 2015). On the other way, smokers are more likely to have an ambulance call and be admitted to the emergency department. A study in Estonia found that current smokers have a higher odds of calling for an ambulance over the past 12 months, 1.63 (95% C.I .= 1.03-2.57) of males, and 1.38 (95% C.I. = 1.00-1.90) on females (Vals et al., 2013). Afterward, a study among asthma patients found that current smokers increase the risk of emergency department visits(OR = 1.46; 95% C.I.= 1.05 - 2.03) and urgent care visits to doctors or other health professional (OR = 1.29; 95% C.I.= 0.96 - 1.73) (Khokhawalla et al., 2015).

2.1.8. Healthcare Expenditure and Economic Cost

Smoking increases the risk of hospitalization and emergency care utilization, which elevates healthcare costs (USDHHS, 2014). Previous studies from Iran and Spain found that current and former smokers have a higher healthcare cost than non-smokers (Sari et al., 2016, López Ibáñez de Aldecoa et al., 2019). Another panel data from 1992 through 2009 in 51 states of the US revealed that a total of 1% reduction of smoking prevalence and packed of cigarettes consumed would decrease about 0.1% of per capita health expenditures (Lightwood and Glantz, 2016). Furthermore, the healthcare spending attributed to smoking is approximately $170 billion per year, representing 8.7% of annual health expenditure in the US (Xu et al., 2015).

In 2015, the total NCD treatment cost associated with smoking was approximately $2.29 billion in Indonesia (Kristina et al., 2018). Most of this spending was incurred by Hypertension (55%), COPD (31%), and ischemic heart disease (4%) (Kristina et al., 2018). Furthermore, another study yielded that the estimated macroeconomic cost of tobacco, which included expenditure on cigarettes, loss of productivity years due to morbidity, disability, premature mortality, inpatients service cost, was about $45.9 billion (Kosen et al., 2017). This amount was substantially higher than the revenue from excise tax ($33 billion) in 2015 (Kosen et al., 2017).

2.2. Tobacco Control Regulation

2.2.1. Framework Convention on Tobacco Control (FCTC)

Framework Convention on Tobacco Control is the treaty to combat the globalization of the tobacco epidemic (WHO, 2003). It was adopted during the 56th World Health Assembly 2003 and entered into force on February 27th, 2005 (WHO, 2003). WHO FCTC is the first global public health and one of the most widely

embraced acquired United Nations treaties (UN, 2020). One hundred eighty-two countries have embraced this treaty, covering 90% world population (UN, 2020).

The WHO FCTC emphasizes the importance of demand and supply reduction strategies to curb the tobacco epidemic (WHO, 2003). The demand reduction strategies include price and tax as well as on-price measures (WHO, 2003). Non-price measures include protection from tobacco smoke exposure, regulation of the contents and tobacco product disclosures, packaging and labeling, education, communication, training, public awareness, tobacco advertising, promotion, sponsorship, and tobacco cessation services (WHO, 2003). The supply reduction provisions include regulation on illicit trade in tobacco products, sales to and by minors, and provisions of alternative activities for tobacco farmers (WHO, 2003).

After a decade of implementation, FCTC has contributed significantly to implementing comprehensive smoke-free area regulation for indoor, restaurant, and bars, larger graphic health warnings in tobacco packs, mass media campaigns, and the ban on tobacco products sale to minors (Chung-Hall et al., 2019). It also has a partial contribution to the progress of tobacco taxes and price increases, comprehensive tobacco advertising, promotion, and sponsorship ban, cessation services, scaling down illicit tobacco trade, disclosure of information on the content and emission of the tobacco product, and research, surveillance and knowledge exchange program (Chung-Hall et al., 2019). However, the FCTC has little contribution to the prevention of tobacco industry interference in the tobacco control policy, content, and emission of tobacco products regulation, promotion of alternatives for tobacco farmers, minimization of the health and environmental impact of tobacco cultivation and

production, legislative action against the tobacco industry, and acceleration of international cooperation (Chung-Hall et al., 2019).

In 20018, the WHO proposed a set of policy interventions called MPOWER (WHO, 2008). This package is the core of the WHO FCTC, which consists of six proven policies including (1) Monitor tobacco use and prevention policies; (2) Protect people from tobacco smoke; (3) Offer help to quit tobacco use; (4) Warn about the dangers of tobacco; (5) Enforce bans on tobacco advertising, promotion, and sponsorship; (6) Raise taxes on tobacco (WHO, 2008). Proper national and international monitoring is essential to understand the cause of the tobacco problem and evaluate the policy's implementation (WHO, 2008). The monitoring system's essential indicators are the prevalence of tobacco use, the impact of policy interventions, and tobacco industry activities such as promotion, marketing, and lobbying (WHO, 2008).

It has been more than a decade since the WHO FCTC was adopted. About 182 countries have become parties to the treaty as of November 2020 (UN, 2020). Indonesia is the only country in the Asia Pacific region that has not been a party to the WHO FCTC (UN, 2020). There are only eight other countries in the world that have not signed and ratified the WHO FCTC, including South Sudan, Somalia, Monaco, Malawi, Liechtenstein, Eritrea, Dominical Republic, and Andorra (Kusuma et al., 2019). An assessment of the state of FCTC implementation by health system building blocks found that Indonesia had weak tobacco control in leadership and government, financing, and human resources domains (Amul and Pang, 2018). Another study from SEATCA also revealed that the absence of FCTC caused Indonesia to be the second-highest Tobacco Industry Interference (TII) Index in the ASEAN region (Assunta and

Dorotheo, 2016). However, Indonesia has made some progress in national and sub-national tobacco control regulation in the past decade, which will be explained in the following sections.

2.2.2. Government Regulation Number 109 the Year 2012

In 2009, the parliament passed law number 36 year 2009 on health, mandating the executive to create government regulation on tobacco control (Fauzi et al., 2014). The policy development process took three years until the state secretary announced the president signed government regulation number 109 year 2012 (PP 109/2012) in December 2012 (Fauzi et al., 2014). This regulation is the only national directive that specifically rules tobacco control (Fauzi et al., 2014). The PP 109/2012 includes tobacco advertising, promotion, and sponsorship restriction, smoke-free area implementation, and adoption of the pictorial health warnings in the front and back of all cigarette packs (Fauzi et al., 2014).

2.2.3. Smoke Free-Area

Exposure to tobacco smoke contributes to numerous health problems (USDHHS, 2014). There is no safe level of secondhand smoke exposure (USDHHS, 2014). Therefore, the WHO recommends developing smoke-free regulation, which completely bans smoking activities in all indoor preemies in public places, workspaces, and public transport to protect the people from the adverse effect of tobacco smoke exposure (WHO, 2009). Afterward, the regulation is also useful in reducing packs of cigarettes consumed and even helping smokers to quit (WHO, 2009). Moreover, smoke-free area regulation denormalizes smoking behavior and establishes a new social norm, such as maintaining a smoke-free home and personal

vehicle (WHO, 2019). Furthermore, the smoke-free area is one of the most popular tobacco control measures compared to other policies (WHO, 2008).

Indonesia has had a decentralized government system since 1999, which provides more authority to local governments to manage their respective territory of responsibility (Mahendradhata et al., 2017). Government regulation number 109 year 2012 assign the local government to regulate smoke-free areas and outdoor tobacco advertisement (Fauzi et al., 2014). Tobacco control regulation shows more promising progress at the sub-national than at the national level (TCSC-IPHA, 2020). Of 34 provinces, about 245 provinces have adopted smoke-free area regulations (FAKTA, 2020). Furthermore, approximately 67% or 349 cities/municipalities at the district level have adopted smoke-free area regulations as of December 2020 (FAKTA, 2020). However, the level of compliance and enforcement of these local regulations are considerably different between districts (Yunarman et al., 2020, Wahyuti et al., 2019). Therefore, smoke-free area regulation may have little impact on overall cigarette consumption reduction (Septiono et al., 2020).

2.2.4. Tobacco Cessation Service

The success of tobacco control intervention will increase the demand for tobacco cessation services (WHO, 2019). There are a variety of behavioral and pharmacological tobacco cessation interventions (WHO, 2019). In the population-level approach, advising to stop using tobacco during routine consultation or interaction effectively motivates and encourages people to stop smoking (WHO, 2019). A proactive and reactive toll-free quitline is also useful for smokers to receive brief and potentially intensive behavioral counseling (WHO, 2019). A major development of telecommunication and information technology may expand access to

a broader population and more personalized cessation support (WHO, 2019). Besides, smokers can choose more intensive behavioral support or visit specialist cessation clinics (WHO, 2019). Pharmacological interventions include nicotine replacement therapies and medication that does not involve nicotine to relieve smoking withdrawal symptoms (WHO, 2019). Combining behavioral and pharmacological interventions can double the probability of successfully quitting (WHO, 2019). Ultimately, the cessation service should integrate with the existing health system to make the cessation support more feasible and affordable to all people (WHO, 2019).

2.2.5. Pictorial Health Warnings in Tobacco Packages

Despite a large body of evidence on tobacco's harm, smokers are not fully aware of the health impact of the products they purchase and consume (WHO, 2019). Health warnings on tobacco packaging effectively warn people about the dangers of tobacco and are reliable to reach all tobacco users each time they use the product (WHO, 2019). The appropriate health warning mainly uses pictures instead of text only to deliver the messages (WHO, 2011). It depicts the diseases or negative impact of tobacco use (WHO, 2011). The warning should be clear, visible, legible, and large, covering at least half of the main display areas on the packs' front and back (WHO, 2011). The warning features descriptions of harmful effects caused by tobacco written in countries' principal language (WHO, 2011). The warning information should be rotated periodically (WHO, 2011). The warning appears in individual packs and outside packaging (WHO, 2011). Furthermore, smoke countries have implemented a generic (plain or standardized) packaging provision, which only allows cigarette packages to use a standard type of fonts, single-color, and a minimum identity of a product without logo, style fonts, colors, designs, or images (WHO, 2019). Standard

packaging is critical in changing the image of tobacco packs from marketing toward public health property (WHO, 2019).

It needs one and a half years since the introduction of PP 109/2020 to begin the implementation of 40% pictorial health warnings in June 2014 (Fauzi et al., 2018). WHO classified the health warning on cigarette packages in Indonesia as the medium-sized warning with all appropriate characteristics because the size is still below the WHO standard of covering at least 50% of the pack's principal area (WHO, 2019). Furthermore, a survey in 2017 found that the majority (80.4%) of the public supported (extremely support and very support) the government to increase pictorial health warnings to 90% (Fauzi et al., 2018). Therefore, the government is progressing to amend the size of pictorial health warnings from 40% to 90%.

2.2.6. Tobacco Advertising, Promotion, and Sponsorship Ban

The tobacco industry invests massive amounts of money in advertising, promotion, and sponsorship activities every year (WHO, 2013). These activities intend to encourage current smokers to smoke more, decrease motivation to quit, and recruit potential users to start and become long-term customers (WHO, 2008). Tobacco advertisement, promotion, and sponsorship activities normalize tobacco use by portraying it as being the same as any other consumer product (WHO, 2008). It even falsely illustrates tobacco use as desirable qualities, including youth, energy, glamour, and sex appeal (WHO, 2008). Partial bans on tobacco advertising, promotion, and sponsorship have minimum or no effect on reducing smoking prevalence (WHO, 2013). The industry can reallocate the resources to other permitted marketing and promotional activities (WHO, 2013). Therefore, complete bans are necessary to limit the industry's ability to promote and sell its deadly product and

reduce tobacco use prevalence accordingly (WHO, 2013). Tobacco advertising, promotion, and sponsorship bans regulation should cover all media and indirect promotional activity including, print, outdoor, cinemas, broadcast, cable and satellite, outdoor displays, point of sale, internet, free distribution, promotional discount, brand stretching, brand sharing, sponsored events, appearance in audiovisual entertainment, and corporate social responsibility (WHO, 2013).

Indonesia is one of the countries in ASEAN that has not comprehensively banned tobacco advertising, promotion, and sponsorship, together with Malaysia, Myanmar, and The Philippines (Lian and Dorotheo, 2018). To date, there is almost no restriction for tobacco industries to promote and advertise in print media, broadcast, cable, and satellite media, cinemas, outdoor displays, point of sales, and the internet (Sebayang et al., 2012, Lian and Dorotheo, 2018). Moreover, they are also still allowed to indirectly advertise, promote, and sponsor any activities such as the free distribution of tobacco and related samples, promotional discount, brand stretching, brand sharing, the appearance of the products and brands in television, film, and other audio-visual entertainment, sponsored events, and "corporate social responsibility" initiatives (Lian and Dorotheo, 2018).

The national administration has the authority to regulate tobacco advertising, promotion, and sponsorship activities in broadcasting media (television and radio), print media (newspaper and magazine), and the internet (Fauzi et al., 2014). There is only a partial advertisement ban in broadcasting media from 05.00-21.30 in western Indonesian standard time (Fauzi et al., 2014). The tobacco industry is still allowed to advertise in print media and the internet as long as not show cigarettes and smoking

people (Fauzi et al., 2014). Moreover, there are no restrictions on indirect advertising, promotion, or sponsorship activities (Fauzi et al., 2014).

Tobacco advertising, promotion, and sponsorship ban regulation is more advance at the sub-national level. Some cities/municipalities have even ban on direct advertising in point of sale, sponsored events, and outdoor displays (Priyono et al., 2020, Sebayang et al., 2019). Most local regulations also ban tobacco advertising, promotion, and sponsorship inside the smoke-free area (TCSC-IPHA, 2020). However, the absence of a comprehensive ban at the national level may have limited or no effect on protecting people from exposure to tobacco advertising, promotion, sponsorship, and overall smoking prevalence (WHO, 2013). A recent Global Youth Tobacco Survey (GYTS) found that most adolescents noticed tobacco advertising in point of sale (65.2%), television (65.2%), outdoor media (60.9%), and ever saw anyone using tobacco in television, videos, or movies (56.8%) (Kemenkes-Ministry of Health et al., 2020).

2.2.7. Raising Tobacco Taxes

Tobacco tax raise is the single most cost-effective intervention to reduce tobacco consumption (WHO, 2008). Higher tobacco tax also encourages current smokers to quit and hinder tobacco use among vulnerable populations, specifically young people and the poor (WHO, 2015). Besides, the tobacco tax increase generates more government revenue and avert tobacco-related deaths at the same time (WHO, 2015). This revenue can be used to develop, implement, and enforce tobacco control policies and other health and social programs. Furthermore, tobacco tax raise is inexpensive to implement and administer (WHO, 2015).

Most of the counties levied excise taxes, value-added taxes, general sales taxes, and import duties to raise the tobacco tax (WHO, 2015). Tobacco excise tax is essential in attaining public health objectives in tobacco taxation (WHO, 2015). It is uniquely charged to tobacco products to elevate the price of tobacco products relative to other goods and services (WHO, 2015). Excise taxes mainly account for the largest share of tobacco products prices compared to other taxes (WHO, 2015).

There are two types of excise tax, namely specific and ad valorem (WHO, 2015). Specific means a specific tariff levied on a given quantity of tobacco product such as stick, pack, carton, or weight (WHO, 2015). Ad valorem refers to excise taxes levied as a percentage of retail, wholesale, producer, or CIF prices (WHO, 2015). Imposing the same specific excise taxes tariff to all brands limits the tobacco industry's opportunities to create a more significant price gap between premium and lower prices alternatives (WHO, 2015). It also communicates to the public that all tobacco products are equally harmful (WHO, 2015). The specific excise tax tariff should also be adjusted for inflation annually to make tobacco prices relatively less affordable (WHO, 2015). Ultimately, the WHO set the minimum contribution of specific tobacco excise tax at least 75% of the retail price to maximize the public health impact of tobacco taxes (WHO, 2008).

Taxation policy is usually inexpensive to implement and administer (WHO, 2008). However, some countries have a complicated tax structure with different tiers based on product characteristics (WHO, 2015). This leads to greater variability in product prices that create opportunities for smokers to switch to cheaper brands (WHO, 2015). A complex tax system also opens the chance for the tobacco industry for tax avoidance and tax evasion (WHO, 2015). Besides, it is more difficult to

administer and hinder the tobacco excise taxes impact on smoking reduction and rising government revenue (WHO, 2015).

The tobacco tax increase has an immediate impact on reducing cigarette consumption (IARC, 2011). A time-series study in Australia yields that the 25% tobacco tax increase in 2010 was associated with the relative reduction in smoking prevalence of 4.2% (Wilkinson et al., 2019). Another study in the US found an additional $0.25 tobacco tax per pack significantly reduces the smoking prevalence by 0.6% (Sharbaugh et al., 2018). The greatest impact of the cigarettes tax increase was observed among youth aged 18-24, with an estimated 1.5% absolute reduction in smoking prevalence (Sharbaugh et al., 2018). Besides, Turkey's government introduced a special consumption tax on tobacco during the period of 2008 to 2012 (Kostova et al., 2014). The policy significantly increased the average real cigarette price to 42.1% and reduced the smoking prevalence by 14.6% (Kostova et al., 2014). The policy had the most significant impact among persons in the bottom tercile of the wealth index with an absolute reduction of 30.3% (Kostova et al., 2014).

2.3. Tobacco Tax Policy in Indonesia

2.3.1. Tobacco Excise Tax System

The type of tobacco tax in Indonesia consists of excise taxes, value-added taxes, and local taxes (Ahsan et al., 2016). Excise taxes are regulated under law number 39 year 2007, which sets the maximum allowable excise taxes rate at 57% (Ahsan et al., 2016). The ministry of finance regulation further determines the excises taxes' structure and tariff. It is issued annually and announced during the state budgeting process. Moreover, the finance minister issued regulation number 207/PMK.010/2016, which charges the value-added taxes for tobacco products at

9.1% of the retail price. This regulation has been enacted since 2017 and is planned to be increased to 10% in the future. Ultimately, law number 28 the year 2009 mandated that the local tax rate equals 10% of tobacco excise taxes (Ahsan et al., 2016). The revenue is levied by the national government but allocated to the sub-national government based on the population (Ahsan et al., 2016).

In Indonesia, the tobacco excise taxes system has changed over time. In 1945-1974, the tobacco excises taxes structure consisted of two tiers of the specific tariff, specifically machine-made and hand-rolled cigarettes (Ahsan et al., 2016). Those tiers were charged with a single tariff regardless of production volumes and retail price (Ahsan et al., 2016). There was a significant change in the excise taxes system in 1974 when the government introduced multi-tariff based on production volumes replacing the single tariff system (Ahsan et al., 2016). The type of excise taxes also changed from specific to ad valorem (Ahsan et al., 2016). The government proposed a new excise structure in 2001 by introducing the retail price (*Harga Jual Eceran – HJE)* (Ahsan et al., 2016). The tax tariff was determined by the production volumes, retail price, and type of cigarettes (machine-made, handroll, and white cigarettes) (Ahsan et al., 2016). In 2006-2009, the excise taxes system changed from ad valorem to a combination of ad valorem and specific (Ahsan et al., 2016). Furthermore, the excise taxes system was modified again to the multi-tiers specific tariff in 2009 (Ahsan et al., 2016).

The current excises policy is regulated under the minister of finance regulation number 152/PMK.101/2019. The excise taxes system is still complex, using specific tariffs for different tiers based on the type of cigarettes, production volumes, and retail price. The type of cigarettes consists of machine-mad kreteks, hand-rolled, white, and

filtered cigarettes. Machine-made kreteks and white cigarettes each had two-level of production volumes and three levels of retail prices. Hand-rolled cigarettes had the lowest excise taxes tariff (Rp. 790-485) and retail price (Rp. 1,460-450) compared to other types. There is only one specific excise taxes tariff (Rp. 740) and retail price (Rp. 1,700) for filtered cigarettes (Kemenkeu-Ministry of Finance, 2019). Imported cigarettes have only a single retail price with excise taxes rate between 29%-44% based on the type of cigarettes. The detailed excise taxes structure is shown in table 2

Table 2. Tobacco Excise Tax Structure and Tarif (in IDR), 2020

Type of Cigarettes	**Production volumes category**	**Retail price per stick**	**Excise taxes Tariff**	**% excise to retail price**
Domestically produced				
Machine-made kreteks (SKM)*	I	1,700	740	43
	II	1,275	470	36
		1,020-1,275	455	44
White cigarettes (SPM)*	I	1,790	790	44
	II	1,485	485	32
		1,015-1,485	470	46
Hand-rolled kreteks or cigarettes (SKT or	I	1,460	425	29
		1,015-1,460	330	32

Type of Cigarettes	Production volumes category	Retail price per stick	Excise taxes Tariff	% excise to retail price
SPT)**	II	535	200	37
	III	450	110	24
Filtered cigarettes (SKTF or SPTF)	N/A	1.700	740	43
Imported				
SKM	N/A	1,700	740	43
SPM	N/A	1,790	790	44
SKT or SPT	N/A	1,461	425	29
SKTF or SPTF	N/A	1,700	740	43

*Production volumes = number of sticks produced per year, (I). > 3 billion, (II). < 3 billion; **(I). > 2 billion, (II). 500 million – 2 billion, (III). <500 million.

Source: (Kemenkeu-Ministry of Finance, 2019)

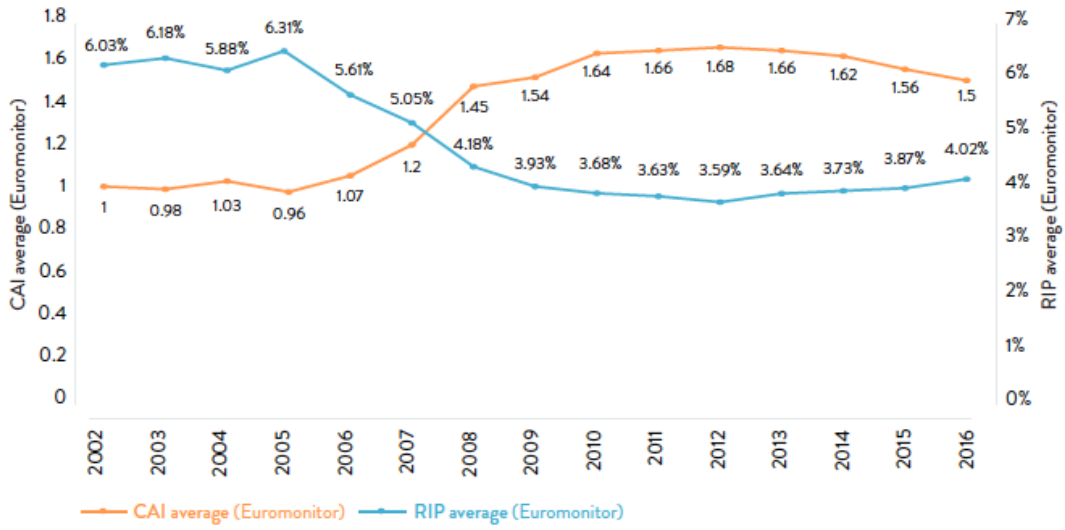
2.3.2. Cigarette Prices and Affordability

The complexity of Indonesia's excise taxes system may counteract the effectiveness of tax increases on cigarette consumption (Barber and Ahsan, 2009). The multi-tier excise taxes rate creates loopholes for the tobacco industry to lower their production level to avoid higher tax brackets (Barber and Ahsan, 2009). The big company can also establish, buy, or subcontract production to a smaller firm, enabling them to incur lower excise tax rates (Barber and Ahsan, 2009). In Addition, the small firm that produced hand-rolled kreteks (SKT) has received the most favorable excise

tax rates in the current system since 2009 (Ahsan et al., 2016). Therefore, the SKT had the highest number of brands sold (1,309 brands) compared to SKM (921 brands) and SPM (118 brands) in 2017 (Prasetyo and Adrison, 2020).

The complex tobacco taxes system makes an excise rate increase are less effective in elevating cigarettes prices (Prasetyo and Adrison, 2020). The system provides an incentive for the tobacco industry to produce cigarettes which incurred lower tax rates (Prasetyo and Adrison, 2020). A previous econometrics study found that a percentage increase in excise taxes would only rise 0.153 of SKT, 0.363 of SKM, and 0.773 of SPM prices (Prasetyo and Adrison, 2020). This yields a wide variety of cigarettes price between the premium brand and lower price alternatives that allow consumers to substitute for the cheaper product in response to the price change (Barber and Ahsan, 2009).

Figure 5. Cigarettes affordability in Indonesia, 2002-2016



Source: (Zheng et al., 2018)

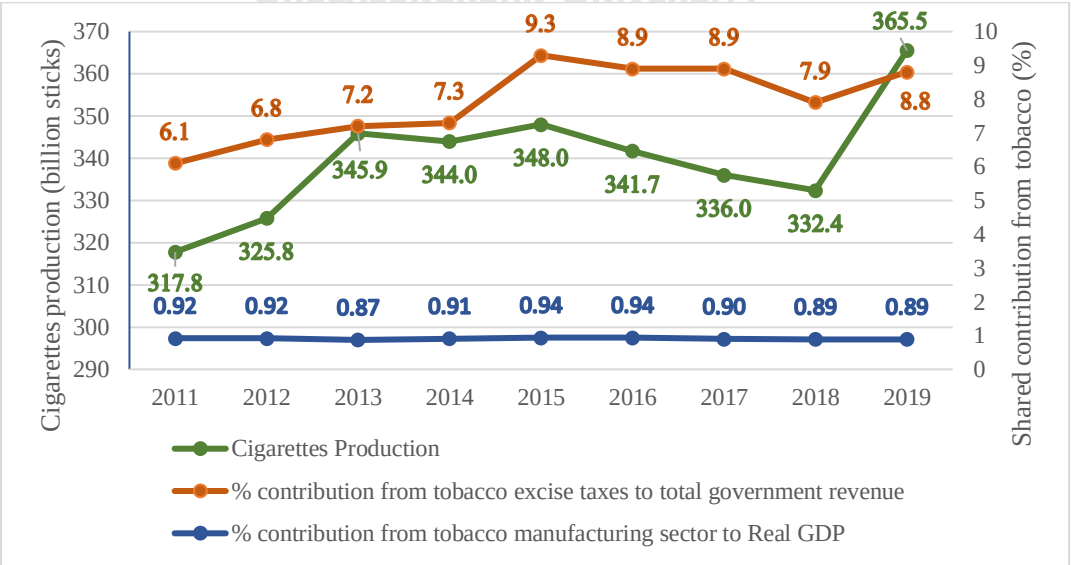
The Indonesian government has increased the excise taxes tariff every year, but 2014 and 2019 (Kemenkeu-Ministry of Finance, 2018, Zheng et al., 2018). For

instance, the excise taxes tariff for hand-rolled cigarettes production volumes III was Rp. 65 for the retail price of Rp. 235 in 2009 (Kemenkeu-Ministry of Finance, 2009). Afterward, the excises taxes tariff and retail price doubled in 2019, Rp. 110 and Rp. 450, respectively (Kemenkeu-Ministry of Finance, 2019). However, the tobacco excise taxes change may not necessarily make cigarette prices less affordable. Therefore, it should be regularly adjusted for inflation, income growth, and consumer purchasing power to remain effective (WHO, 2015).

Research from the World Bank found that cigarette price affordability fluctuated between 2002 to 2005. It became to be more affordable from 2006 to 2012. Then, it started to be less affordable from 2013 to 2016. However, the price of cigarettes was relatively more affordable in 2016 compared to 2002. The cigarettes' relative income price reduced from 6.02% in 2002 to 4.02% in 2016. Also, the cigarette affordability index was 500% higher in 2016 than the base year 2002. Figure 6 depicts cigarette affordability in Indonesia from 2002 to 2016.

2.3.3. Government Revenue from Tobacco Excise Taxes

Figure 6. Cigarette production and government revenue from tobacco industry



Source: (TCSC-IPHA, 2020, Kemenkeu-Ministry of Finance, 2020, BPS-Statistics Indonesia, 2020a)

Figure 6 shows the tobacco industry production and share contribution to government revenue and gross domestic product from 2011 to 2019. The cigarette production growth presents three phases during 2011-2019: an increasing stage from 2011 to 2013, a fluctuating stage from 2014 to 2015, and an increasing stage from 2016 to 2018. During the whole period, the highest cigarette production was in 2019, totaling around 365.5 billion sticks a year. This production increment may relate to the absence of excises taxes increase and the general election in 2019. However, the share of tobacco excise taxes to state revenue reached a peak (9.3%) in 2015. The share contribution in 2019 (8.9%) was even lower than in 2016 (8.8%) and 2017 (8.8%) despite having the highest tobacco production. For GDP contribution, the share from tobacco manufacturing has been relatively stable, about 0.9% since 2011.

Table 3. Tobacco industry contribution to the economy in trillion rupiahs, 2011-2019

Year	Total Government Revenue	Tobacco Excise Taxes Revenue	GDP*	GDP from tobacco manufacturing industry*
2011	1,210.6	73.3	7,831.7	71.7
2012	1,338.1	90.6	8,615.7	79.3
2013	1,438.9	103.6	9,546.1	82.7
2014	1,550.5	112.5	10,569.7	95.7
2015	1,508.0	139.5	11,526.3	108.7
2016	1,555.9	138.0	12,401.7	117.1
2017	1,666.4	147.7	13,589.8	122.2

Year	Total Government Revenue	Tobacco Excise Taxes Revenue	GDP*	GDP from tobacco manufacturing industry*
2018	1,943.7	152.9	14,838.3	131.9
2019	1,960.6	172.4	15,833.9	141.0

* Constant 2010

Source: (Kemenkeu-Ministry of Finance, 2020, BPS-Statistics Indonesia, 2020a)

The contribution from the tobacco industry both for government revenue and GDP has increased during the past decade. The tobacco excise taxes generated 73.3 trillion rupiahs in 2011, while the amount was double (172.4 trillion rupiahs) in 2019. A similar trend was also seen in the share contribution to GDP from 71.1 trillion rupiahs in 2011 to 141 trillion rupiahs in 2019. However, the tobacco industry's share contribution is the same during the whole period because the size of Indonesia's economy is also growing at the same time. Although the tobacco industry has a decent contribution to national economics, the macroeconomic cost due to tobacco-related illness and mortality is substantially higher. A study in 2015 found that the economic loss associated with tobacco was approximately 596,6 trillion rupiahs, while the excise taxes revenue and tobacco manufacturing GDP contribution in 2015 were only 139.5 and 108.7 trillion rupiahs, respectively. Table 3 depicts the tobacco industry's contribution to the economy.

2.4. Demand for Cigarettes and Price Elasticity

2.4.1. Demand for Cigarettes

The general theory of demand states that if a product's price increases, its quantity of demand would decrease, *ceteris paribus*. It believes that there is a causal

relationship between price and quantity demanded. However, the relationship between the price of quantity demands is far more complicated in the real world. The direction of price and demand causation is not merely one way. There is also interaction in the market in which the price influences demand, so do demands influence price. Moreover, the demand is also influenced by other factors outside price, such as disposable income, taste, weather, and price-related goods.

The previous study found that demand for cigarettes is related to the product's price, disposable income, demographic characteristics, socioeconomic status, tobacco control policy (e.g. smoke-free area, tobacco advertising promotion and sponsorship ban, minor sales ban), knowledge and information about the adverse effect of tobacco use, and place of residence (WHO, 2010). However, the demand model for tobacco products has been the subject of debate over the years (NCI and WHO, 2016). There is still a major dispute on how to model tobacco products' consumption as an addictive good (NCI and WHO, 2016).

2.4.2. Conventional Demand Model

Conventional economics assumes that people have self-control and always make a rational choice to maximize their utility (NCI and WHO, 2016). The utility in each consumption does not relate to the consumption in other periods (NCI and WHO, 2016). The quantity demanded in a given period depends solely on the independent variables in that period (WHO, 2010). Therefore, the conventional demand model is called a static model of demand (Wilkins et al., 2013). The conventional cigarettes demand model is represented in equation 1.

$$Q_t = \alpha_0 + \alpha_1 P_t + \alpha_2 I_t + \alpha_3 D_t + \alpha_4 S_t + \alpha_5 TC_{t+} \alpha_5 K_t + \alpha_6 R_t + \epsilon_t \quad (1)$$

Where:

Q_t = quantity of cigarettes consumption in year t.

α = coefficient corresponding to the independent variables.

P = average retail price of cigarettes.

D = demographic characteristics, e.g., age, sex, or ethnicity.

S = socioeconomic status, e.g., education, employment status, etc.

TC = tobacco control regulation.

K = knowledge and information toward adverse health effects of tobacco.

R = place of residence, e.g., urban vs. rural, region, etc.

ϵ = error term.

This model's drawback is either ignoring the nature of cigarettes as an addictive product or considering smoking as an irrational behavior (NCI and WHO, 2016). Most current adult smokers have started to smoke at a younger age (Lian and Dorotheo, 2018). In Indonesia, the mean age of smoking initiation is approximately 17.6 years old (Lian and Dorotheo, 2018). Besides, smokers would likely quit because of future health concerns and costs (Smith et al., 2015). Thus, the current cigarette consumption depends on past and future implications of their decision (Wilkins et al., 2013). Under the irrationality assumption, cigarettes' demand might not follow the classic demand theory of a causal relationship between price and consumption (NCI and WHO, 2016). The price elasticity for cigarette demand was approximately at -0.4, ranging from -0.2 to -0.6 (NCI and WHO, 2016). For the Lower middle-income countries, the price elasticity was around -0.5, with an estimate falling between -0.2 to -0.8 (NCI and WHO, 2016). The price changes significantly affect its demand (NCI and WHO, 2016). These weaknesses lead to the development of specific addiction demand models: myopic addiction and the rational addiction model (WHO, 2010).

2.4.3. Myopic Addiction Demand Model

The myopic addiction model assumes myopic behavior as the assumption for analyzing demand for cigarettes (NCI and WHO, 2016). It takes into account the past consumption of tobacco to present smoking behavior (NCI and WHO, 2016). Thus, it is also called the short-sighted addictive behavior model (Wilkins et al., 2013). This myopic addiction model is represented in equation 2.

$$Q_t = \alpha_0 + \alpha_1 P_t + \alpha_2 I_t + \alpha_3 D_t + \alpha_4 S_t + \alpha_5 TC_t + \alpha_5 K_t + \alpha_6 R_t + \alpha_7 Q_{t-1} + \epsilon_t \quad (2)$$

Where:

Q_{t-1} = quantity of cigarettes consumption in year t-1.

All other variables the same as for equation 1.

This model's weakness is that it naively ignores the influence of future consumption and consequences on the current smoking decision (Wilkins et al., 2013). Many studies reveal that future health concerns and medical costs are typical reasons for smoking cessation (Smith et al., 2015). Previous studies also found that smokers might lower their cigarette consumption if the cigarette's price increases in the future (NCI and WHO, 2016). These findings imply that smoking may not be a myopic behavior (Wilkins et al., 2013).

2.4.4. Rational Addiction Demand Model

The rational addiction model has been widely used in analyzing cigarette demand (NCI and WHO, 2016). It assumes that smoking is a rational behavior involving foresight utility maximization with stable preference over the life cycle (NCI and WHO, 2016). In this model, tobacco consumption decision is affected by past and future cigarette consumption as well as the cost or consequences (NCI and WHO, 2016). In this context, the cost incorporates the cigarette's retail price and all

costs associated with tobacco, such as illness, medical expenditure, social disapproval, and expected quality of life after quitting (NCI and WHO, 2016). Therefore, this model is called the dynamic model (Wilkins et al., 2013). The rational addiction model is represented in equation 3.

$$Q_t = \alpha_0 + \alpha_1 P_t + \alpha_2 I_t + \alpha_3 D_t + \alpha_4 S_t + \alpha_5 TC_{t+} \alpha_5 K_t + \alpha_6 R_t + \alpha_7 Q_{t-1+} \alpha_8 Q_{t+1} + \epsilon_t \quad (3)$$

Where:

Q_{t-1} = quantity of cigarettes consumption in year t-1.

Q_{t+1} = quantity of cigarettes consumption in year t+1.

All other variables the same as for equation 1.

This model has been widely used in analyzing the demand for addictive goods. However, the model has also been criticized for its several assumptions (NCI and WHO, 2016). The assumption of looking-forward rational maximization means that the smokers are “happily addicted,” which is not entirely correct (NCI and WHO, 2016). A substantial body of evidence shows that most smokers would like to stop smoking and regret their decision (NCI and WHO, 2016). Besides, the onset of tobacco-related diseases may need a long time from smoking initiation (USDHHS, 2014). Consequently, people tend to underestimate the adverse consequences of smoking and are prone to have time-inconsistent preferences (NCI and WHO, 2016). Therefore, the model fails to meet the rational economic assumptions that cigarettes consumers possess the perfect information and have stable preferences in this context (Wilkins et al., 2013).

All the existing models may not be perfect in analyzing the demand for cigarettes. Therefore, the decision to choose the appropriate model depends on the researcher. Some important aspects should be considered, including the availability of

the data, the characteristics of the data (e.g., number of samples, data collection method, validity, number of missing data), and data type (aggregate time-series, aggregate cross-sectional, individual cross-sectional pooled time-series cross-sectional, panel cross-sectional or longitudinal data) (Wilkins et al., 2013).

2.4.5. Cigarette Price Elasticity

Price is the most important variable in determining the quantity of demand, including tobacco products (NCI and WHO, 2016). There is an essential to a very strong correlation between price changes and per capita cigarette consumption (NCI and WHO, 2016). From the economic perspective, the quantity of demand's responsiveness to change in areal price is usually called the price elasticity of demand. Further, the definition of the price elasticity of demand is the percentage change in demand or consumption (the number of cigarettes consumed) that results from a one-percent increase in the inflation-adjusted (real) price of cigarettes (Wilkins et al., 2013). Demand is inelastic if the percentage change in consumption is lesser than the real price percentage change (Wilkins et al., 2013). Therefore, the inelastic price elasticity of demand yields a coefficient between 0 and -1, or whose absolute value is smaller than 1 (Wilkins et al., 2013). The price elasticity is represented in the following equation.

$$E = \frac{(Q_t - Q_0)/Q_0}{(P_t - P_0)/P_0} = \frac{\Delta Q}{\Delta P} * \frac{P_0}{Q_0} \quad (4)$$

Where:

E = Price elasticity of demand coefficient.

Q_t = quantity of cigarettes consumption at t.

Q_0 = quantity of cigarettes consumption at baseline.

P_t = real price of cigarettes at t.

P_0 = real price of cigarettes at baseline.

Δ = change in quantity at 0 to t.

2.4.6. Data for Analysis of Cigarette Demand and Price Elasticity

In economic studies, various types of data are used in analyzing cigarette demand and elasticity, including aggregate time-series, cross-sectional, time-series of cross-sectional (pooled data), and longitudinal of individual data (Wilkins et al., 2013). The unit of analysis can be aggregate level (national or sub-national) and individual-level data (household or individual) (Wilkins et al., 2013). Many studies in LMICs use aggregate data as a unit of analysis due to a lack of available individual-level datasets (Wilkins et al., 2013). The household-level dataset is also commonly used in recent years (Wilkins et al., 2013). However, Individual-level datasets are more useful in analyzing demand and elasticity (Wilkins et al., 2013). Moreover, the aggregate time-series data may not be available for an extended period to achieve a meaningful sample size (Wilkins et al., 2013). Therefore, pooled cross-sectional datasets are large enough to estimate demand and elasticity (Wilkins et al., 2013).

Some studies drop non-smokers from the analysis because of generates zero consumption variable (Wilkins et al., 2013). The logarithmic regression analysis uses a log for dependent variable estimations (Wilkins et al., 2013). Therefore, the dependent variable (cigarette consumption) should have a positive value (Wilkins et al., 2013). In reality, the tobacco taxes or pricing policy impact both smoking and non-smoking decision (Wilkins et al., 2013). The cigarette price increase may reduce the number of cigarettes consumed and encourages them to stop (Wilkins et al., 2013). On the other hand, non-smokers might start smoking if the price were getting cheaper (Wilkins et al., 2013).

2.4.7. Two-Part Model

The two-part model is one of the most widely used techniques in analyzing demand and price elasticity (WHO, 2010). Craig coined the model in 1971 to address the typical logarithmic regression problems (Wilkins et al., 2013). This model consists of two parts, which involve regression in each part (Wilkins et al., 2013). The first part of the model estimates an individual decision to smoke (Wilkins et al., 2013). The outcome variable is dichotomous (smoking vs. non-smoking). It can use a probability or logit specification and includes all samples in the analysis (Wilkins et al., 2013). Meanwhile, the second part of the model can use Ordinary Least Square (OLS) techniques (Wilkins et al., 2013). It analyzes the number of cigarettes smoked among those who smoke tobacco(Wilkins et al., 2013). Therefore, it is called conditional demand (Wilkins et al., 2013).

The first part of the model with logit specification is represented in the following equations:

$$\Pr(y=1) = \frac{1}{1+\exp(\beta_0+\beta_1 P+\beta_i X_i+\epsilon)} \quad (5)$$

Where:

Pr(y) = probability of smoking.

β = coefficient corresponding to independent variables.

P = log of the average retail price of cigarettes in the sample.

X_i = all other independent variables.

ϵ = error term.

Equation 6 shows the linear function of the second part of the model.

$$E(y|y>1) = \alpha_0 + \alpha_1 P + \alpha_2 X_i + \varepsilon \quad (6)$$

Where:

$E(y \mid y>1)$ = log of quantity of cigarettes smoking among current smokers.

α = coefficient corresponding to independent variables.

All variables are the same as for equation 5.

Equations 7 presents the total demand using two-parts model.

$$E(y) = Pr\,(y=1) \times E(y \mid y>1) \quad (7)$$

Where:

$E(y)$ = total demand of cigarettes

All variables are the same as for equation 5 and 6.

The price elasticity on smoking participation takes on the following form:

$$E_p = \beta_{price} * (1-E(y|x)) \quad (8)$$

Where:

E_p = price elasticity of smoking participation.

β_1 = coefficient corresponding to price variable in equation 5.

$E(y|x)$ = % cigarettes smoking in the sample.

The price elasticity of conditional smoking can be expressed as:

$$E_c = \alpha_{price} \quad (9)$$

Where:

E_c = price elasticity of conditional demand.

α_1 = coefficient corresponding to price variable in equation 6.

Further, the price elasticity of demand can be calculated by summing the price elasticity of demand from smoking participation in the first part and the conditional demand in the second part (Equation 10).

$$E_t = E_p + E_c = \beta_{price} * (1 - \%S) + \alpha_{price} \quad (10)$$

Where:

E_t = total price elasticity

All variables are the same es for equations 5-9.

2.4.8. The Rationale for Government Intervention in Cigarette Market

Interaction of demand and supply in a perfect competition market generates the most efficient price or highest valued alternatives to society. Consumers' sovereignty is the core assumption of a perfect competition market in which individuals understand the risks and benefits involved in the product. Then, they will decide the products consumed in their best interest resulting in inefficient resource allocation. Nevertheless, cigarettes are nowhere classified as a normal product and cause market failure that results in economic inefficiency (Wilkins et al., 2013). Further, cigarettes are categorized as a universally consumed commodity but unnecessarily for life. This type of good perfectly fits the subject of taxation (NCI and WHO, 2016).

There is information failure about the addictive nature of tobacco products and the health risk of smoking (Wilkins et al., 2013). People tend to underestimate the risk of nicotine addiction (NCI and WHO, 2016). Once people are addicted to smoking, it is difficult and incurs a high cost to stop (Wilkins et al., 2013). Evidence shows that less than 10% of current smokers are successfully quit (Creamer et al., 2019). Besides, people are unaware of smoking's adverse health effects because of the

long delay between smoking initiation and the onset of tobacco-related diseases (NCI and WHO, 2016).

Smoking incurs an external cost on non-smokers. Involuntary tobacco smoke has a myriad of adverse consequences, including health impacts, loss of productivity, air pollution, fire, and property damage (Wilkins et al., 2013). It also impacts public finance, such as increasing the government subsidies to tobacco-related diseases care expenditure and overall health expenditure (Wilkins et al., 2013). Furthermore, smoking lead to intangible externality cost, such as mental suffering of non-smoker due to the illness and death of a smoker (Wilkins et al., 2013).

2.5. Previous Studies on Cigarette Price Elasticity

The previous evidence was retrieved from two major databases; Pubmed and Scopus. The papers should be published from January 2010 to December 2020. The search terms include “Price OR Taxes AND Cigarette OR Tobacco AND Elasticity OR "Price Elasticity" AND Asia”. The literature included original articles with individual, household, and aggregate data. The study specifically took place in one Asian Country. Table 4 shows a summary of previous studies on cigarette price elasticity.

Table 4. Summary of Previous Studies on Cigarette Price Elasticity.

Study	Method	Results
Price elasticity of tobacco products among economic classes in India, 2011–2012 (Selvaraj et al.,	• Design: Cross-sectional. • Data Source: Consumer Expenditure Survey India 2011-2012.	The Price elasticity was -0.832 in the poor, -0.0913 in the

Study	Method	Results
2015).	• Participants: 101,662 Households in India. • Demand model: conventional. • Variables in the model: quantity of tobacco product consumed per month, the average price of tobacco, budget share tobacco product per month, total households' expenditure per month, household size, the ratio of males in the household, the ratio of adult (aged 15 above) in the household, maximum years of education of any household member, religion, social group (caste and tribe), place of residence (urban vs. rural).	middle, and -0.2645 in the richest households.
The effect of taxation and regulation on cigarette smoking: Fresh evidence from Turkey (Cetin, 2017).	• Design: Aggregate time series. • Data Source: Government of Turkey from 2005-2014. • Sample: Aggregate monthly and quarterly data.	The price elasticity was -0.56.

Study	Method	Results
	• Demand model: conventional. • Variables in the model: number of cigarettes consumed per year, the average price of cigarettes, country's income per year, smoke-free area regulation, taxes regulation, and anti-alcohol policy.	
Differential responsiveness to cigarette price by education and income among adult urban Chinese smokers: findings from the ITC China Survey (Huang et al., 2015).	• Design: Cohort. • Data Source: The International Tobacco Control (ITC) Project China Wave 1-3 (2006, 2007/2008, 2009/2010). • Participants: 14,561 adult smokers aged 18 above. • Demand model: conventional. • Variables in the model: cigarettes consumption per day, average cigarette price, sex, age group, marital status, income, education, and occupation.	Conditional price elasticity was estimated from -0.12 to -0.14.
Effect of cigarette prices	• Design: Cross-sectional.	The price

Study	Method	Results
on smoking initiation and cessation in China: a duration analysis (Kostova et al., 2016).	• Data Source: Global Adult Tobacco Survey China 2004. • Participants: 8,197 adults aged 15 above. • Demand model: conventional. • Variables in the model: smoking status, the average price of cigarette, age, place of residence, education level, and wealth index.	elasticity of smoking initiation was about -1.070.
The health, financial and distributional consequences of increases in the tobacco excise tax among smokers in Lebanon (Salti et al., 2016).	• Design: Cross-sectional. • Data Source: National Living Conditions of Households Survey Lebanon 2004. • Participants: 4,821 households. • Demand model: conventional. • Variables in the model: cigarette demand per month, price of cigarette, household characteristics (income, size, % of adults, % of males, % of children, education, occupation,	The price elasticity was -0.32 in Q1 (poorest), -0.27 in Q2, -0.26 in Q3, -0.24 in Q4, -0.22 in Q5 (richest) household.

Study	Method	Results
	disability, health insurance coverage, number of rooms in the house, car ownership, employs a maid), household head characteristics (age, sex, and marital status).	
Economics of tobacco control in Pakistan: estimating elasticities of cigarette demand (Mushtaq et al., 2011).	• Design: Aggregate time series. • Data Source: Government of Pakistan and International Institution from 1981 to 2009. • Sample: Aggregate annual data. • Demand model: conventional. • Variables in the model: cigarette consumption per adult, per capita income, and years of study.	The price elasticity was -1.17.
The Economics of Tobacco Use in Jordan (Sweis and Chaloupka, 2014).	• Design: Cross-sectional. • Data Source: Primary data in 2011. • Participants: 4,090 individuals aged 15 in Jordan. • Demand model: two-part.	The total price elasticity was -0.6.

Study	Method	Results
	• Variables in the model: cigarette consumption (participation and conditional), price, age, sex, education, work status, number of individual and male adults in the household, rules of smoking at home and workplace, and wealth index.	
Who pays the most cigarette tax in Turkey (Önder and Yürekli, 2016).	• Design: Cross-sectional. • Data Source: Turkish Households Expenditure Survey 2013. • Participants: 25,764 households. • Demand model: two-part. • Variables in the model: tobacco expenditure, total household expenditure, household characteristics (% children, % adult, education, % male, working status, and health insurance), and time of interview.	The price elasticity was -1.412 in the poor, -0.816 in the middle, and -0.741 in the richest households.

Study	Method	Results
The effect of taxation on tobacco consumption and public revenues in Lebanon (Salti et al., 2015).	• Design: Cross-sectional. • Data Source: National Living Conditions of Households Survey Lebanon 2005. • Participants: 7,431 households. • Demand model: conventional. • Variables in the model: not stated.	The price elasticity of was -1.54 for local cigarettes and -0.22 for imported cigarettes.
Smokers' strategic responses to sin taxes: evidence from panel data in Thailand (White and Ross, 2015).	• Design: Cohort. • Data Source: International Tobacco Control Southeast Asia Survey 2005 (Wave I) and 2006 (Wave II). • Participants: 1,436 men in Wave I and 1,422 men in Wave II. • Demand model: conventional. • Variables in the model: cigarettes consumption, price of tobacco, household income, age, education level, place of residence, exposure to tobacco advertising, exposure to anti-	Price elasticity of quitting estimateed around 0.2133 to 0.3527.

Study	Method	Results
	tobacco messages, smoking restriction at home or workplace.	
Are lower income smokers more price sensitive? the evidence from Korean cigarette tax increases (Choi, 2016).	• Design: Repeated Cross-Sectional. • Data Source: Korea National Health and Nutrition Examination Survey (1998, 2001, 2005, 2007, 2008, 2009, 2010) • Participants: 54,167 individuals. • Demand model: two-part. • Variables in the model: cigarette consumption per day, price of cigarettes, age, household income, sex, place of residence, marital status, education level, and occupational categories.	The price elasticity was -0.425.
The price sensitivity of cigarette consumption in Bangladesh: evidence from the International	• Design: Cohort. • Data Source: The International Tobacco Control (ITC) Project Bangladesh 2009 (Wave I), and	The price elasticity was -0.49.

Study	Method	Results
Tobacco Control (ITC) Bangladesh Wave 1 (2009) and Wave 2 (2010) Surveys (Nargis et al., 2014).	2010 (Wave II). • Participants: 8,507 adults (aged 15 above). • Demand model: two-part. • Variables in the model: cigarette use (participation and conditional), household income, sex, household size, education, occupation, restriction of smoking at house or workplace, place of residence, and wave of survey.	
The Influence of Prices on Youth Tobacco Use in India (Joseph and Chaloupka, 2014)	• Design: Cross-sectional. • Data Source: Global Youth Tobacco Survey India 2004. • Participants: 73,356 youths (aged 13-15). • Demand model: conventional. • Variables in the model: cigarettes smoking, price, personal income, age, sex, school grade, and state	The price elasticity was -0.4.

Study	Method	Results
	characteristics (per capita income, literacy-level, religious composition, survey year, and region).	
Cigarette demand is responsive to higher prices: findings from a survey of University students in Jordan (Sweis and Cherukupalli, 2016)	• Design: Cross-sectional. • Data Source: Primary data in 2014. • Participants: 1,540 public university students aged 18-24. • Demand model: two-part. • Variables in the model: cigarette consumption (participation and conditional), price, sex, marital status, work status, and religion.	The price was -1.15.
Cigarette smoking in Indonesia: examination of a myopic model of addictive behaviour (Hidayat and Thabrany, 2010).	• Design: Aggregate panel data. • Data Source: Indonesian Family Life Survey 1993-200. • Sample: Aggregate annual data. • Demand model: myopic. • Variables in the model: current cigarette consumption, one lag cigarette consumption, current	The price elasticity was -0.26 in the short run and -0.73 in the long run

Study	Method	Results
	cigarette price, current alcohol price, monthly per capita income, working status, age, one lag price, house characteristics, and religion.	

Most previous studies use aggregate or household data. The drawback of aggregate data does not take into account the variation of cigarette prices within countries. In fact, the price of goods varies significantly across regions in most LMIC (John et al., 2019). The cross-sectional household survey may capture the variation of cigarette prices between geographical areas (WHO, 2010). However, it does not provide information about how the change in price and smoking patterns over time (WHO, 2010). Besides, individual datasets are more useful in analyzing smoking behavior than households (WHO, 2010).

2.6. Previous Studies on Tobacco Tax Simulation

The previous studies were retrieved from Pubmed and Scopus. The papers were limited to the original articles of policy simulation or model the single effect of tobacco taxes increase. The study should show the policy simulation in Asian countries that was published from January 2010 to December 2020. The search terms include “Price OR Taxes AND Cigarette OR Tobacco AND Simulation OR Model AND Asia”. Table 5 summarizes previous studies on policy simulation of tobacco taxes increase.

Table 5. Summary of Previous Studies on Tobacco Tax Simulation

Study	Method	Results
Raising cigarette excise tax to reduce consumption in low-and middle-income countries of the Asia-Pacific region: a simulation of the anticipated health and taxation revenues impacts (Ho et al., 2018).	• Design: compartmental model, static, one-time. • Setting: 22 low and middle-income countries. • Main outcome measures: annual taxes revenue, number of smokers.	A 9.51% increase in cigarette prices would reduce 3.56% of cigarettes consumption and elevate 16.20% of the cigarettes taxes revenue on average.
The health, poverty, and financial consequences of a cigarette price increase among 500 million male smokers in 13 middle income countries: compartmental model study (Global Tobacco Economics Consortium, 2018)	• Design: compartmental model, static, one-time. • Setting: 13 middle-income countries. • Main outcome measures: life-years gained, number of men avoiding	A 50% increase in cigarette prices would increase 450 million years of life gained, avert $157 billion treatment costs, avoid 8.8 million men falling into poverty, prevent 15.5 million men face catastrophic health expenditure, and collect additional $122 billon

Study	Method	Results
	catastrophic healthcare expenditure and poverty, averted treatment cost, and tax revenue.	revenue.
The effect of taxation on tobacco consumption and public revenues in Lebanon (Salti et al., 2015).	• Design: compartmental model, static, one-time. • Setting: Lebanon. • Main outcome measures: life-years gained, number of men avoiding catastrophic healthcare expenditure and poverty, averted treatment cost, and tax revenue.	A $5 increase in imported cigarette price would reduce consumption by almost 20% and increase the government revenue to $126 million (52%).
The consequences of	• Design:	A 50% increase in retail price

Study	Method	Results
tobacco tax on household health and finances in rich and poor smokers in China: an extended cost-effectiveness analysis (Verguet et al., 2015)	compartmental model, static, one-time. • Setting: China. • Main outcome measures: life-years gained, expenditure on tobacco, averted treatment expenditure, and tax revenue.	would lead to 231 million years of life gained, an increase of $703 billion additional taxes revenue, an increase of $376 overall household expenditure, and $21 billion tobacco-related expenditure, and provide financial risk protection worth $1.8 billion.
The health, financial and distributional consequences of increases in the tobacco excise tax among smokers in Lebanon (Salti et al., 2016)	• Design: compartmental model, static, one-time. • Setting: Lebanon. • Main outcome measures: premature mortality, tax revenue, expenditure on	A 50% increase in imported cigarettes price would prevent 65,000 premature mortality, generate $300 million additional taxes revenue, $254 million change in tobacco product expenditure, avert $37 million tobacco-related treatment expenditure, and avert 26,800 poverty cases.

Study	Method	Results
	tobacco products, averted treatment expenditure, averted poverty cases.	
Tobacco control and Healthy China 2030 (Goodchild and Zheng, 2019).	• Design: compartmental model, dynamic, one-time. • Setting: China. • Main outcome measures: smoking rate, tax revenue.	Non-price tobacco control measure would lead to a 5.7% reduction of smoking rate and generate RMB 447 billion taxes revenue. In comparison, combination 50% taxes increase with non-price intervention would reduce 8% of the smoking rate and yield RMB 633 billion taxes revenue in 2030.
Are lower income smokers more price sensitive? the evidence from Korean cigarette tax increases (Choi, 2016).	• Design: compartmental model, static, one-time. • Setting: Korea. • Main outcome	A 140% increase in cigarette price would lead to a 25.8% reduction in cigarettes consumption, and 15.600 million won additional revenue.

Study	Method	Results
	measures: smoking rate, tax revenue.	
The role of taxation in tobacco control and its potential economic impact in China (Hu et al., 2010)	• Design: compartmental model, dynamic, one-time. • Setting: China. • Main outcome measures: smoking rate, tax revenue.	A 10.6% increase in the total tax as % of cigarette retail price would lead to a 3.42 million reduction of smokers, 1.14 million lives saved, RMB 129.4 additional tax revenue.
Revenue implications to the Vietnamese government of using taxes to curb cigarette smoking (Doran et al., 2010)	• Design: compartmental model, dynamic, multi-years. • Setting: Vietnam. • Main outcome measures: smoking rate, tax revenue.	A 90% excise taxes rate would reduce the smoking rate at 1.3% and yield VND 108,498.8 billion compared to the base case scenario in 2016.
The effect of tobacco control measures during a period of rising cardiovascular disease risk	• Design: compartmental model, dynamic, multi-years.	A 300% increase in cigarette taxes would reduce 4.9% Myocardial Infarction and 5% stroke mortality.

Study	Method	Results
in India: A mathematical model of Myocardial Infarction and Stroke (Basu et al., 2013)	• Setting: India. • Main outcome measures: smoking rate, tax revenue.	
Smoking prevalence and attributable deaths in Thailand: predicting outcomes of different tobacco control interventions (Aungkulanon et al., 2019)	• Design: compartmental model, dynamic, multi-years. • Setting: Thailand. • Main outcome measures: smoking rate, deaths averted.	Price increase policy would lead to a 1.7% decrease in smoking prevalence and a 1.08% reduction in mortality in 2025.
Distributional benefits of tobacco tax and smoke–free workplaces in China: A modeling study (Verguet et al., 2017)	• Design: compartmental model, static, one-time. • Setting: China. • Main outcome measures: smoking rate, deaths averted.	A 75% increase in cigarette prices would lead to 24 million lives saved, $46 billion additional taxes revenue annually, and 9 million poverty cases prevented.
The potential effects of tobacco control in China:	• Design: compartmental	A 75% tobacco tax rate would reduce smoking prevalence at

Study	Method	Results
projections from the China SimSmoke simulation model (Levy et al., 2014)	model, dynamic, multi-years. • Setting: China. • Main outcome measures: smoking rate, death averted, and life-years gained.	12.9%, prevent more than 3 million premature deaths, and lead to 44 million life-years gained.

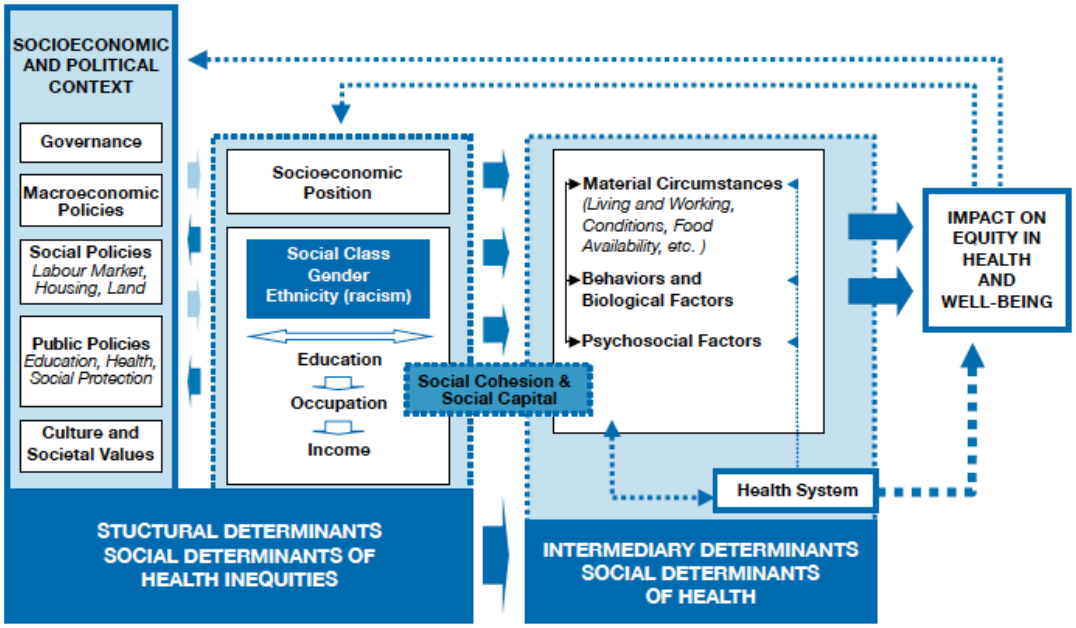
Most of these studies do not consider the tobacco industry pricing strategy in response to the tobacco tax increase. Big tobacco will increase the cigarette price gradually to soften the impact (Apollonio and Glantz, 2020). They encourage smokers to purchase cigarettes with lower-taxed (Apollonio and Glantz, 2020). Besides, the tobacco industry can lower the production to udershift smaller tax increases (Apollonio and Glantz, 2020). Thus, the average cigarette price increase would be lower than the amount of the tax.

2.7. Social Determinants of Health

Social Determinants of Health are defined as the condition in which people are born, grow, live, work, age, and the system that affects health (CSDH, 2008). This approach does not see health and diseases as the product of the absence of medical care alone (CSDH, 2008). A substantial part of the burden of illness arises due to education, social class, ethnicity, occupation, income, living condition, working environment, food availability, social capital, social cohesions, psychological stressors, genetic factors, behavioral options. Those burdens are unequally distributed

among social groups (CSDH, 2008). The commission of social determinants of health also calls for the global communities to improve daily living conditions and tackle the inequitable distribution of power, money, and resources to address health inequity and improve population health (CSDH, 2008).

Figure 7. Social determinants of health framework



Source: (Solar and Irwin, 2010)

Government rules and regulations influence nearly all aspects of the social determinants of health (Glymour, 2014). Some policies even do not intend to address health problems directly but extensively affect population health (Glymour, 2014). For instance, the tobacco taxes policy was initially used to generate revenue for the government (NCI and WHO, 2016). Further, it is a powerful tool to reduce tobacco consumption (NCI and WHO, 2016). The policy also influences the proximal risk factors for health, such as unhealthy air quality in indoor public spaces (NCI and WHO, 2016, Glymour, 2014). Government ordinance on smoke-free area regulation effectively improves air quality and even changes society's attitude toward smoking

behavior (NCI and WHO, 2016, Glymour, 2014). Therefore, policy change should be a primary public health intervention given the wide-ranging target and substantial effect on improving population health and reducing health inequity (Glymour, 2014).

Figure 7 shows how the policy shapes social determinants of health and health outcomes in the population. Socioeconomic and political contexts influence health-determining social factors such as education, occupation, and income. This social influence, together with social cohesion and social capital, are associated with intermediary determinants of health such as material circumstances (e.g., living and working conditions, healthy food availability), behaviors and biological factors (e.g., tobacco and alcohol consumption, physical exercise, diet, genetic factors), psychosocial factors (e.g., adverse live event, job stress, stressful living, lack of social support, coping style). The combination of the health system and these intermediary social determinants will inevitably impact people's equity in health and well-being

Tobacco use is a major public health threat and contributes to health inequity (NCI and WHO, 2016). Tobacco consumption is much concentrated in certain social groups in Indonesia. Ministry of Health reported that current smoking prevalence was higher among those with no education than those who finished colleges/higher education in 2018 (22.5% vs. 21.1%) (Kemenkes-Ministry of Health, 2019). In terms of residential location, smokers are more prevalent in rural (30.3%) than in urban (27.6%) (Kemenkes-Ministry of Health, 2019). In addition, the lower economic groups consistently have had a higher rate of male smoking than in higher wealth index groups over the years (TCSC-IPHA, 2020). Furthermore, the lower socioeconomics group may have less access to care for tobacco-related illnesses. A national social security council study revealed that the lowest health insurance class

(third class) has a low utilization rate of inpatient and outpatient care than first and second-class members (DJSN-National Social Security Council, 2020). Therefore, tobacco control measures should be more beneficial to the poor, given this group's heightened tobacco use burden.

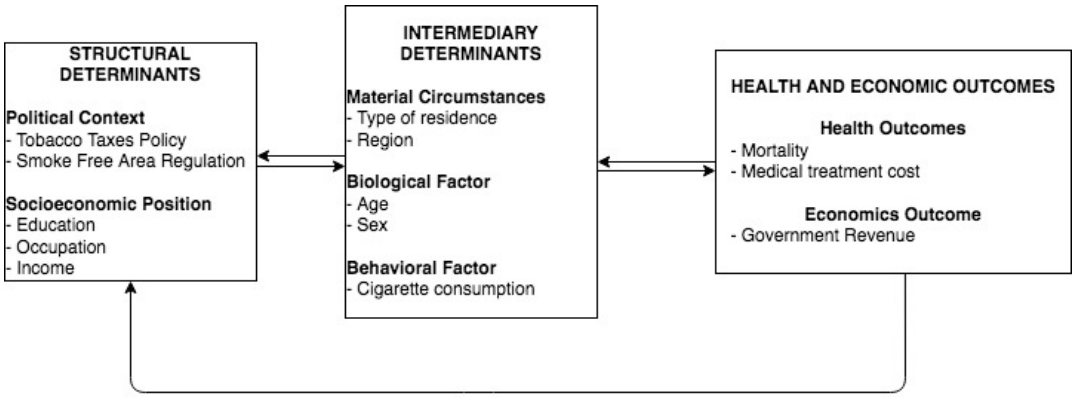
Tobacco use may be typically regressive in the low socioeconomic population, who are more likely to smoke, lower disposable income, pay a more considerable share of the income as tobacco taxes (NCI and WHO, 2016). However, the overall progressivity should also be considered (NCI and WHO, 2016). Local tobacco tax revenue has been used to subsidize the national health insurance program, which provides free health insurance premiums for the poor (TCSC-IPHA, 2020). The tobacco tax increase does not elevate the regressivity (NCI and WHO, 2016). A literature review evaluating several tobacco control interventions showed that tobacco tax increase positively affects socioeconomic equity (Hill et al., 2014). The tobacco taxes policy will increase the price of cigarettes and have a more significant impact on the poor (NCI and WHO, 2016). A prior study found that the effect of cigarettes price increase was double in the poor households than in wealthier households (Adioetomo et al., 2005). Tobacco taxes increase encourages them to stop smoking, while higher economic groups are less likely to quit (NCI and WHO, 2016). This shifts the tobacco tax burden from the poor to wealthier smokers. Besides, tobacco taxes increase generates higher earmarking state revenue from tobacco taxes for social security programs for the poor (NCI and WHO, 2016).

2.8. Theoretical Framework

The study used social determinants of health concepts and previous studies to evaluate the impact of tobacco excise policy on cigarette consumption and propose

the scenario to reduce cigarette consumption, tobacco-related mortality, and treatment cost as well as increase government revenue. Figure 8 presents the theoretical framework of the study.

Figure 8. Theoretical framework



CHAPTER III METHOD

The study consisted of two phases. The first phase analyzed cigarette demand and price elasticity. The second phase was to model the impact of tobacco excise tax increase on cigarette consumption, tobacco-attributed mortality, tobacco attributable medical care cost, life-years gained, and government revenue. This chapter explained the detail of the research method of both phases.

3.1. Phase I

3.1.1. Research Design

The study design of phase I was a pooled cross-sectional study. This study used individual-level cross-sectional data from different years. All the data were pooled together into a single database. The data is retrieved from National Socioeconomic Survey or *Survei Sosial Ekonomi Nasional (Susenas)* 2015, 2016, 2017, 2019, and 2020.

3.1.2. Data Sources

The study used the *Susenas* datasets from 2015-2020. The detailed information about the surveys and their procedure is in the following sections.

3.1.2.1. National Socioeconomic Survey (*Susenas*)

The *Susenas* is a multi-purpose household survey organized by the Central Agency of Statistics (Adji and Asmanto, 2019). The survey has been conducted annually or biennially since 1963 (Surbakti, 1995). It collects the information from 200,000-300,000 households in all districts (Surbakti, 1995). The *Susenas*

questionnaires consist of core and consumption expenditure modules. It collects broad socioeconomic information, including education, criminality, utilization of communication and information technology, employment, access to healthcare, smoking behavior, nutrition, maternal and child health care, family planning, housing, social security, access to the financial institution, asset ownership, and food and non-food expenditure (BPS-Statistics Indonesia, 2020b).

3.1.2.2. *Susenas* Sampling

The sampling method of the *Susenas* used multi-stages sampling (Adji and Asmanto, 2019). First, a total of 25%-40% census blocks were selected from the population census 2010 using probability proportional to the size stratified by type of residence (urban vs. rural) and household economic status in each district (Adji and Asmanto, 2019, BPS-Statistics Indonesia, 2020b). Second, about ten households were systematically chosen from each selected census block stratified by the household head's education level (Adji and Asmanto, 2019). Then, data from all selected household members were collected. The final sample size was around 300,000 households (about 1-2 million individuals) from all districts (Adji and Asmanto, 2019). The survey excluded particular households such as dormitories and prisons (Kemenkes-Ministry of Health, 2019).

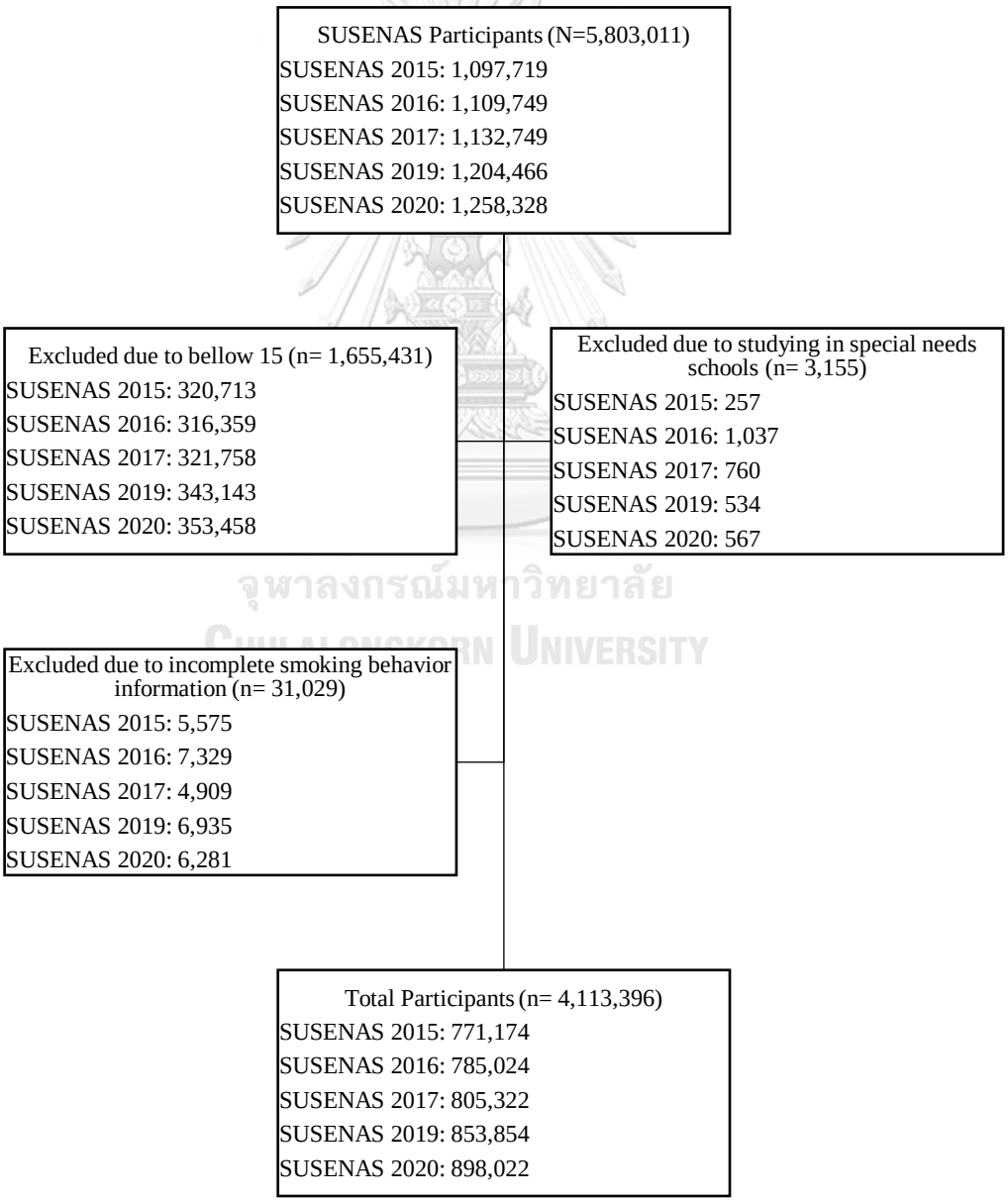
3.1.3. Study Area and Participants

The study area for this dissertation was a national level, which covered 34 provinces and 514 districts in Indonesia. The inclusion criteria were all individuals aged 15 above as identified in the survey dataset and never attending special needs education. Those who have incomplete smoking information were excluded from the analysis.

3.1.4. Data Cleaning

Total participants of the SUSENAS 2015, 2016, 2017, 2019 and 2020 were 5,803,011. A total of 1,689,615 participants did not meet the inclusion criteria, such as bellow 15 years old (1,655,431), studying in special needs schools (3,155), and incomplete smoking behavior information (31,029). Therefore, the total participants included in the final analysis were 4,113,396 (figure 9)

Figure 9. Data cleaning process



3.1.5. Variables

3.1.4.1. Dependent Variables

A two-part model was employed to estimate the price elasticity of demand. The first regression analyzed an individual decision to smoke, called smoking participation. The dependent variable, current smoking status, was a dichotomous variable that equals 1 for smokers and 0 for non-smokers. Smokers were those who reported smoking cigarettes during the past months. This variable was obtained from the *Susenas* (Kemenkes-Ministry of Health, 2019, BPS-Statistics Indonesia, 2020b). The regression model of smoking participation is represented in the following equation.

$$\text{Current Smoking Status} = \beta_0 + \beta_1 \text{Price} + \beta_z \text{Other variables} + ... + \epsilon_t \quad (11)$$

The second part of the model analyzed the average number of cigarettes smoked in a week conditional on being a smoker. It estimated smoking intensity elasticity. The *Susenas* provided information on the average number of cigarettes consumed among smokers on a weekly basis to minimize recall bias (BPS-Statistics Indonesia, 2020b, Kemenkes-Ministry of Health, 2019). The outcome was in discrete format starting from 0. Although observations for non-smokers were not analyzed, the covariates were the same as in the first model. The second part of the model is represented in the following equation.

$$\text{Number of cigarettes smoked} = \alpha_0 + \alpha_1 \text{Price} + \alpha_z \text{Other variables} + \ldots\ldots + \epsilon_t \quad (12)$$

This study uses a two-part model to analyze cigarette demand. The total cigarette price elasticity was calculated by summing the cigarette price elasticity of demand from smoking participation (first part) and the smoking intensity (second

part) (Wilkins et al., 2013). The total cigarette price elasticity estimation takes on the following form.

$$E_t = E_p + E_c \quad (13)$$

Where:

E = elasticity.

t = total.

p = participation.

c = conditional.

3.1.4.2. Independent Variables

The conventional method refers to cigarette price as the average amount of money spent to buy a stick of cigarette in the last purchase. The value of the cigarette prices is computed from the total expenditure to buy cigarettes divided by the quantity of cigarettes smoked. However, this approach introduces a problem of endogeneity (WHO, 2010). The quantities and price of cigarettes bought and sold in the market are formed simultaneously (Wilkins et al., 2013). Thus, the independent and dependent variable's values are jointly determined in this case, resulting in the independent variable correlating with the error term (WHO, 2010). The failure to take into account endogeneity generates biased estimation in price elasticity (WHO, 2010, Wilkins et al., 2013, John et al., 2019).

Another problem of the conventional method is assigning zero prices to non-smokers. The non-smokers will not report any information on the number of cigarettes smoked and the amount of money spent to purchase cigarettes. In reality, smokers and non-smokers face the same market price for cigarettes (Wilkins et al., 2013). Besides, cigarette price has a major role in influencing the decision to smoke.

Thus, it impacts all people regardless of whether they are smokers or non-smokers (WHO, 2010).

Previous studies applied the average price among smokers in different locations to create the price variable (WHO, 2010). This location-specific cigarette market price is assigned to smokers and non-smokers residing there (WHO, 2010). This approach is supported by the assumption of spatial variation of most goods' prices in LMICs due to different transportation costs and other factors (John et al., 2019). People living close to one another should face the same price as they purchase in the same market and at the same time (John et al., 2019). On the other hand, the price should be different for those who reside away from each other (John et al., 2019). This approach is useful to address endogeneity and zero price assignment problems. In this study, the location-specific cigarette price was assigned based on the type of residence in each city/district and year of the survey and measured in Rupiah (IDR).

This study adjusted the cigarette price for inflation in 2020 (BPS-Statistics Indonesia, 2022c). The standard method to calculate the deflated price is dividing the nominal price by the Consumer Price Index (CPI) level and multiplying by CPI at the base year (WHO, 2010). Equation 14 presents the method for inflation price adjustment.

$$Real\ Price_x = \frac{CPI_{2020}}{CPI_x}\ x\ Nominal\ Price_x \quad (14)$$

Where:

Nominal prices$_x$ = reported price in the year *x*.

Real prices$_x$ = inflation-adjusted price in the year *x*.

CPI = consumer price index.

Individual characteristic variables included age, sex, educational attainment, marital status, and working status. All of these variables will be obtained from the *Susenas* (BPS-Statistics Indonesia, 2020b). Age was expressed in years during the data collection. Sex was a dichotomous variable equal to 1 for males and 0 for females. Education attainment was counted as the total number of years of formal education completed or its equivalent. It did not take into account extracurricular courses and preschool education.

Marital status was classified into three categories: (1) single, (2) married, and (3) divorced/widowed. Single was referred to as never having any formal marital relationship. Married was defined as currently having a formal marriage relationship, while divorced or widowed category was assigned to those who ever get married but currently have no formal marriage relationship. Working status was classified into two categories, (1) including working and (2) not working. Working was assigned to those engaged in work as the main activity in the past week. For not working category, it included student and unemployed.

The wealth quintile was assessed using household expenditure per capita. Household expenditure meant household members' spending on foods, beverages, tobacco, housing and household facilities, various goods and services, clothing, durable goods, taxes, retribution and insurance, and festive feast needs in a month (BPS-Statistics Indonesia, 2020b). Consumption expenditure per capita was calculated as the total household expenditure divided by the number of household members. The result was further categorized into five quintiles. The value of 1 was assigned to the household with lowest wealth quintiles (poorest).

Income and consumption are direct measurements of living standards. Nevertheless, consumption expenditure is a preferable measurement, particularly in developing countries (O'Donnell et al., 2008). First, measuring the consumption expenditure is more stable than income for a full year. Second, it is more challenging to collect (O'Donnell et al., 2008). It is often inaccurate in measuring self-employment, informal economic activities, and reluctance to disclose income information (O'Donnell et al., 2008). In LMICs, most people work in the informal sector, change the source of income continually, and perform extensive home production activities (O'Donnell et al., 2008).

Other variables include the type of residence, geographical region, and the study year. The value of 0 in the type of residence variable exhibits the participant living in a rural village. The regional classification was indicated into three categories: (1) Sumatera, (2) Java & Bali, (3) Central (NTB, Kalimantan & Sulawesi), and (4) Eastern (NTT, Maluku, and Papua) region.

As the price of cigarettes may differ across the region and the year, this study proposed three model specifications. The first model controlled the price, the demographic, health, socioeconomic, and years of the survey variables. Other models included an interaction term between price and geographical region (model 2) and price and survey year (model 3). The model specifications were presented in equations 15-17.

Model 1: Smoking = β_1Price + β_2Age + β_3 Edu + β_4Work + β_4 Married + β_5 Widowed/Divorced + β_6 Health + β_7 HHE + β_8 Urban + β_9 Java-Bali + β_{10} Central + β_{11} Eastern + β_{12} 2016 + β_{13} 2017 + β_{14} 2019 + β_{15} 2020 + € (15)

Model 2: Smoking = β_1Price + β_2Age + β_3 Edu + β_4Work + β_4 Married + β_5 Widowed/Divorced + β_6 Health + β_7 HHE + β_8 Urban + β_9 Java-Bali + β_{10} Central + β_{11} Eastern + β_{12} 2016 + β_{13} 2017 + β_{14} 2019 + β_{15} 2020 + β_{16} Java-Bali#Price + β_{17} Central#Price + β_{18} Eastern#Price + € (16)

Model 3: β_1Price + β_2Age + β_3 Edu + β_4Work + β_4 Married + β_5 Widowed/Divorced + β_6 Health + β_7 HHE + β_8 Urban + β_9 Java-Bali + β_{10} Central + β_{11} Eastern + β_{12} 2016 + β_{13} 2017 + β_{14} 2019 + β_{15} 2020 + β_{16} 2016#Price + β_{17} 2017#Price + β_{18} 2019#Price + β_{19} 2020#Price € (17)

3.1.6. Data Analysis

Descriptive statistics were employed for all variables. Qualitative data such as smoking status, sex, marital status, working status, wealth quintiles, type of residence, and geographical region were described by frequency and percentage. The number of cigarettes smoked and age were presented by mean and standard deviation.

The two-part model was used to analyze the demand for cigarettes. The multivariable logistic regression will be employed to examine smoking participation in the first part of the model. The second part of the model was examined by the Generalized Linear Model (GLM). Several analyses were conducted to assess the model fit. The Boxcox test was used to determine the link function, and the modified park test was used to examine family distribution. The results of those tests revealed the appropriate family distribution was Poisson, while the link function was the log. Ultimately, the model fit was evaluated using Pregibon's link test. The results of the model fit evaluation are in the appendix.

Previous studies found that cigarette price elasticity is different between age groups (NCI & WHO, 2016). Therefore, we carried out a sub-group analysis to

evaluate elasticity in the age group of 15-24 (youth), 25-34, 35-44, 45-54, 55-64, and 65 years above (elderly). All statistical analyses were performed using Stata software version MP 16.1.

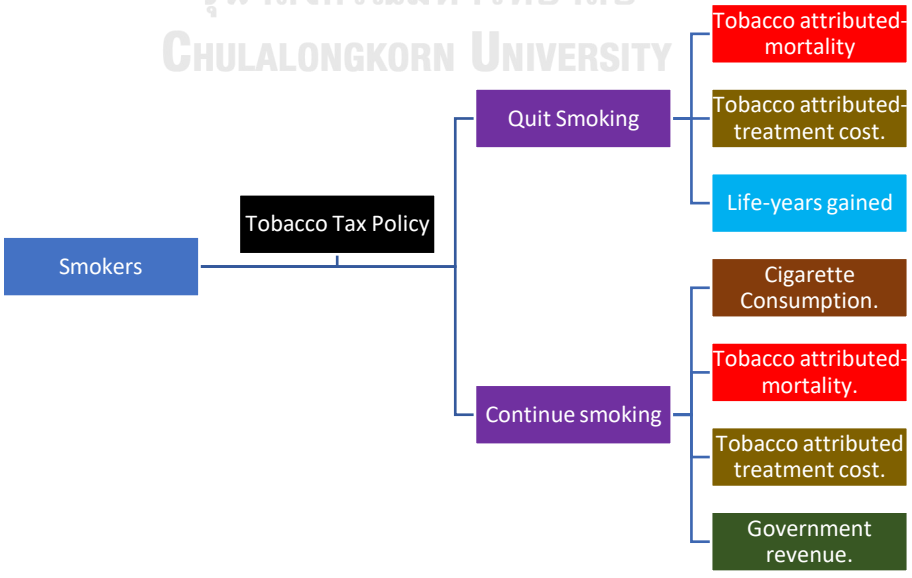
3.2. Phase II

3.2.1. Research Design

A compartmental or aggregate model was developed to assess the cumulative impact of an increase of tobacco excise taxes on public health as well as the economy. The initial population was an estimated number of smokers in Indonesia. The size of population changed based on the tobacco excise tax tariff scenarios, which determined the ourcome. The model estimated a one-time reduction of smoking and not a long-term estimation. This simulation used a deterministic model, meaning that it did not involve any randomness or uncertainty in its computations. Thus, the model would generate the same results or output if the parameterizations remain unchanged.

3.2.2.Model Structure

Figure 10. Model structure



The model classified smokers into two conditions after the cigarettes tax tariff increased. First, smokers completely quit smoking cigarettes. Second, they still smoked cigarettes, but the amount of consumption changed. This study estimated the tobacco attributed mortality and tobacco attributed treatment costs incurred by those who quit and continue smoking cigarettes after increased taxes. In addition, the model assessed the impact of quitting smoking on life-years gained. Ultimately, it projected that cigarette consumption and government revenue would change if a new tobacco taxes tariff was proposed. The model structure is presented in figure 10.

3.2.3. Model Parameterizations

The study participants were current smokers aged fifteen above, both males and females, in 2020. The participants were divided into seven age groups: 10-15, 15-24, 25-34, 35-44, 45-54, 55-64, and 65 years above. These groups were further divided based on sex. The model estimated the total population using the national census 2020 and prevalence of smoking using *Riskesdas* 2018 to estimate the total participants (current smokers) (BPS-Statistics Indonesia, 2022c, Kemenkes-Ministry of Health, 2019). The corresponding equation for the number of participants estimation and total cigarette consumption are as follows.

$$S_{b,a} = Pop_a * Prev_a \quad (18)$$

Where:

S = number of smokers.

Pop = Population.

Prev = Prevalence of smoking.

α = age group.

b = baseline.

The total cigarette consumption was counted on a yearly basis. There are 366 days a year assumed in this model. The estimated number of cigarettes consumed per smoker was assigned based on *Riskesdas* 2018 (Kemenkes-Ministry of Health, 2019). The following equations calculate the average number of cigarette sticks consumed in the age group α per year.

$$\bar{q}_{y,a} = 366\ days * \bar{q}_{a,w} \quad (19)$$

Where:

$\bar{q}$ = average cigarettes consumption per smoker.

w = week

y = year.

Another symbol as the same as in equation 18

3.2.4. Model Scenarios

The model assesses the cumulative impact of a one-time tobacco excise tax increase in six scenarios: 0% (baseline) 12.5%, 25%, 50%, 75%, 100%, and 200% increase. In addition, the Laffer curve was constructed to estimate the government revenue in different excise tax increase scenarios. The Laffer curve show the relationship between the tax tariff on the government revenue. It was further be compared with the estimated medical care expenditure associated with tobacco use. The recommendation for a minimum tobacco excise tax increase was proposed based on the point at which the curve's lines of the government revenue and medical treatment cost intersect.

3.2.5. Model Output

Tobacco excise tax increases will elevate the retail cigarette prices making the cigarette less affordable (NCI and WHO, 2016). This intervention will encourage

current smokers to quit. The magnitude of the quit rate is related to smoking participation price elasticity. The estimated price elasticity of smoking participation in each age group was drawn from phase I results. The estimated number of smokers after a new tobacco excise tax tariff was introduced in the age group α after the excise tax increased in scenario *sc* is represented in Equations 20-21.

$$S_{sc,a} = S_{b,a} - QUIT_{sc,a} \quad (20)$$

$$Quit_{sc,a} = S_{b,a} * (E_p * \left(\frac{P_{sc}-P_b}{P_b}\right) + 1) \quad (21)$$

Where:

Quit = number of quitters.

sc = scenario sc.

E_p = elasticity participation.

P = Price of cigarettes

All other symbols were the same as in equations 18-19

The change in the number of cigarettes consumed among smokers is related to the elasticity of smoking intensity among remaining smokers. The coefficient of the smoking intensity elasticity was derived from Phase I. The estimated number of cigarettes consumed in the age group α after the excise tax increased in scenario *sc* is on the following equation.

$$Q_{sc,a} = S_{sc,a} * \bar{q}_{y,sc,a} \quad (22)$$

$$\bar{q}_{y,sc,a} = \bar{q}_{y,b,a} * (E_c * \left(\frac{P_{sc}-P_b}{P_b}\right) + 1) \quad (23)$$

Where:

Q = number of cigarette consumed in a year.

$\bar{q}$ = the average number of cigarettes smoked among smokers per day.

E_c = elasticity conditional.

All other symbols were the same as in equations 18-21.

Epidemiological studies found that about half of the smokers will be died attributed to tobacco use (Thun et al., 2013, Doll et al., 2004, Pirie et al., 2013). This risk of death is gradually reduced by quitting early in life. This model applied the age-specific benefit of quit smoking on the risk of mortality from the previous study, which accounted the risk reduction at 3% in smokers who quit at the age of 15-24 years-olds, 15% in 25-44 years-olds, 25% in 45-64 years-olds, and 75% in 65 years above (Global Tobacco Economics Consortium, 2018, Verguet et al., 2015, Salti et al., 2016). To be conservative, the model does not take into account the benefit of cigarette smoking intensity reduction. The estimated number of tobacco-associated mortality in the age group α after the excise tax increased in scenario *sc* takes on the following equation.

$$M_{a,sc} = \frac{1}{2} * S_{a,sc} + (\frac{1}{2} Quit_{a,sc} * RR_a) \quad (24)$$

Where:

M = tobacco-attributed mortality.

RR = risk of death attributed to tobacco.

All other symbols were the same as in equations 18-23.

Life-years gained were generated as a result of smoking cessation. To be conservative, there is no additional benefit in reducing cigarette consumption among the remaining smokers in this model. The life span difference between quitters and current smokers varies depending on the smoking cessation age (USDHHS, 2020). This model assigned age-specific life-years gained based on previous epidemiological studies: 10 years for the age less than 30 years, nine years for the age of 35-44 years,

six years for the age of 45-54 years, three years for the age of 55-64 years, and 1.5 years for the age of 65 years above (Jha et al., 2013, Doll et al., 2004, Pirie et al., 2013). The estimated number of life-years gained in the age group α after the excise tax increase is represented in equation 25.

$$LYG_{\alpha} = Quit_{sc,\alpha} * Y_{\alpha} \quad (25)$$

Where:

LYG = life-years gained

Y = age-specific life-years gained

All other symbols were the same as in equations 18-24.

The model calculated medical treatment costs incurred by remaining smokers and quitters. To be conservative, it does not take into account the benefit of the number of cigarette smoking reduction. Tobacco-Related Diseases comprise 27 causes of smoking-related mortality (table 6). The shared contribution from each type of disease was proportioned based on the Global Burden of Diseases Study 2019 for Indonesia (IHME, 2020). The annual treatment cost was calculated from the cost of one episode of inpatient service and two times outpatient service. The average medical treatment cost of each disease was obtained from the national health insurance claim database 2018 (Ariawan et al., 2020). The cost was adjusted to the consumer price index 2020. Medical treatment cost (TC) of diseases *d* is represented in the following equation.

$$TC_d = M * \%TRD_d * UC_d \quad (26)$$

Where:

%TRD = % contribution to tobacco-related disease cases.

UC = Unit cost annual medical treatment.

d = disease d.

Another symbol was the same as in equations 18-25.

Three types of tobacco taxes pass on into cigarettes prices, specifically excise taxes, value-added taxes, and local tobacco taxes (Ahsan et al., 2016). The finance ministry assigned the excise tax tariff and minimum retail price annually (Kemenkeu-Ministry of Finance, 2019). The local tax rate is 10% of the excise tax tariff, while the value-added tax rate is 9.1% of cigarette prices (Ahsan et al., 2016). The detailed calculation of the government revenue from tobacco tax is on the following equations.

$$ET_{sc} = P_{sc} * Q_{sc} * t_{sc} \quad (27)$$

$$VAT_{sc} = P_{sc} * Q_{sc} * 9.1\% \quad (28)$$

$$LT_{sc} = ET_{sc} * 10\% \quad (29)$$

$$GR_{sc} = ET_{sc} + VAT_{sc} + LT_{sc} = P_{sc}Q_{sc}(1.1t_{sc} + 9.1\%) \quad (30)$$

Where:

ET = tobacco excise tax revenue.

t = % of cigarettes excise tariff from the retail price.

VAT = Value added tax revenue.

LT = local tobacco tax revenue.

GR = total government revenue from tobacco taxes.

Another symbol was the same as in equations 18-26.

Table 6. ICD-10 code, shared of mortality and unit cost of tobacco related diseases

No.	Diseases	ICD-10 code	Shared of mortality (%)	Unit Cost (IDR)
1	Heart disease	I20-I25	23.98	5,637,596

No.	Diseases	ICD-10 code	Shared of mortality (%)	Unit Cost (IDR)
2	Stroke	I60-I69	21.96	5,158,222
3	Atrial fibrillation and flutter	I48	0.14	5,827,974
4	Aortic Aneurysm	I71	0.42	10,317,985
5	Diabetes mellitus	E10-E14	4.66	5,234,930
6	Chronic obstructive pulmonary disease	J41-J44	16.04	3,844,188
7	Asthma	J45-J46	1.88	2,999,331
8	Alzheimer's disease and other dementias	F00-F06, G30-G32	1.33	7,965,359
9	Gallbladder and biliary diseases	K80-K83, K87	0.13	5,229,588
10	Upper digestive system disease	K21-K22, K25-K30, R12	0.14	2,171,945
11	Tracheal, bronchus, and lung cancer	C33-C34	11.37	8,618,514
12	Colon and rectum cancer	C18-C21	1.59	9,664,622
13	Stomach cancer	C16	0.82	9,794,454
14	Liver cancer	C22	0.33	6,594,620
15	Esophageal cancer	C15	0.78	8,475,315
16	Kidney cancer	C64-C65	0.21	5,395,500

No.	Diseases	ICD-10 code	Shared of mortality (%)	Unit Cost (IDR)
17	Bladder cancer	C67	0.51	7,482,909
18	Pancreatic cancer	C25	0.71	9,672,959
19	Leukemia	C91-C95	0.70	8,367,441
20	Lip and oral cavity cancer	C00-C08	0.63	8,091,408
21	Nasopharynx cancer	C11	0.33	6,772,992
22	Larynx cancer	C32	0.56	9,969,833
23	Prostate cancer	C61	0.43	6,009,471
24	Breast Cancer	C50	0.08	6,852,389
25	Cervical Cancer	C53	0.21	6,345,671
26	Lower respiratory infections	J09-J22, J85-J91, P23	2.87	4,790,898
27	Tuberculosis	A10-A16	7.18	5,290,953

3.2.6. Sensitivity Analysis

The univariate sensitivity analysis was performed to evaluate the impact of key parameter changes on the model outputs. This study examined all outcomes of different elasticity coefficients derived from phase I.

3.3. Ethical Consideration

The study has no more than minimal risk to participants since it used publicly accessed databased from the government institution. Participants, households, or communities in the datasets could not be identified. The Research Ethics Review

Committee of Chulalongkorn University had granted ethical review exemption for this study (COA number 040/2021).

CHAPTER IV RESULTS

This chapter described the results of phase I and phase II. The phase I results consisted of participants' characteristics and multivariate analysis of smoking participation and smoking intensity models. The results of phase II covered a simulation of tobacco excise tax increase on cigarette consumption, tobacco attributed mortality, medical treatment cost of tobacco-related diseases, life-years gained, and government revenue. This chapter also proposed an ideal tobacco excise tax rate.

4.1. Phase I

4.1.1. Descriptive Statistics

Table 7. Characteristics Participants

Variables	All Participants		Smokers	
	N	Mean(SD)/%	N	Mean(SD)/%
Sex				
Female	2,072,428	50.38%	27,577	2.36%
Male	2,040,970	49.62%	1,141,877	97.64%
Age in years	4,113,398	39.7 (16.3)	1,169,454	40.86 (14.06)
Health problem				
No	2,940,044	71.47%	858,366	73.40%
Yes	1,173,354	28.53%	311,088	26.60%
Education	4,113,398	8.7 (4.3)	1,169,454	8.38 (3.96)

Variables	All Participants		Smokers	
	N	Mean(SD)/%	N	Mean(SD)/%
Working status				
No	1,473,182	35.81%	117,150	10.02%
Yes	2,640,216	64.19%	89.98	89.98%
Marital Status				
Single	990,643	24.08%	231,503	19.80%
Married	2,731,883	66.41%	878,121	75.09%
Divorced/widowed	390,872	9.50%	59,830	5.12%
Wealth quintiles				
Poorest	891,299	21.67%	232,724	19.90%
Poorer	863,280	21.99%	252,890	21.62%
Middle	831,957	20.23%	252,581	21.60%
Richer	796,741	19.37%	239,346	20.47%
Richest	730,121	17.75%	191,913	16.41%
Place of residence				
Rural	2,343,296	56.97%	708,533	60.59%
Urban	1,770,102	43.03%	460,921	39.41%
Region				
Sumatera	1,178,363	28.65%	350,833	30.00%
Java & Bali	1,367,969	33.26%	385,207	32.94%
Central	1,060,747	25.79%	293,677	25.11%
Eastern	506,319	12.31%	139,737	11.95%

Variables	All Participants		Smokers	
	N	Mean(SD)/%	N	Mean(SD)/%
Smoking status				
No	2,943,944	71.57%	n/a	n/a
Yes	1,169,454	28.43%	n/a	n/a
Weekly cigarette use	n/a	n/a	1,169,454	86.36(58.13)
Cigarette Prices	4,113,398	1,032.79(259.93)	1,169,454	1,025.21(251.21)
Survey year				
2015	771,174	18.75%	224,554	19.20%
2016	785,024	19.08%	220,445	18.85%
2017	805,322	19.58%	229,758	19.65%
2019	853,856	20.76%	243,418	20.81%
2020	898,022	21.83%	251,279	21.49%

Table 7 presents the descriptive characteristics of study participants. The total number of participants was 4,113,398. The proportion of the gender of study participants was nearly similar between males and females (49.6% vs. 50.4%). The mean age of participants was approximately 39.7 ± 16.3. The participants had eight years of schooling or equal to lower secondary school education. About 28.53% of participants reported having health problems in the past month. More than half (64.3%) of the participants were engaged in working as the primary income-earning activity. In terms of marital status, most of the participants (64.3%) had been married, while about a quarter (24.1%) were single. In terms of wealth quintiles, only 17.8%

came from the richest household, and about 21.7% were from the poorest households. Regarding geographical region, 61.9% of participants lived in the western region (Sumatera, Java & Bali), while those living in the central and eastern regions were 25.8% and 12.3%, respectively.

About 1,169,454 participants or 28.43% were smokers. The average cigarette consumption was 86.36 (58.13) sticks per week. The majority of smokers (97.64%) were male. The average age and education of smokers were nearly similar to full participants, which were 40.86 (14.06), and 8.38 (3.96) years, respectively. A total of 10.02% of smokers were not currently working. The majority of smokers (73.40%) reported no health issues in the past month. In terms of marital status, most of the smokers (75.09%) were currently married. The proportion of smokers from the poorest household was higher than those from the richest (19.90% Vs. 16.41%). More than half of the smokers (60.59%) lived in rural areas. A total of 32.94% lived in Java and Bali region.

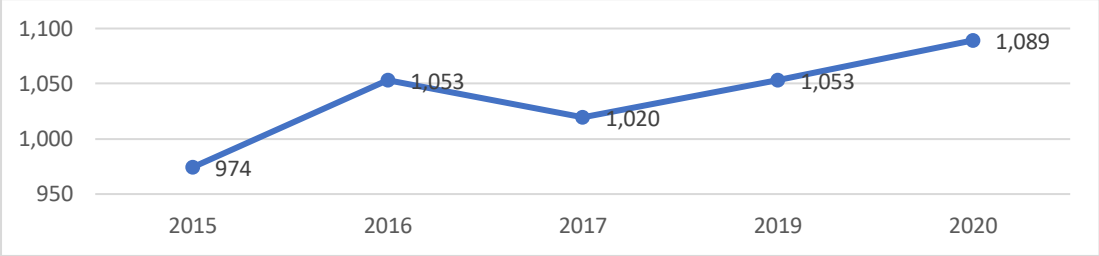
Table 8. Prevalence of smoking by year, 2015-2020

Smoking Prevalence	2015	2016	2017	2019	2020
Sex					
Female	1.47	1.24	1.42	1.30	1.24
Male	57.11	55.17	56.19	56.15	55.22

The prevalence of smokers was substantially different between males and females. In females, smoking prevalence was relatively stable, around 1 percent, while more than half of males were classified as current smokers. There were only

minor changes in the smoking proportion among males, from 57.11% in 2015 to 55.22% in 2020 (Table 8).

Figure 11. Price of cigarettes by year, 2015-2020



The cigarette price generally fluctuated over the last five years. In 2015, the cigarette price was approximately 937 Rupiah. The price significantly elevated to 1,053 rupiahs in 2016. However, it became cheaper in 2017 to 1,019 Rupiah. The price was then back to 1,053 in 2019 and slightly increased to 1,089 Rupiah in 2020 (Figure 11).

4.1.2. Demand for Cigarettes of All Participants

Table 9 revealed the regression coefficient of smoking participation by model specifications. The first model controlled the prices, demographic, health problems, socioeconomic, and years of the survey. Other models included an interaction term between price and geographical region (model 2) and price and survey year (model 3). As seen in table 9, All models showed similar results. Cigarette prices were negatively associated with the chance of smoking, and the results were statistically significant. Age and education were inversely associated with smoking participation. Being male were more likely to smoke cigarettes than females. Those currently working might increase the likelihood of smoking compared to those unemployed/retired. Having a health problem could reduce the probability of being a smoker. Participants who ever had married and divorced/widowed were more likely to

smoke cigarettes than those who had never married. Individuals from the poorest economic status were less likely to smoke than their counterparts. The geographical region was significantly associated with smoking status. Those who resided in urban areas were less likely to smoke cigarettes than those in rural areas. The interaction terms in models 2 and 3 were statistically significant, implying that the price of cigarettes was significantly different across geographical regions and years.

Table 9. Model of smoking participation of all participants, coefficient(SE)

Independent Variables	**Model 1**	**Model 2**	**Model 3**
Price	-0.0002(0.0001)*	-0.0004(0.00002)*	-0.0003(0.00002)*
Sex			
Female	Ref.	Ref.	Ref.
Male	4.5719(0.0064)*	4.5720(0.0064)*	4.5721(0.0064)*
Age	-0.0133(0.0001)*	-0.0133(0.0001)*	-0.0133(0.0001)*
Health problem			
No	Ref.	Ref.	Ref.
Yes	-0.0706(0.0034)*	-0.0705(0.0034)*	-0.0705(0.0034)*
Education	-0.0756(0.0004)*	-0.0756(0.0004)*	-0.0757(0.0004)*
Working status			
No	Ref.	Ref.	Ref.
Yes	1.3105(0.0042)*	1.3108(0.0042)*	1.3108(0.0042)*

Independent Variables	Model 1	Model 2	Model 3
Marital Status			
Never married	Ref.	Ref.	Ref.
Married	0.7283(0.0047)*	0.7271(0.0047)*	0.7284(0.0047)*
Divorced/Widowed	0.9189(0.0088)*	0.9186(0.0088)*	0.9189(0.0088)*
Wealth quintiles			
Poorest	Ref.	Ref.	Ref.
Poorer	0.2604(0.0045)*	0.2584(0.0045)*	0.2600(0.0045)*
Middle	0.3748(0.0046)*	0.3721(0.0046)*	0.3739(0.0046)*
Richer	0.4152(0.0047)*	0.4118(0.0048)*	0.4147(0.0048)*
Richest	0.3060(0.0052)*	0.2999(0.0052)*	0.3044(0.0052)*
Type of Residence			
Rural	Ref.	Ref.	Ref.
Urban	-0.1085(0.0033)*	-0.1069(0.0033)*	-0.1084(0.0033)*
Region			
Sumatera	Ref.	Ref.	Ref.
Java & Bali	-0.0471(0.0038)*	-0.4116(0.0217)*	-0.0492(0.0038)*
Central	-0.2014(0.0040)*	-0.6311(0.0231)*	-0.2017(0.0040)*
Eastern	-0.1885(0.0058)*	-0.4183(0.0229)*	-0.1955(0.0059)*

Independent Variables	Model 1	Model 2	Model 3
Year of survey			
2015	Ref.	Ref.	Ref.
2016	-0.0619(0.0048)*	-0.0621(0.0048)*	-0.1136(0.0204)
2017	-0.0040(0.0048)	-0.0052(0.0048)	-0.0970(0.0226)*
2019	0.0087(0.0047)	0.0056(0.0047)	-0.2474(0.0212)*
2020	-0.0124(0.0047)*	-0.0143(0.0048)*	-0.1561(0.0200)*
Region#Price			
Sumatera		Ref.	
Java & Bali		0.0004(0.00002)*	
Central		0.0004(0.00002)*	
Eastern		0.0002(0.00002)*	
Year#Price			
2015			Ref.
2016			0.0001(0.00002)*
2017			0.0001(0.00002)*
2019			0.0003(0.00002)*
2020			0.0001(0.00002)*
Constant	-4.6312(0.0113)*	-4.3685(0.0186)*	-4.5276(0.0176)*

*p<0.05; #= interaction; n = 4,113,398

Table 10 presents the coefficient of smoking intensity among smokers by demand models. The coefficient of price was negative and statistically significant in all models. This may suggest that cigarette consumption among smokers declines

when the price increases. The results also found that age and years of schooling were inversely associated with smoking intensity among smokers. Among smokers, the number of cigarettes smoked per week in males was significantly higher than in females. The individuals from the poorer, middle, richer, and richest households consumed more cigarettes than those from the poorest economic status among smokers. Having health problems and living in urban could reduce the number of cigarettes smoked among smokers. The results were statistically significant. Other variables, including working, married, and divorced/widowed, were significantly associated with the number of cigarettes smoked among remaining smokers.

Table 10. Model of smoking intensity of all participants, coefficient(SE)

Independent Variables	**Model 1**	**Model 2**	**Model 3**
Price	-0.0003(0.00000)*	-0.0004(0.00001)*	-0.0003(0.00001)*
Sex			
Female	Ref.	Ref.	Ref.
Male	0.2628(0.0049)*	0.2646(0.0049)*	0.2635(0.0049)*
Age	-0.0026(0.0001)*	-0.0026(0.0001)*	-0.0026(0.0001)*
Health problem			
No	Ref.	Ref.	Ref.
Yes	-0.0439(0.0014)*	-0.0429(0.0014)*	-0.0439(0.0014)*
Education	-0.0065(0.0002)*	-0.0062(0.0002)*	-0.0065(0.0002)*

Independent Variables	Model 1	Model 2	Model 3
Working status			
No	Ref.	Ref.	Ref.
Yes	0.1795(0.0024)*	0.1795(0.0024)*	0.1791(0.0024)*
Marital Status			
Never married	Ref.	Ref.	Ref.
Married	0.1678(0.0018)*	0.1664(0.0018)*	0.1678(0.0018)*
Divorced/Widowed	0.0874(0.0033)*	0.0849(0.0033)*	0.0874(0.0033)*
Wealth quintiles			
Poorest	Ref.	Ref.	Ref.
Poorer	0.1861(0.0019)*	0.1854(0.0019)*	0.1866(0.0019)*
Middle	0.2822(0.0019)*	0.2829(0.0019)*	0.2829(0.0019)*
Richer	0.3737(0.0020)*	0.3750(0.0020)*	0.3739(0.0020)*
Richest	0.4967(0.0022)*	0.4989(0.0022)*	0.4975(0.0022)*
Type of Residence			
Rural	Ref.	Ref.	Ref.
Urban	-0.0335(0.0014)*	-0.0224(0.0014)*	-0.0339(0.0014)*
Region			
Sumatera	Ref.	Ref.	Ref.
Java & Bali	-0.2620(0.0015)*	-0.3728(0.0090)*	-0.2605(0.0015)*
Central	-0.0347(0.0015)*	0.1389(0.0089)*	-0.0342(0.0015)*
Eastern	-0.2820(0.0030)*	-0.7250(0.0112)*	-0.2785(0.0029)*

Independent Variables	Model 1	Model 2	Model 3
Year of survey			
2015	Ref.	Ref.	Ref.
2016	0.0832(0.0019)*	0.0919(0.0019)*	-0.0043(0.0120)
2017	0.0622(0.0018)*	0.0693(0.0018)*	0.1085(0.0106)*
2019	0.0980(0.0019)*	0.1061(0.0019)*	0.1839(0.0108)*
2020	0.0851(0.0019)*	0.0946(0.0019)*	0.1721(0.0107)*
Region#Price			
Sumatera		Ref.	
Java & Bali		0.0001(0.00001)*	
Central		-0.0002(0.00001)*	
Eastern		0.0004(0.00001)*	
Year#Price			
2015			Ref.
2016			0.0001(0.00001)*
2017			-0.00005(0.00001)*
2019			-0.0001(0.00001)*
2020			-0.0001(0.00001)*
Constant	4.1858(0.0071)*	4.2757(0.0086)*	4.1582(0.0102)*

*p<0.05; #= interaction; n =1,169,454

4.1.3. Demand for Cigarettes among Youth

Table 11 presents the model of smoking participation among youth by models specifications. All models revealed that the price and years of education completed

were negatively associated with smoking status, while regression coefficients in the age variable were positive. The results were statistically significant. Being male was strongly associated with smoking participation. Working status, marital status, wealth quintiles, type of residence, and geographical region were significantly associated with the probability of smoking cigarettes in the past month among youth in Indonesia.

Table 11. Model of smoking participation among youth, coefficient(SE)

Independent Variables	**Model 1**	**Model 2**	**Model 3**
Price	-0.0004(0.00002)*	-0.0008(0.00004)*	-0.0004(0.00004)*
Sex			
Female	Ref.	Ref.	Ref.
Male	4.8049(0.0224)*	4.8046(0.0224)*	4.8049(0.0224)*
Age	0.2602(0.0016)*	0.2603(0.0016)*	0.2602(0.0016)*
Health problem			
No	Ref.	Ref.	Ref.
Yes	0.0848(0.0099)*	0.0856(0.0099)*	0.0846(0.0099)*
Education	-0.1246(0.0013)*	-0.1244(0.0013)*	-0.1245(0.0013)*
Working status			
No	Ref.	Ref.	Ref.
Yes	1.1788(0.0084)*	1.1794(0.0084)*	1.1787(0.0084)*

Independent Variables	Model 1	Model 2	Model 3
Marital Status			
Never married	Ref.	Ref.	Ref.
Married	0.4044(0.0135)*	0.4021(0.0135)*	0.4043(0.0135)*
Divorced/Widowed	0.6984(0.0566)*	0.6973(0.0566)*	0.6977(0.0566)*
Wealth quintiles			
Poorest	Ref.	Ref.	Ref.
Poorer	0.3075(0.0114)*	0.3038(0.0114)*	0.3078(0.0114)*
Middle	0.4878(0.0115)*	0.4836(0.0115)*	0.4883(0.0115)*
Richer	0.5735(0.0119)*	0.5681(0.0119)*	0.5740(0.0119)*
Richest	0.5160(0.0132)*	0.5068(0.0132)*	0.5156(0.0132)*
Type of Residence			
Rural	Ref.	Ref.	Ref.
Urban	-0.1368(0.0083)*	-0.1319(0.0084)*	-0.1361(0.0083)*
Region			
Sumatera	Ref.	Ref.	Ref.
Java & Bali	0.2641(0.0096)*	-0.3304(0.0549)*	0.2640(0.0096)*
Central	-0.0698(0.0097)*	-0.8124(0.0567)*	-0.0704(0.0097)*
Eastern	-0.1343(0.0145)*	-0.6115(0.0604)*	-0.1330(0.0145)*

Independent Variables	Model 1	Model 2	Model 3
Year of survey			
2015	Ref.	Ref.	Ref.
2016	-0.0191(0.0120)	-0.0170(0.0121)	-0.0990(0.0555)
2017	0.1292(0.0117)*	0.1292(0.0118)*	0.1196(0.0555)*
2019	0.1498(0.0118)*	0.1473(0.0118)*	0.0788(0.0529)
2020	0.1535(0.0118)*	0.1537(0.0119)*	0.0792(0.0494)
Region#Price		.	
Sumatera		Ref	
Java & Bali		0.0006(0.0001)*	
Central		0.0008(0.0001)*	
Eastern		0.0005(0.0001)*	
Year#Price			
2015			Ref.
2016			0.0001(0.0001)
2017			0.00001(0.0001)
2019			0.0001(0.0001)
2020			0.0001(0.00005)
Constant	-10.0292(0.0416)*	-9.5625(0.0547)*	-9.9755(0.0532)*

*p<0.05, # = interaction, n= 886,521

Table 12 presents the coefficient of the smoking intensity model among youth using GLMs. The results revealed that the price was significantly associated with smoking intensity among smokers. If cigarettes price increased, the number of

cigarettes used among smokers could be lower. Among smokers, participants who divorced/widowed tended to smoke more cigarettes than those who never married. However, the results were not statistically significant. In all specifications, sex, age, health problem, education, working status, and wealth quintiles were significantly associated with the number of cigarettes consumed in the past week among smokers.

Table 12. Model of smoking intensity among youth, coefficient(SE)

Independent Variables	**Model 1**	**Model 2**	**Model 3**
Price	-0.0003(0.000005)*	-0.0005(0.00002)*	-0.0003(0.00003)*
Sex			
Female	Ref.	Ref.	Ref.
Male	0.0331(0.0158)*	0.0362(0.0158)*	0.0342(0.0158)*
Age	-0.0275(0.0008)*	0.0278(0.0008)*	0.0275(0.0008)*
Health problem			
No	Ref.	Ref.	Ref.
Yes	0.0637(0.0047)*	-0.0617(0.0047)*	0.0636(0.0047)*
Education	-0.0152(0.0005)*	-0.0148(0.0005)*	-0.0152(0.0005)*
Working status			
No	Ref.	Ref.	Ref.
Yes	0.2455(0.0047)*	0.2438(0.0047)*	0.2453(0.0047)*

Independent Variables	Model 1	Model 2	Model 3
Marital Status			
Never married	Ref.	Ref,	Ref.
Married	0.0602(0.0044)*	0.0584(0.0044)*	0.0601(0.0044)*
Divorced/Widowed	0.0322(0.0175)	0.0293(0.0174)	0.0333(0.0174)
Wealth quintiles			
Poorest	Ref.	Ref.	Ref.
Poorer	0.2184(0.0056)*	0.2174(0.0056)*	0.2187(0.0056)*
Middle	0.3180(0.0056)*	0.3191(0.0055)*	0.3185(0.0056)*
Richer	0.4076(0.0056)*	0.4092(0.0056)*	0.4075(0.0056)*
Richest	0.5100(0.0063)*	0.5123(0.0063)*	0.5106(0.0063)*
Type of Residence			
Rural	Ref.	Ref.	Ref.
Urban	-0.0087(0.0039)*	-0.0760(0.0039)*	-0.0890(0.0039)*
Region			
Sumatera	Ref.	Ref.	Ref.
Java & Bali	-0.2193(0.0043)*	-0.4209(0.0264)*	-0.2176(0.0043)*
Central	-0.0253(0.0041)*	0.0191(0.0257)	-0.0247(0.0041)*
Eastern	-0.3362(0.0084)*	-0.9236(0.0320)*	-0.3321(0.0082)*
Year of survey			
2015	Ref.	Ref.	Ref.
2016	0.0988(0.0054)*	0.1082(0.0054)*	-0.0024(0.0347)

Independent Variables	Model 1	Model 2	Model 3
2017	0.0742(0.0050)*	0.0821(0.0050)*	0.1087(0.0301)*
2019	0.1081(0.0054)*	0.1167(0.0054)*	0.2333(0.0306)*
2020	0.1051(0.0054)*	0.1141(0.0053)*	0.1644(0.0299)*
Region#Price			
Sumatera		Ref.	
Java & Bali		0.0002(0.00003)*	
Central		-0.0001(0.00003)	
Eastern		0.0005(0.00003)*	
Year#Price			
2015			Ref.
2016			0.0001(0.00004)*
2017			-0.00004(0.00003)
2019			-0.0001(0.00003)*
2020			-0.0001(0.00003)
Constant	3.7883(0.0345)*	3.9513(0.0285)*	3.7452(0.0323)*

*p<0.05, # = interaction, n= 154,514

4.1.4. Demand for Cigarettes Among Adults Aged 25-34

Table 13 summarizes the logit estimates for smoking participation by model specifications among adults aged 25-34. The coefficient of price was -0.0003 (0.00002) in model 1, -0.0005 (0.00004) in model 2, and -0.0002 (0.0003) in model 3, affirming that higher prices were associated with a lower chance of being current smokers. Health problems were not a significant covariate in all model specifications.

Sex, age, education, working status, marital status, wealth quintiles, and type of residence were significantly associated with smoking participation in all specifications.

Table 13. Model of smoking participation among adults aged 25-34, coefficient(SE)

Independent Variables	Model 1	Model 2	Model 3
Price	-0.0003(0.00002)*	-0.0005(0.00004)*	-0.0002(0.00003)*
Sex			
Female	Ref.	Ref.	Ref.
Male	5.3836(0.0172)*	5.3843(0.0172)*	5.3837(0.0172)*
Age	0.0119(0.0013)*	0.0120(0.0013)*	0.0119(0.0013)*
Health problem			
No	Ref.	Ref.	Ref.
Yes	0.0170(0.0087)	0.0168(0.0087)	0.0171(0.0087)
Education	-0.1091(0.0011)*	-0.1090(0.0011)*	-0.1092 (0.0011)*
Working status			
No	Ref.	Ref.	Ref.
Yes	0.4879(0.0121)*	0.4875(0.0121)*	0.4884(0.0121)*
Marital Status			
Never married	Ref.	Ref.	Ref.
Married	0.2038(0.0081)*	0.2022(0.0081)*	0.2039(0.0081)*
Divorced/Widowed	0.6855(0.0283)*	0.6840(0.0283)*	0.6864(0.0283)*

Independent Variables	Model 1	Model 2	Model 3
Wealth quintiles			
Poorest	Ref.	Ref.	Ref.
Poorer	0.3388(0.0108)*	0.3371(0.0108)*	0.3383(0.0108)*
Middle	0.4743(0.0110)*	0.4724(0.0110)*	0.4737(0.0110)*
Richer	0.5256(0.0113)*	0.5232(0.0113)*	0.5253(0.0113)*
Richest	0.4125(0.0120)*	0.4082(0.0120)*	0.4117(0.0120)*
Type of Residence			
Rural	Ref.	Ref.	Ref.
Urban	-0.1656(0.0076)*	-0.1628(0.0077)*	-0.1670(0.0076)*
Region			
Sumatera	Ref.	Ref.	Ref.
Java & Bali	-0.1080(0.0089)*	-0.4167(0.0507)*	-0.1092(0.0089)*
Central	-0.2732(0.0092)*	-0.7101(0.0529)*	-0.2730(0.0092)*
Eastern	-0.1080(0.0136)*	-0.3804(0.0535)*	-0.1124(0.0137)*
Year of survey			
2015	Ref.	Ref.	Ref.
2016	-0.0259(0.0112)*	-0.0246(0.0112)*	0.1361(0.0481)*
2017	0.0230(0.0110)*	0.0232(0.0110)*	0.1470(0.0512)*
2019	0.0374(0.0110)**	0.0362(0.0111)*	-0.0230(0.0476)
2020	-0.0143(0.0111)	-0.0140(0.0112)	0.0568(0.0445)

Independent Variables	Model 1	Model 2	Model 3
Region#Price			
Sumatera		Ref.	
Java & Bali		0.0003(0.00005)*	
Central		0.0005(0.0001)*	
Eastern		0.0003(0.00005)*	
Year#Price			
2015			Ref.
2016			-0.0002(0.00005)*
2017			-0.0001(0.0001)*
2019			0.00005(0.00005)
2020			-0.0001(0.00004)
Constant	-4.3734(0.0445)*	-4.1115(0.0556)*	-4.4415(0.0526)*

*p<0.05, #interaction, n=809,640

Table 14 contains the multivariate analysis of smoking intensity using GLMs, examining the impact of price and other independent variables on cigarettes smoked per week among adults aged 25-34. Regardless of model specifications, the coefficient of price variable was consistently shown to be in a narrow range between -0.0002 to -0.0005. In models 1 and 2, all the estimated coefficients for the interaction terms were statistically significant. These results imply that the conditional consumption price differed across geographical regions and years of the survey.

Table 14. Model of smoking intensity among adults aged 25-34, coefficient(SE)

Independent Variables	Model 1	Model 2	Model 3
Price	-0.0003(0.00001)*	-0.0005(0.00001)*	-0.0002(0.00002)*
Sex			
Female	Ref.	Ref.	Ref.
Male	0.2148(0.0127)*	0.2174(0.0127)*	0.2167(0.0127)*
Age	0.0055(0.0004)*	0.0055(0.0004)*	0.0055(0.0004)*
Health problem			
No	Ref.	Ref.	Ref.
Yes	-0.032(0.0030)*	-0.0318(0.0030)*	-0.0328(0.0030)*
Education	-0.0097(0.0004)*	-0.0092(0.0003)*	-0.0097(0.0004)*
Working status			
No	Ref.	Ref.	Ref.
Yes	0.0963(0.0054)*	0.0951(0.0054)*	0.0957(0.0054)*
Marital Status			
Never married	Ref.	Ref.	Ref.
Married	0.0736(0.0028)*	0.0722(0.0028)*	0.0736(0.0028)*
Divorced/Widowed	0.0337(0.0075)*	0.0312(0.0075)*	0.0330(0.0075)*

Independent Variables	Model 1	Model 2	Model 3
Wealth quintiles			
Poorest	Ref.	Ref.	Ref.
Poorer	0.1942(00038)*	0.1935(0.0038)*	0.1950(0.0038)*
Middle	0.2961(0.0038)*	0.2970(0.0038)*	0.2973(0.0038)*
Richer	0.3851(0.0040)*	0.3868(0.0040)*	0.3859(0.0040)*
Richest	0.4940(0.0045)*	0.4960(0.0045)*	0.4955(0.0045)*
Type of Residence			
Rural	Ref.	Ref.	Ref.
Urban	-0.0505(0.0028)*	-0.0375(0.0028)*	-0.0510(0.0027)*
Region			
Sumatera	Ref.	Ref.	Ref.
Java & Bali	-0.2540(0.0030)*	-0.4138(0.0184)*	-0.2521(0.0030)*
Central	-0.0430(0.0029)*	0.0855(0.0175)*	-0.0424(0.0029)*
Eastern	-0.2952(0.0057)*	-0.7581(0.0202)*	-0.2908(0.0056)*
Year of survey			
2015	Ref.	Ref.	Ref.
2016	0.0765(0.0038)*	0.0862(0.0037)*	0.0266(0.0226)
2017	0.0559(0.0035)*	0.0643(0.0035)*	0.1623(0.0209)*
2019	0.0970(0.0038)*	0.1065(0.0038)*	0.2111(0.0215)*
2020	0.0811(0.0038)*	0.0920(0.0037)*	0.2377(0.0208)*

Independent Variables	Model 1	Model 2	Model 3
Region#Price			
Sumatera		Ref.	
Java & Bali		0.0002(0.00002)*	
Central		-0.0002(0.00002)*	
Eastern		0.0004(0.00002)*	
Year#Price			
2015			Ref.
2016			0.00004(0.00002)
2017			-0.0001(0.00002)*
2019			-0.0001(0.00002)*
2020			-0.0002(0.00002)*
Constant	4.1705(0.0201)*	4.2999(0.0221)*	4.1059(0.0250)*

*p<0.05, #interaction, n=268,841

4.1.5. Demand for Cigarettes among Adults Aged 35-44

Table 15 presents the GLM estimates of smoking participation from subsample of adults aged 35-44. The model of smoking participation indicated that price played a significant role in the decision to smoke among adults aged 35-44 in all specifications. The results revealed that being male was strongly associated with a higher chance of smoking, and the results were statistically significant. Age and education were negatively and significantly associated with smoking status. In addition, health problems, working status, marital status, wealth quintiles, type of

residence, and geographical region were significant factors determining smoking participation.

Table 15. Model of smoking participation among adults aged 35-34, coefficient(SE)

Independent Variables	Model 1	Model 2	Model 3
Price	-0.0002(0.00002)*	-0.0003(0.00004)*	-0.0002(0.00003)*
Sex			
Female	Ref.	Ref.	Ref.
Male	5.2287(0.0150)*	5.2292(0.0150)*	5.2289(0.0150)*
Age	-0.0275(0.0011)*	-0.0275(0.0011)*	-0.0275(0.0011)*
Health problem			
No	Ref.	Ref.	Ref.
Yes	-0.0306(0.0076)*	-0.0305(0.0076)*	-0.0303(0.0076)*
Education	-0.0859(0.0010)*	-0.0860(0.0010)*	-0.0860(0.0010)*
Working status			
No	Ref.	Ref.	Ref.
Yes	0.4103(0.0148)*	0.4111(0.0148)*	0.4107(0.0148)*
Marital Status			
Never married	Ref.	Ref.	Ref.
Married	0.1620(0.0132)*	0.1617(0.0133)*	0.1620(0.0133)*
Divorced/Widowed	0.5920(0.0242)*	0.5925(0.0242)*	0.5919(0.0242)*

Independent Variables	Model 1	Model 2	Model 3
Wealth quintiles			
Poorest	Ref.	Ref.	Ref.
Poorer	0.2880(0.0099)*	0.2864(0.0099)*	0.2875(0.0099)*
Middle	0.3990(0.0102)*	0.3961(0.0102)*	0.3981(0.0102)*
Richer	0.3847(0.0104)*	0.3805(0.0104)*	0.3840(0.0104)*
Richest	0.2882(0.0113)*	0.2818(0.0113)*	0.2871(0.0113)*
Type of Residence			
Rural	Ref.	Ref.	Ref.
Urban	-0.1131(0.0072)*	-0.1188(0.0073)*	-0.1137(0.0072)*
Region			
Sumatera	Ref.	Ref.	Ref.
Java & Bali	-0.1494(0.0084)*	-0.3386(0.0479)*	-0.1512(0.0084)*
Central	-0.2942(0.0088)*	-0.6279(0.0505)*	-0.2942(0.0088)*
Eastern	-0.1725(0.0131)*	-0.1638(0.0506)*	-0.1804(0.0132)*
Year of survey			
2015	Ref.	Ref.	Ref.
2016	-0.0065(0.0106)	-0.0123(0.0106)	-0.0380(0.0417)
2017	0.0101(0.0105)	0.0046(0.0106)	-0.0141(0.0484)
2019	0.0602(0.0104)*	0.0524(0.0105)*	-0.1888(0.0451)*
2020	0.0441(0.0104)*	0.0359(0.0105)*	0.0274(0.0411)

Independent Variables	Model 1	Model 2	Model 3
Region#Price			
Sumatera		Ref.	
Java & Bali		0.0002(0.00005)*	
Central		0.0004(0.0001)*	
Eastern		0.00002(0.00004)	
Year#Price			
2015			Ref.
2016			0.00004(0.00004)
2017			0.00003(0.00005)
2019			0.0002(0.00004)
2020			0.00002(0.00004)*
Constant			0.00004(0.00004)
Constant	-3.0178(0.0506)*	-2.9120(0.0604)*	-2.9651(0.0573)*

*p<0.05, #interaction, n=879,204

Table 16 presents the results of the multivariate analysis of smoking participation using GLMs by model specifications. The price was negatively and significantly associated with the number of cigarettes consumed per week among smokers. Among smokers, being male, younger, having fewer years of education completed, and living in rural were factors associated with heavier smoking. Smokers who have health problems tend to smoke fewer cigarettes per week than their counterparts. Geographical regions, wealth quintiles, and marital status were significant drivers of smoking intensity among smokers.

Table 16. Model of smoking intensity among adults aged 35-44, coefficient(SE)

Independent Variables	Model 1	Model 2	Model 3
Price	-0.0003(0.00001)*	-0.0004(0.00001)*	-0.0003(0.00002)*
Sex			
Female	Ref.	Ref.	Ref.
Male	0.3577(0.0111)*	0.3584(0.0111)*	0.3584(0.0111)*
Age	-0.0016(0.0004)*	-0.0016(0.0004)*	-0.0016(0.0004)*
Health problem			
No	Ref.	Ref.	Ref.
Yes	-0.0291(0.0027)*	-0.0286(0.0027)*	-0.0292(0.0027)*
Education	-0.0073(0.0003)*	-0.0069(0.0003)*	-0.0073(0.0003)*
Working status			
No	Ref.	Ref.	Ref.
Yes	0.0763(0.0067)*	0.0750(0.0067)*	0.0759(0.0067)*
Marital Status			
Never married	Ref.	Ref.	Ref.
Married	0.1266(0.0047)*	0.1251(0.0047)*	0.1268(0.0047)*
Divorced/Widowed	0.0570(0.0073)*	0.0545(0.0073)*	0.0571(0.0073)*

Independent Variables	Model 1	Model 2	Model 3
Wealth quintiles			
Poorest	Ref.	Ref.	Ref.
Poorer	0.1827(0.0035)*	0.1825(0.0035)*	0.1832(0.0035)*
Middle	0.2762(0.0036)*	0.2775(0.0036)*	0.2769(0.0036)*
Richer	0.3668(0.0037)*	0.3688(0.0037)*	0.3670(0.0037)*
Richest	0.4867(0.0042)*	0.4896(0.0042)*	0.4875(0.0042)*
Type of Residence			
Rural	Ref.	Ref.	Ref.
Urban	-0.0346(0.0027)*	-0.0232(0.0026)*	-0.0346(0.0026)*
Region			
Sumatera	Ref.	Ref.	Ref.
Java & Bali	-0.2668(0.0029)*	-0.3430(0.0174)*	-0.2657(0.0029)*
Central	-0.0410(0.0028)*	0.1357(0.0168)*	-0.0408(0.0028)*
Eastern	-0.2783(0.0057)*	-0.6770(0.0217)*	-0.2754(0.0056)*
Year of survey			
2015	Ref.	Ref.	Ref.
2016	0.0848(0.0037)*	0.0940(0.0037)*	-0.0167(0.0230)
2017	0.0680(0.0035)*	0.0755(0.0035)*	0.0783(0.0195)*
2019	0.1025(0.0037)*	0.1114(0.0036)*	0.1484(0.0198)*
2020	0.0872(0.0036)*	0.0978(0.0036)*	0.1252(0.0208)*

Independent Variables	Model 1	Model 2	Model 3
Region#Price			
Sumatera		Ref.	Ref.
Java & Bali		0.0001(0.00002)*	
Central		-0.0002(0.00002)*	
Eastern		0.0003(0.00002)*	
Year#Price			
2015			Ref.
2016			0.0001(0.00002)*
2017			-0.00001(0.00002)
2019			-0.00004(0.00002)*
2020			-0.00004(0.00002)
Constant	4.2180(0.0216)*	4.0232(0.0026)*	4.2206(0.0251)*

*p<0.05, #interaction, n=301,433

4.1.6. Demand for Cigarettes among Adults Aged 45-54

Table 17 shows that price was negatively associated with smoking participation among adults aged 45-54 in all model specifications, and the results were statistically significant. Sex, age, health problems, working status, marital status, wealth quintiles, type of residence, region, and year of the survey were significantly associated with the chance of being current smokers. In addition, the interaction terms between price and years in model 3 and price and geographical region in model 2 were statistically significant, implying that the consumption price was different across regions and years of the survey.

Table 17. Model of smoking participation among adults aged 45-54, coefficient(SE)

Independent Variables	Model 1	Model 2	Model 3
Price	-0.0001(0.00002)*	-0.0003(0.00004)*	-0.0003(0.00004)*
Sex			
Female	Ref.	Ref.	Ref.
Male	4.6175(0.0135)*	4.6180(0.0135)*	4.6182(0.0135)*
Age	-0.0248(0.0012)*	-0.0248(0.0012)*	-0.0248(0.0012)*
Health problem			
No	Ref.	Ref.	Ref.
Yes	-0.0815(0.0073)*	-0.0813(0.0073)*	-0.0811(0.0073)*
Education	-0.0805(0.0009)*	-0.0805(0.0009)*	-0.0806(0.0009)*
Working status			
No	Ref.	Ref.	Ref.
Yes	0.4480(0.0139)*	0.4486(0.0139)*	0.4486(0.0139)*
Marital Status			
Never married	Ref.	Ref.	Ref.
Married	0.2510(0.0213)*	0.2501(0.0213)*	0.2502(0.0213)*
Divorced/Widowed	0.5056(0.0264)*	0.5058(0.0264)*	0.5043(0.0264)*

Independent Variables	Model 1	Model 2	Model 3
Wealth quintiles			
Poorest	Ref.	Ref.	Ref.
Poorer	0.2613(0.0110)*	0.2592(0.0110)*	0.2603(0.0110)*
Middle	0.3341(0.0110)*	0.3309(0.0110)*	0.3319(0.0110)*
Richer	0.3698(0.0111)*	0.3660(0.0111)*	0.3682(0.0111)*
Richest	0.2328(0.0118)*	0.2257(0.0118)*	0.2291(0.0118)*
Type of Residence			
Rural	Ref.	Ref.	Ref.
Urban	-0.1550(0.0075)*	-0.1543(0.0076)*	-0.1556(0.0075)*
Region			
Sumatera	Ref.	Ref.	Ref.
Java & Bali	-0.1725(0.0087)*	-0.5874(0.0501)*	-0.1766(0.0087)*
Central	-0.2554(0.0093)*	-0.6427(0.0542)*	-0.2553(0.0093)*
Eastern	-0.2374(0.0140)*	-0.4225(0.0555)*	-0.2518(0.0142)*
Year of survey			
2015	Ref.	Ref.	Ref.
2016	-0.1023(0.0112)*	-0.1033(0.0112)*	-0.1871(0.0477)*
2017	-0.0450(0.0110)*	-0.0472(0.0111)*	-0.2666(0.0537)*
2019	-0.0386(0.0109)*	-0.0431(0.0110)*	-0.4448(0.0501)*
2020	-0.0557(0.0109)*	-0.0596(0.0110)*	-0.3570(0.0492)*

Independent Variables	Model 1	Model 2	Model 3
Region#Price			
Sumatera		Ref.	
Java & Bali		0.0004(0.00005)*	
Central		0.0004(0.0001)*	
Eastern		0.0002(0.00005)*	
Year#Price			Ref.
2015			-0.1871(0.0477)*
2016			-0.2666(0.0537)*
2017			-0.4448(0.0501)*
2019			-0.3570(0.0492)*
2020			-0.1871(0.0477)*
Constant	-2.7394(0.0658)*	-2.4784(0.0746)*	-2.5495(0.0735)*

*p<0.05, #interaction, n=734,591

Table 18 presents the smoking intensity model among adults aged 45-54. Price was negatively associated with smoking intensity among smokers. Sex was positively associated with the number of cigarettes smoked in a week. Among smokers, males smoked more cigarettes than females, and the results were statistically significant. Age and education negatively correlated with heavier smoking. Other variables such as health problems, working status, marital status, wealth quintiles, type of residence, and geographical regions were significant factors of smoking intensity among smokers.

Table 18. Model of smoking intensity among adults aged 45-54, coefficient(SE)

Independent Variables	Model 1	Model 2	Model 3
Price	-0.0003(0.00001)*	-0.0004(0.00001)*	-0.0003(0.00002)*
Sex			
Female	Ref.	Ref.	Ref.
Male	0.3297(0.0099)*	0.3314(0.0099)*	0.3302(0.0099)*
Age	-0.0076(0.0005)*	-0.0074(0.0005)*	-0.0076(0.0005)*
Health problem			
No	Ref.	Ref.	Ref.
Yes	-0.0357(0.0029)*	-0.0350(0.0029)*	-0.0358(0.0029)*
Education	-0.0058(0.0004)*	-0.0056(0.0004)*	-0.0058(0.0004)*
Working status			
No	Ref.	Ref.	Ref.
Yes	0.0827(0.0070)*	0.0818(0.0070)*	0.0822(0.0070)*
Marital Status			
Never married	Ref.	Ref.	Ref.
Married	0.1315(0.0092)*	0.1300(0.0092)*	0.1315(0.0092)*
Divorced/Widowed	0.0600(0.0109)*	0.0577(0.0108)*	0.0601(0.0108)*

Independent Variables	Model 1	Model 2	Model 3
Wealth quintiles			
Poorest	Ref.	Ref.	Ref.
Poorer	0.1757(0.0044)*	0.1746(0.0044)*	0.1761(0.0044)*
Middle	0.2658(0.0043)*	0.2656(0.0043)*	0.2665(0.0043)*
Richer	0.3613(0.0044)*	0.3616(0.0044)*	0.3615(0.0044)*
Richest	0.4987(0.0048)*	0.5000(0.0048)*	0.4995(0.0048)*
Type of Residence			
Rural	Ref.	Ref.	Ref.
Urban	-0.0262(0.0030)*	-0.0163(0.0030)*	-0.0265(0.0030)*
Region			
Sumatera	Ref.	Ref.	Ref.
Java & Bali	-0.2680(0.0033)*	-0.3669(0.0195)*	-0.2663(0.0033)*
Central	-0.0301(0.0033)*	0.1718(0.0198)*	-0.0296(0.0033)*
Eastern	-0.2555(0.0066)*	-0.6806(0.0266)*	-0.2518(0.0065)*
Year of survey			
2015	Ref.	Ref.	Ref.
2016	0.0817(0.0043)*	0.0889(0.0042)*	-0.0375(0.0268)
2017	0.0586(0.0040)*	0.0641(0.0040)*	0.0521(0.0235)*
2019	0.0910(0.0043)*	0.0974(0.0042)*	0.1715(0.0240)*
2020	0.0799(0.0042)*	0.0881(0.0041)*	0.1540(0.0234)*

Independent Variables	Model 1	Model 2	Model 3
Region#Price			
Sumatera		Ref.	
Java & Bali		0.0001(0.00002)*	
Central		-0.0002(0.00002)*	
Eastern		0.0003(0.00002)*	
Year#Price			
2015			Ref.
2016			0.0001(0.00003)*
2017			0.00001(0.00002)
2019			-0.0001(0.00003)*
2020			-0.0001(0.00002)*
Constant	4.5092(0.0284)*	4.5742(0.0303)*	4.5031(0.0326)*

*p<0.05, #interaction, n=235,718

4.1.7. Demand for Cigarettes among Adults Aged 55-64

Table 19 presents the smoking participation model of adults aged 55-64. Price was inversely associated with the decision to smoke. If the individuals belong to the poorer, middle, richer, and richest households, then he(she) was more likely to smoke than those from the poorest household. Participants with more years of education completed were less likely to smoke cigarettes. Age had a negative correlation with the chance of smoking. Those living in urban areas were negatively associated with smoking participation, and the results were statistically significant. Other independent

variables such as sex, health problem, working status, marital status, and region were statistically significant in determining current smoking status in all specifications.

Table 19. Model of smoking participation among adults aged 55-64, coefficient(SE)

Independent Variables	Model 1	Model 2	Model 3
Price	-0.0001(0.00002)*	-0.0004(0.00005)*	-0.0004(0.00005)*
Sex			
Female	Ref.	Ref.	Ref.
Male	4.0752(0.0150)*	4.0754(0.0150)*	4.0760(0.0150)*
Age	-0.0348(0.0015)*	-0.0348(0.0015)*	-0.0348(0.0015)*
Health problem			
No	Ref.	Ref.	Ref.
Yes	-0.1414(0.0083)*	-0.1413(0.0083)*	-0.1412(0.0083)*
Education	-0.0675(0.0011)*	-0.0674(0.0011)*	-0.0676(0.0011)*
Working status			
No	Ref.	Ref.	Ref.
Yes	0.6014(0.0111)*	0.6015(0.0111)*	0.6019(0.0111)*
Marital Status			
Never married	Ref.	Ref.	Ref.
Married	0.2908(0.0339)*	0.2892(0.0339)*	0.2903(0.0338)*
Divorced/Widowed	0.3900(0.0361)*	0.3897(0.0361)*	0.3891(0.0360)*

Independent Variables	Model 1	Model 2	Model 3
Wealth quintiles			
Poorest	Ref.	Ref.	Ref.
Poorer	0.2183(0.0130)*	0.2158(0.0130)*	0.2178(0.0130)*
Middle	0.3134(0.0131)*	0.3106(0.0131)*	0.3121(0.0131)*
Richer	0.3471(0.0132)*	0.3435(0.0133)*	0.3467(0.0133)*
Richest	0.1963(0.0143)*	0.1908(0.0143)*	0.1940(0.0143)*
Type of Residence			
Rural	Ref.	Ref.	Ref.
Urban	-0.1923(0.0091)*	-0.1895(0.0092)*	-0.1910(0.0091)*
Region			
Sumatera	Ref.	Ref.	Ref.
Java & Bali	-0.0900(0.0103)*	-0.4655(0.0597)*	-0.0938(0.0103)*
Central	-0.2231(0.0115)*	-0.7369(0.0663)*	-0.2245(0.0115)*
Eastern	-0.2713(0.0171)*	-0.5606(0.0676)*	-0.2831(0.0172)*
Year of survey			
2015	Ref.	Ref.	Ref.
2016	-0.1401(0.0135)*	-0.1396(0.0135)*	-0.3555(0.0587)*
2017	-0.1020(0.0133)*	-0.1023(0.0133)*	-0.3192(0.0660)*
2019	-0.1017(0.0132)*	-0.1040(0.0132)*	-0.6094(0.0619)*
2020	-0.1232(0.0131)*	-0.1238(0.0132)*	-0.5257(0.0598)*

Independent Variables	Model 1	Model 2	Model 3
Region#Price			
Sumatera		Ref.	
Java & Bali		0.0004(0.0001)*	
Central		0.0005(0.0001)*	
Eastern		0.0003(0.0001)*	
Year#Price			Ref.
2015			0.0002(0.0001)*
2016			0.0002(0.0001)*
2017			0.0005(0.0001)*
2019			0.0004(0.0001)*
2020			0.0002(0.0001)*
Constant	-1.8517(0.0957)*	-1.5434(0.1051)*	-1.5766(0.1040)*

*p<0.05, #interaction, n=482,004

From the smoking intensity model, as shown in table 20, the price was negatively correlated with the quantity of smoked. The results were statistically significant. Sex was significantly associated with smoking intensity. Males tended to smoke more cigarettes per week than females. Those with health problems were more likely to smoke a higher quantity, and the results were statistically significant. Age and education inversely correlated with the number of cigarettes smoked among smokers, and the results were statistically significant. Working status, marital status, wealth quintiles, type of residence, and geographical region were significant covariates in all specifications.

Table 20. Model of smoking intensity among adults aged 55-64, coefficient(SE)

Independent Variables	Model 1	Model 2	Model 3
Price	-0.0004(0.00001)*	-0.0004(0.00002)*	-0.0003(0.00003)*
Sex			
Female	Ref.	Ref.	
Male	0.2904(0.0109)*	0.2912(0.0109)*	0.2904(0.0109)*
Age	-0.0091(0.0006)*	-0.0090(0.0006)*	-0.0090(0.0006)*
Health problem			
No	Ref.	Ref.	Ref.
Yes	-0.0485(0.0036)*	-0.0472(0.0036)*	-0.0486(0.0036)*
Education	-0.0061(0.0005)*	-0.0060(0.0005)*	-0.0061(0.0005)*
Working status			
No	Ref.	Ref.	Ref.
Yes	0.0910(0.0060)*	0.0902(0.0060)*	0.0907(0.0060)*
Marital Status			
Never married	Ref.	Ref.	Ref.
Married	0.1405(0.0178)*	0.1384(0.0178)*	0.1402(0.0178)*
Divorced/Widowed	0.0728(0.0187)*	0.0686(0.0186)*	0.0726(0.0187)*

Independent Variables	Model 1	Model 2	Model 3
Wealth quintiles			
Poorest	Ref.	Ref.	Ref.
Poorer	0.1676(0.0060)*	0.1662(0.0060)*	0.1681(0.0060)*
Middle	0.2647(0.0059)*	0.2642(0.0059)*	0.2653(0.0059)*
Richer	0.3648(0.0060)*	0.3651(0.0060)*	0.3647(0.0060)*
Richest	0.4940(0.0066)*	0.4958(0.0066)*	0.4944(0.0066)*
Type of Residence			
Rural	Ref.	Ref.	Ref.
Urban	-0.0088(0.0041)*	-0.0009(0.0041)	-0.0100(0.0041)*
Region			
Sumatera	Ref.	Ref.	Ref.
Java & Bali	-0.2572(0.0043)*	-0.2913(0.0264)*	-0.2555(0.0043)*
Central	-0.0283(0.0045)*	0.2359(0.0272)*	-0.0277(0.0045)*
Eastern	-0.2421(0.0090)*	-0.6762(0.0363)*	-0.2392(0.0090)*
Year of survey			
2015	Ref.	Ref.	Ref.
2016	0.0818(0.0057)*	0.0886(0.0057)*	-0.0220(0.0365)
2017	0.0673(0.0054)*	0.0724(0.0054)*	0.1147(0.0336)*
2019	0.0997(0.0057)*	0.1052(0.0057)*	0.1975(0.0334)*
2020	0.0903(0.0056)*	0.0966(0.0056)*	0.1995(0.0317)*

Independent Variables	Model 1	Model 2	Model 3
Region#Price			
Sumatera		Ref.	
Java & Bali		0.00003(0.00003)*	
Central		-0.0003(0.00003)	
Eastern		0.0003(0.00003)*	
Year#Price			Ref.
2015			0.0001(0.00004)*
2016			-0.0001(0.00004)*
2017			-0.0001(0.00004)
2019			-0.0001(0.00003)*
2020			0.0001(0.00004)*
Constant	4.6524 (0.0442)*	4.6746(0.0467)*	4.6153(0.0501)*

*p<0.05, #interaction, n=142,067

4.1.8. Demand for Cigarettes among the Elderly

Table 21 lists results for the logit model of smoking participation among the subsample of the elderly. The results indicated that higher price was negatively and significantly associated with smoking participation. Males were more likely to smoke than females. The decision to smoke was also influenced by age and education. Those with health problems were less likely to consume cigarettes. Other variables such as working status, marital status, wealth quintiles, type of residence, region, and year were significantly associated with smoking participation.

Table 21. Model of smoking participation among the elderly, coefficient(SE)

Independent Variables	Model 1	Model 2	Model 3
Price	-0.0002(0.00003)*	-0.0007(0.0001)*	-0.0006(0.0001)*
Sex			
Female	Ref.	Ref.	Ref.
Male	3.4993(0.0186)*	3.4995(0.0186)*	3.5007(0.0186)*
Age	-0.0264(0.0009)*	-0.0264(0.0009)*	-0.0264(0.0009)*
Health problem			
No	Ref.	Ref.	Ref.
Yes	-0.1427(0.0105)*	-0.1412(0.0105)*	-0.1424(0.0105)*
Education	-0.0661(0.0015)*	-0.0657(0.0015)*	-0.0662(0.0015)*
Working status			
No	Ref.	Ref.	Ref.
Yes	0.7991(0.0115)*	0.7979(0.0115)*	0.7999(0.0115)*
Marital Status			
Never married	Ref.	Ref.	Ref.
Married	0.2463(0.0545)*	0.2421(0.0546)*	0.2435(0.0545)*
Divorced/Widowed	0.2567(0.0551)*	0.2516(0.0552)*	0.2538(0.0551)*

Independent Variables	Model 1	Model 2	Model 3
Wealth quintiles			
Poorest	Ref.	Ref.	Ref.
Poorer	0.1411(0.0151)*	0.1402(0.0151)*	0.1408(0.0151)*
Middle	0.2233(0.0158)*	0.2244(0.0158)*	0.2219(0.0158)*
Richer	0.2663(0.0167)*	0.2694(0.0167)*	0.2654(0.0167)*
Richest	0.0732(0.0192)*	0.0790(0.0192)*	0.0705(0.0192)*
Type of Residence			
Rural	Ref.	Ref.	Ref.
Urban	-0.2471(0.0120)*	-0.2327(0.0121)*	-0.2464(0.0120)*
Region			
Sumatera	Ref.	Ref.	Ref.
Java & Bali	0.0718(0.0134)*	-0.3378(0.0785)*	0.0685(0.0134)*
Central	-0.1448(0.0152)*	-0.5554(0.0890)*	-0.1466(0.0153)*
Eastern	-0.2964(0.0223)*	-1.1939(0.0890)*	-0.3087(0.0225)*
Year of survey			
2015	Ref.	Ref.	Ref.
2016	-0.1479(0.0173)*	-0.1352(0.0173)*	-0.5504(0.0865)*
2017	-0.0920(0.0171)*	-0.0834(0.0171)*	-0.5141(0.0884)*
2019	-0.1134(0.0169)*	-0.1041(0.0169)*	-0.6336(0.0833)*
2020	-0.1261(0.0168)*	-0.1127(0.0168)*	-0.7476(0.0801)*

Independent Variables	Model 1	Model 2	Model 3
Region#Price			
Sumatera		Ref.	
Java & Bali		0.0004(0.0001)*	
Central		0.0004(0.0001)*	
Eastern		0.0008(0.0001)*	
Year#Price			Ref.
2015			0.0004(0.0001)*
2016			0.0005(0.0001)*
2017			0.0006(0.0001)*
2019			0.0007(0.0001)*
2020			0.0004(0.0001)*
Constant	-1.9249(0.0937)*	-1.4487(0.1109)*	-1.5227(0.1086)*

*p<0.05, #interaction, n=321,438

Table 22 outlines the smoking intensity model among the elderly. The price had a negative sign and was statistically significant, meaning that a higher price could reduce cigarette consumption among smokers. Age and education also were negatively and significantly associated with smoking intensity. Being male and married were more likely to smoke heavier cigarettes. The wealth quintiles positively and significantly correlated with the intensity of cigarettes used among smokers. Other variables such as health problems, working status, type of residence, and year were statistically significant in determining smoking intensity. Those who live in

urban consume fewer cigarettes than their counterparts. However, the results were not statistically significant.

Table 22. Model of smoking intensity among the elderly, coefficient(SE)

Independent Variables	Model 1	Model 2	Model 3
Price	-0.0003(0.00002)*	-0.0004(0.00003)*	-0.0003(0.00004)*
Sex			
Female	Ref.	Ref.	Ref.
Male	0.2234(0.0149)*	0.2261(0.0149)*	0.2237(0.0149)*
Age	-0.0089(0.0005)*	-0.0089(0.0005)*	-0.0089(0.0005)*
Health problem			
No	Ref.	Ref.	Ref.
Yes	-0.0588(0.0056)*	-0.0572(0.0056)*	-0.0588(0.0056)*
Education	-0.0064(0.0009)*	-0.0065(0.0009)*	-0.0064(0.0009)*
Working status			
No	Ref.	Ref.	Ref.
Yes	0.1126(0.0069)*	0.1119(0.0069)*	0.1124(0.0069)*
Marital Status			
Never married	Ref.	Ref.	Ref.
Married	0.1539(0.0306)*	0.1523(0.0305)*	0.1541(0.0306)*
Divorced/Widowed	0.0847(0.0310)*	0.0825(0.0309)*	0.0850(0.0310)*

Independent Variables	Model 1	Model 2	Model 3
Wealth quintiles			
Poorest	Ref.	Ref.	Ref.
Poorer	0.1652(0.0082)*	0.1639(0.0082)*	0.1652(0.0082)*
Middle	0.2680(0.0085)*	0.2687(0.0085)*	0.2685(0.0085)*
Richer	0.3474(0.0088)*	0.3496(0.0088)*	0.3474(0.0088)*
Richest	0.4941(0.0106)*	0.4991(0.0106)*	0.4943(0.0106)*
Type of Residence			
Rural	Ref.	Ref.	Ref.
Urban	-0.0067(0.0065)	0.0010(0.0065)	-0.0074(0.0065)
Region			
Sumatera	Ref.	Ref.	Ref.
Java & Bali	-0.2419(0.0070)*	-0.2949(0.0434)*	-0.2411(0.0070)*
Central	0.000004(0.0075)	0.2187(0.0446)*	0.0002(0.0075)
Eastern	-0.2788(0.0147)*	-0.8214(0.0498)*	-0.2770(0.0146)*
Year of survey			
2015	Ref.	Ref.	Ref.
2016	0.0739(0.0093)*	0.0820(0.0093)*	0.0603(0.0627)
2017	0.0542(0.0087)*	0.0599(0.0087)*	0.2715(0.0521)*
2019	0.1031(0.0091)*	0.1100(0.0091)*	0.1525(0.0523)*
2020	0.0819(0.0090)*	0.0894(0.0089)*	0.1655(0.0473)*

Independent Variables	Model 1	Model 2	Model 3
Region#Price			
Sumatera		Ref.	
Java & Bali		0.0001(0.00004)	
Central		-0.0002(0.00005)*	
Eastern		0.0004(0.00004)*	
Year#Price			
2015			Ref.
2016			0.00001(0.0001)
2017			-0.0002(0.0001)*
2019			-0.0001(0.0001)
2020			-0.0001(0.0001)
Constant	4.6634(0.0550)*	4.7254(0.0608)*	4.5977(0.0631)*

*p<0.05, #interaction, n=66,881

4.1.9. Cigarettes Price Elasticity

Table 23 summarizes the price elasticity by age group. The overall price elasticity was inelastic, as the price elasticity coefficient was less than -1. The current study revaled that the price elasticity coefficient was between -0.4277 to -0.4933. In subgroup analysis, the cigarettes price elasticity was inelastic in all age groups. The adults aged 45-54 years were least affected by price change with a price elasticity coefficient between -0.3498 to -0.4069. The study also found that the youth and elderly were more sensitive to the price change than other age groups. The cigarette price elasticity among youth was approximately -0.6649 to -0.7492, while the

coefficient in the elderly was -0.4631 to -0.6283. The results of the model fit evaluation are presented in the appendix.

Table 23. Cigarettes Price Elasticity

	Smoking Participations			**Smoking Intensity**			**Total**
	Coeff.	**Upper**	**Lower**	**Coeff.**	**Upper**	**Lower**	
All participants							
Model 1	-0.1162	-0.1269	-0.1054	-0.3162	-0.3253	-0.3070	-0.4324
Model 2	-0.1156	-0.1278	-0.1034	-0.3777	-0.3852	-0.3702	-0.4933
Model 3	-0.1084	-0.1197	-0.0971	-0.3193	-0.3278	-0.3108	-0.4277
Youth							
Model 1	-0.3075	-0.3419	-0.2731	-0.3574	-0.3829	-0.3318	-0.6649
Model 2	-0.3297	-0.3657	-0.2938	-0.4195	-0.4412	-0.3977	-0.7492
Model 3*	-0.3130	-0.3473	-0.2788	-0.3610	-0.3850	-0.3369	-0.6740
Adults (25-34)							
Model 1	-0.1772	-0.2017	-0.1527	-0.3172	-0.3350	-0.2994	-0.4944
Model 2*	-0.1878	-0.2143	-0.1613	-0.3897	-0.4046	-0.3748	-0.5775
Model 3	-0.1697	-0.1950	-0.1445	-0.3215	-0.3381	-0.3050	-0.4912
Adults (35-44)							
Model 1	-0.1263	-0.1475	-0.1051	-0.2984	-0.3169	-0.2800	-0.4247
Model 2	-0.0906	-0.1152	-0.0660	-0.3672	-0.3815	-0.3528	-0.4578
Model 3	-0.1161	-0.1381	-0.0941	-0.3026	-0.3196	-0.2856	-0.4187
Adults (45-54)							
Model 1	-0.0466	-0.0705	-0.0227	-0.3165	-0.3368	-0.2962	-0.3631
Model 2*	-0.0384	-0.0651	-0.0116	-0.3685	-0.3850	-0.3520	-0.4069
Model 3	-0.0297	-0.0548	-0.0046	-0.3201	-0.3387	-0.3016	-0.3498

	Smoking Participations			Smoking Intensity			Total
	Coeff.	**Upper**	**Lower**	**Coeff.**	**Upper**	**Lower**	
Adults (55-64)							
Model 1	-0.0636	-0.0934	-0.0337	-0.3541	-0.3791	-0.3291	-0.4177
Model 2*	-0.0709	-0.1042	-0.0375	-0.3927	-0.4151	-0.3703	-0.4636
Model 3	-0.0555	-0.0869	-0.0240	-0.3525	-0.3765	-0.3285	-0.4080
Elderly							
Model 1	-0.1376	-0.1847	-0.0905	-0.3332	-0.3736	-0.2928	-0.4708
Model 2*	-0.2479	-0.2959	-0.1998	-0.3804	-0.4164	-0.3444	-0.6283
Model 3	-0.1275	-0.1756	-0.0794	-0.3356	-0.3746	-0.2966	-0.4631

*****Pregibon's link test at p>0.05 (specification fit)

4.2. Phase II

4.2.1. Prices and Taxes Scenarios

Table 24. Tobacco taxes and prices scenarios

	Tobacco Excise Taxes Increased						
	0.0%	**12.5%**	**25%**	**50%**	**75%**	**100%**	**200%**
Prices	1,174.0	1,229.9	1,285.9	1,397.8	1,509.6	1,621.5	2,069.0
Excise tax tariff	447.5	503.5	559.4	671.3	783.1	895.0	1,342.5
% From prices	38.1%	40.9%	43.5%	48.0%	51.9%	55.2%	64.9%

Table 24 shows the excise taxes tariff and cigarettes prices based on different tax increased scenarios. The average excise taxes tariff was 447.5 rupiahs in 2020. The existing regulation required increasing the excise taxes to 504.5 rupiahs on average or 12.5% from the previous years. If the taxes tariff was increased to 50%,

100%, and 200% from the existing regulation, the price of cigarettes would be about 1,398, 1,622, and 2,069 rupiahs, respectively.

4.2.2. Cigarette Consumption at Base Scenario

Table 25 presents the total population, the estimated number of smokers, and the number of cigarettes smoked in a year. The number of current smokers was approximately 65.8 million, and they consumed about 306.8 billion cigarettes sticks in a year. About 4.8 million smokers were under 19 years old, and they smoked around 15 billion cigarettes sticks. The most prevalent smokers were from the age group 30-34, about 8 million smokers. This age group also smoked the highest number of cigarettes, with a cumulative consumption of more than 39 billion cigarettes in a year.

Table 25. The number of smokers and cigarette consumption at baseline

Age groups	Total population	Smoking prevalence	Number of smokers	Daily cigarette consumption	Annual cigarette consumption
10-14	22,195,880	2.1%	466,113	6.75	1,151,533,352
15-19	22,312,590	19.6%	4,373,268	9.26	14,821,703,755
20-24	22,682,370	33.2%	7,530,547	11.93	32,881,229,111
25-29	22,355,975	35.2%	7,869,303	12.90	37,154,128,128
30-34	21,904,549	36.7%	8,038,969	13.27	39,043,827,764
35-39	20,910,927	36.5%	7,632,488	13.71	38,298,758,017
40-44	19,943,111	35.8%	7,139,634	13.75	35,930,206,786
45-49	18,022,497	34.5%	6,217,761	13.78	31,359,155,593
50-54	15,746,392	33.2%	5,227,802	13.43	25,696,634,103
55-59	13,120,852	32.3%	4,238,035	13.04	20,226,616,298

Age groups	Total population	Smoking prevalence	Number of smokers	Daily cigarette consumption	Annual cigarette consumption
60-64	10,209,493	30.1%	3,073,057	12.43	13,980,505,843
65+	16,632,429	24.3%	4,041,680	11.02	16,301,389,774
Total	226,037,065		65,848,659		306,845,688,525

Source: BPS-Statistics Indonesia (2020) and Kemkes-MOH (2018)

4.2.3. Impact of Tobacco Excise Tax Increase on Smoking Participation

As seen in Table 26, the number of smokers was approximately 65.8 million. The number of smokers would decline to 65.3 million from 65.8 million if the government increased the tobacco excise tax by 12.5%. A total of 1 million smokers would stop smoking with the condition that the tobacco excise tax was elevated by 25% from the current tariff. Furthermore, the prevalence of smoking could fall to 28.2% from 29.1% in the case that the government raised the tobacco excise tax to 50% of the current rate. A more significant tax increase (100% and 200%) would reduce the number of smokers by 1.7% and 3.5%, respectively.

Table 26. The number of smokers by excise tax scenarios, million people

Age groups	Tobacco excise tax increase						
	0%	12.5%	25%	50%	75%	100%	200%
10-14	0.466	0.451	0.437	0.408	0.378	0.349	0.232
15-19	4.373	4.305	4.236	4.098	3.961	3.824	3.274
20-24	7.531	7.412	7.294	7.057	6.821	6.584	5.638
25-29	7.869	7.799	7.728	7.587	7.447	7.306	6.743
30-34	8.039	7.967	7.895	7.751	7.607	7.464	6.888

Age groups	Tobacco excise tax increase						
	0%	12.5%	25%	50%	75%	100%	200%
35-39	7.632	7.600	7.567	7.501	7.435	7.369	7.105
40-44	7.139	7.109	7.078	7.016	6.955	6.893	6.647
45-49	6.218	6.206	6.195	6.172	6.150	6.127	6.036
50-54	5.238	5.218	5.209	5.190	5.170	5.151	5.075
55-59	4.24	4.224	4.209	4.181	4.152	4.124	4.009
60-64	3.073	3.063	3.052	3.032	3.011	2.990	2.907
65+	4.042	3.994	3.946	3.851	3.755	3.660	3.278
Total	65.848	65.348	64.846	63.844	62.842	61.840	57.830
Prevalence (%)	29.1	28.9	28.7	28.2	27.8	27.4	25.6

4.2.4. Impact of Tobacco Excise Tax Increase on Smoking Intensity

Table 27. The number of cigarettes smoked in a year by excise tax scenarios, billion sticks

Age groups	Tobacco excise tax increase						
	0.0%	12.5%	25.0%	50.0%	75.0%	100.0%	200.0%
10-14	1.152	1.106	1.059	0.958	0.861	0.764	0.875
15-19	14.822	14.525	14.229	13.575	12.952	12.329	13.044
20-24	32.881	32.224	31.567	30.116	28.734	27.351	28.938
25-29	37.154	36.464	35.774	34.289	32.857	31.424	33.015
30-34	39.044	38.319	37.594	36.033	34.694	33.022	27.444
35-39	38.299	37.629	36.959	35.514	34.278	32.729	27.578
40-44	35.930	35.302	34.673	33.318	32.158	30.705	25.872

Age groups	Tobacco excise tax increase						
	0.0%	**12.5%**	**25.0%**	**50.0%**	**75.0%**	**100.0%**	**200.0%**
45-49	31.359	30.809	30.258	29.058	28.056	26.757	22.550
50-54	25.697	25.245	24.794	23.811	22.990	21.926	18.478
55-59	20.227	19.848	19.470	18.626	17.956	17.026	14.171
60-64	13.981	13.719	13.457	12.874	12.411	11.768	9.795
65+	16.301	16.006	15.710	15.008	14.529	13.714	11.574
Total	306.846	301.195	295.545	283.181	272.944	259.517	216.440

Table 27 presents the number of cigarettes consumed a year by remaining smokers by excise tax increase scenarios. The total annual cigarettes consumption in the baseline scenario was 306 billion sticks. A 12.5% and 25% increase in tobacco excise tax would reduce annual cigarettes consumption between 301 to 295 billion sticks. The annual consumption among youth would decrease by about 23 million sticks if the tax was raised by 755%. Raising the tobacco excise tax by 75% would reduce cigarettes smoked to 272 billion sticks. In addition, a 100-200% tobacco excise tax increase would decrease cigarettes consumption by 47 to 90 billion sticks.

4.2.5. Impact of Tobacco Excise Tax Increase on Tobacco-Attributed Mortality

Table 28 presents the tobacco attributed mortalities in Indonesia based on the tobacco excise tax increase scenarios. In the current situation, the expected number of the tobacco attributed mortalities was approximately 32,924,330. A 50% increase in tobacco excise tax would lead to a reduction in mortality by 0.8 million. About 5% of tobacco attributed mortality would be averted if the government increased the tobacco excise tax by 100% from the current base tariff.

Table 28. Tobacco attributed mortalities by excise tax scenarios

	Tobacco excise tax increase						
	0%	**12.5%**	**25%**	**50%**	**75%**	**100%**	**200%**
Mortality, million	32.924	32.716	32.507	32.090	31.673	31.256	29.589
Mortality averted	0.000	0.208	0.417	0.834	1.251	1.668	3.336
Mortality averted (%)	0.0%	0.6%	1.3%	2.6%	3.8%	5.1%	10.1%

4.2.6. Impact of Tobacco Excise Tax Increase on Life-Years Gained

Table 29 shows the additional life-years gained from the tobacco excise tax increase. A 25% tobacco excise tax increase would generate 8 million life-years. Raising the tobacco excise tax by 50% would produce additional life-years by 25 million. Increasing tobacco excise tax by 75% and 100% would generate life-years gained by 25 and 33 million, respectively. In addition, a 200% increase in tobacco excise tax would produce additional life-years by 67 million. Most of these benefits were derived from the working-age groups.

Table 29. Total life-years gained by tobacco tax increase scenarios, million years

Age	**Tobacco Excise Taxes Increased**					
groups	**12.5%**	**25%**	**50%**	**75%**	**100%**	**200%**
10-14	0.146	0.293	0.586	0.879	1.172	2.343
15-19	0.687	1.374	2.748	4.122	5.496	10.992
20-24	1.183	2.366	4.732	7.098	9.464	18.928
25-29	0.704	1.408	2.817	4.225	5.633	11.266
30-34	0.719	1.439	2.877	4.316	5.755	11.509
35-39	0.297	0.593	1.186	1.779	2.372	4.745

Age groups	Tobacco Excise Taxes Increased					
	12.5%	25%	50%	75%	100%	200%
40-44	0.277	0.555	1.110	1.664	2.219	4.438
45-49	0.068	0.137	0.273	0.410	0.546	1.092
50-54	0.057	0.115	0.230	0.344	0.459	0.918
55-59	0.043	0.086	0.172	0.258	0.344	0.687
60-64	0.031	0.062	0.125	0.187	0.249	0.498
65+	0.036	0.072	0.143	0.215	0.286	0.573
Total	4.249	8.499	16.998	25.496	33.995	67.990

4.2.7. Impact of Tobacco Excise Tax Increase on Tobacco-Attributed Medical Treatment Cost

Table 30. Tobacco-related diseases treatment costs by excise tax scenarios, trillion rupiahs

Disease	Tobacco excise tax increase						
	0%	12.5%	25%	50%	75%	100%	200%
Heart disease	53.317	52.979	52.641	51.966	51.291	50.616	47.915
Stroke	41.541	41.278	41.015	40.489	39.963	39.437	37.332
Atrial fibrillation	0.295	0.293	0.291	0.288	0.284	0.280	0.265
Aortic Aneurysm	1.535	1.526	1.516	1.496	1.477	1.458	1.380
Diabetes mellitus	8.535	8.481	8.427	8.319	8.211	8.103	7.671
COPD	22.228	22.088	21.947	21.665	21.384	21.102	19.976
Asthma	2.067	2.054	2.041	2.015	1.989	1.963	1.858
Alzheimer	4.156	4.130	4.104	4.051	3.999	3.946	3.735
Gallbladder	0.255	0.253	0.251	0.248	0.245	0.242	0.229

Disease	Tobacco excise tax increase						
	0%	12.5%	25%	50%	75%	100%	200%
Upper digestive diseases	0.113	0.112	0.112	0.110	0.109	0.107	0.102
Lung cancer	42.626	42.356	42.086	41.546	41.006	40.467	38.307
Colorectal cancer	7.364	7.317	7.271	7.177	7.084	6.991	6.618
Stomach cancer	3.752	3.728	3.704	3.657	3.609	3.562	3.372
Liver cancer	0.841	0.836	0.830	0.820	0.809	0.798	0.756
Esophageal cancer	1.886	1.874	1.862	1.838	1.815	1.791	1.695
Kidney cancer	0.301	0.299	0.297	0.294	0.290	0.286	0.271
Bladder cancer	1.588	1.578	1.568	1.548	1.528	1.508	1.427
Pancreatic cancer	4.289	4.262	4.234	4.180	4.126	4.071	3.854
Leukemia	2.375	2.360	2.345	2.315	2.285	2.254	2.134
Lip cancer	2.036	2.023	2.010	1.984	1.959	1.933	1.830
Nasopharynx cancer	0.824	0.819	0.813	0.803	0.793	0.782	0.740
Larynx cancer	2.419	2.403	2.388	2.357	2.327	2.296	2.174
Prostate cancer	0.770	0.765	0.760	0.750	0.741	0.731	0.692
Breast cancer	0.231	0.230	0.228	0.225	0.222	0.219	0.208
Cervical cancer	0.474	0.471	0.468	0.462	0.456	0.450	0.426
Lower Respiratory Inf,	4.844	4.813	4.782	4.721	4.660	4.598	4.353
Tuberculosis	13.130	13.047	12.964	12.797	12.631	12.465	11.800
Total	223.792	222.375	220.958	218.124	215.290	212.456	201.119

Table 30 presents the medical treatment cost of tobacco-related diseases. The total cost of tobacco-related diseases was approximately 224 trillion rupiahs in the current situation. The cost would be reduced by between 1 to 2 trillion rupiahs if the government raised the tobacco tax from around 12.5% to 25%. A 50% and 75%

increase in tobacco excise tax would reduce medical treatment costs to approximately 218 and 2015 trillion rupiahs. If the government was doubled or tripled the cigarette excise tax, the medical treatment cost would significantly decrease between 12-23 trillion rupiahs.

4.2.8. Impact of Tobacco Excise Tax Increase on Government Revenue

Table 31. Government revenue by excise tax increase scenarios, trillion rupiahs

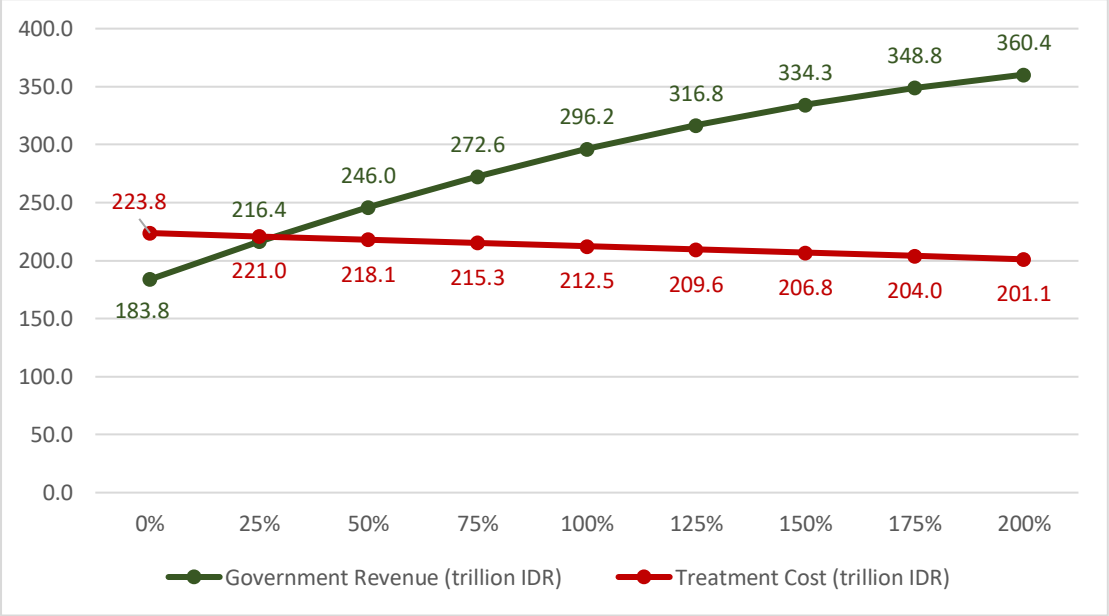
Tobacco Taxes	**Tobacco excise tax increase**						
Revenue	**0%**	**12.5%**	**25%**	**50%**	**75%**	**100%**	**200%**
Excise taxes	137.313	151.633	165.320	190.086	213.749	232.268	290.571
VAT	32.782	33.711	34.583	36.019	37.496	38.293	40.751
Local taxes	13.731	15.163	16.532	19.009	21.375	23.227	29.057
Total	183.826	200.507	216.436	245.113	272.620	293.788	360.379

Table 31 presents the government revenue from excise, value-added, and local tobacco tax. More than 75% of tobacco tax revenue was from excise tax. The estimated government revenue from tobacco tax was approximately 183 trillion rupiahs in the current situation. A 12.5% and 25% increase in tobacco excise tax would elevate the government revenue to 200 and 2016 trillion rupiahs. Raising the tobacco excise tax by 50% and 75% could generate an additional 62 and 89 million in government revenue. In addition, a substantial increase in tobacco excise tax by around 100-200% would produce additional revenue between 110 to 177 trillion rupiahs.

4.2.9. Optimal Tobacco Excise Tax Increase Option

Figure 12 shows a curve comparing government revenue from tobacco tax and annual medical treatment costs of tobacco-related diseases. The curves intersected at the point around 30% of the tobacco excise tax. This intersection point meant that the government revenue generating from the tobacco taxes had outweighed the annual medical treatment costs of tobacco related diseases. Thus, a minimum tobacco excise tax increase was at least 30%.

Figure 12. Proposed minimum tobacco excise tax increase



4.2.10. Sensitivity Analysis

Figure 13. Sensitivity analysis of smoking participation

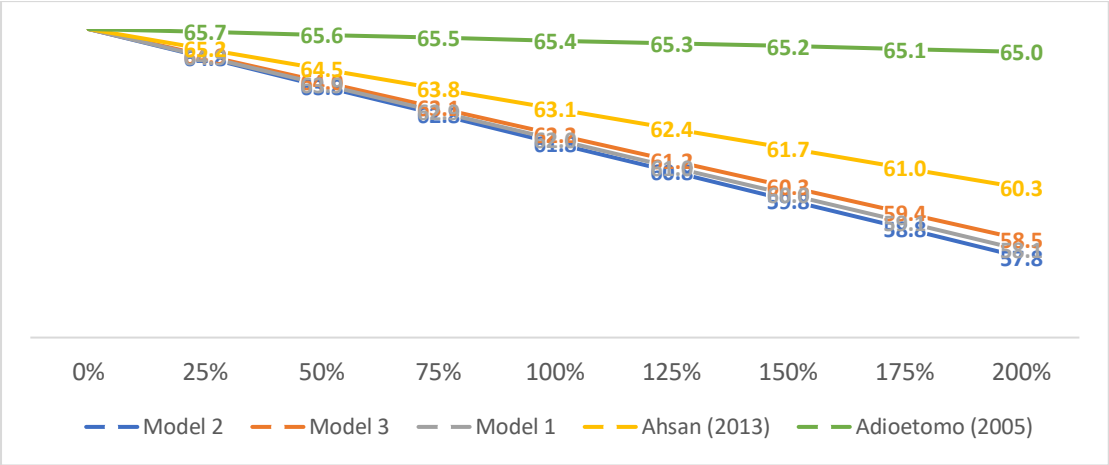


Figure 13 presents the results of the univariate sensitivity analysis of smoking participation and smoking intensity using a different price elasticity coefficient from model specifications 1 and 3 as well as previous demand studies. Model 1-3 and Ahsan (2013) generated similar results in smoking participation. The model using price elasticity coefficient from Adioetomo (2005) generated a different result with other models and yielded the most conservative results.

Figure 14. Sensitivity analysis of smoking intensity

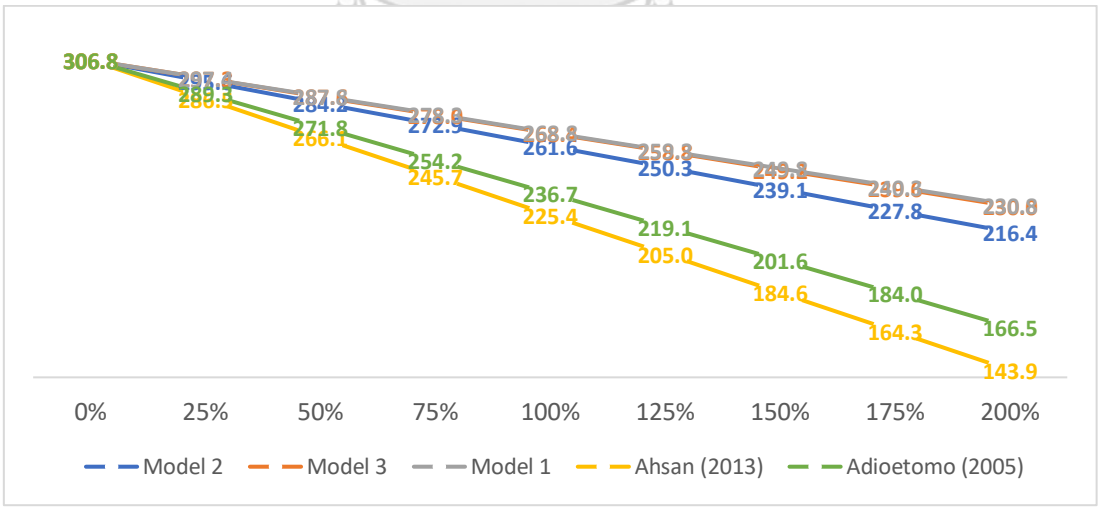


Figure 14 shows the sensitivity analysis of smoking intensity. It showed that the cumulative difference of smoking intensity between model 1-3 was less than 1%.

The results using the elasticity coefficient from Ahsan (2013) and Adioetomo (2005) produced more conservative results compared to the model 1-3.

Figure 15. Sensitivity analysis of tobacco attributed mortality

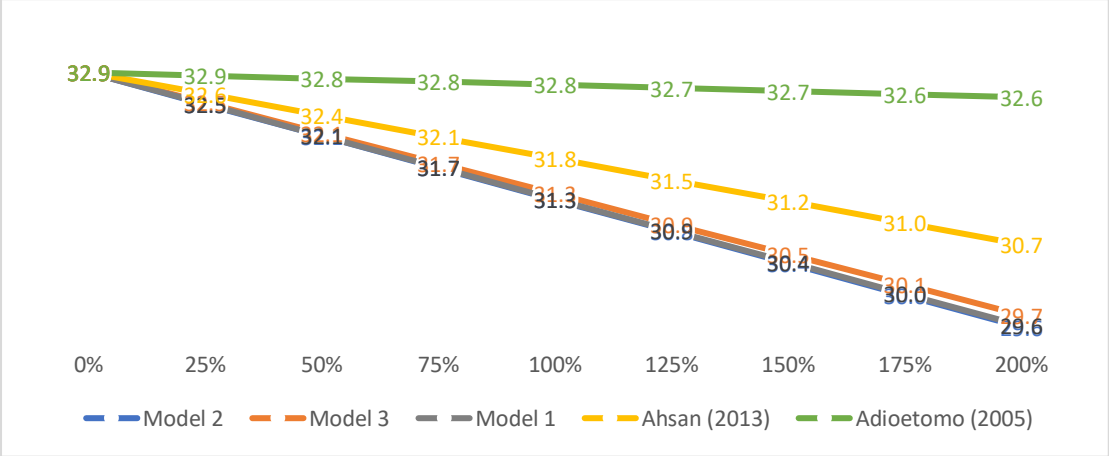


Figure 15 and 16 shows the sensitivity analysis of tobacco attributed mortality and medical treatment costs. The most conservative result was generated from the Adieotomo (2005), while the most significant result was obtained from the model 2 and 1.

Figure 16. Sensitivity analysis of tobacco-attributed medical treatment cost

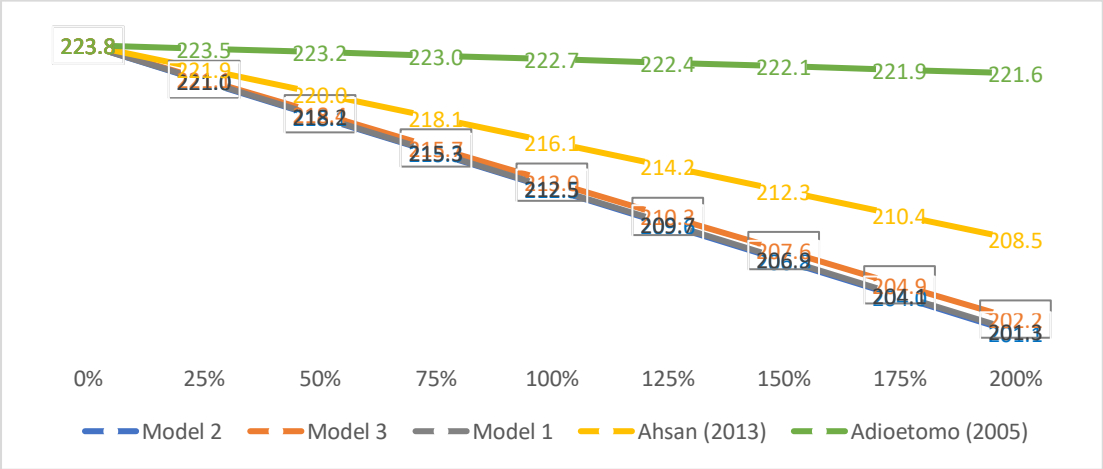


Figure 17 and 18 present the sensitivity analysis of life-years gained and the government revenue in different tobacco excise tax increase scenarios. The life-years gained generating from the models 1-3 were substantially higher than from the

Adioetomo (2005). Moreover, the government revenue reached the peak at the tobacco excise tax increase rate of 100% In the Ahsan (2013) and Adioetomo (2005) model. The government revenue in model 1-3 did not reached the peak yet in the tobacco excise tax increase scenarios 0% to 200%.

Figure 17. Sensitivity analysis of life-years gained

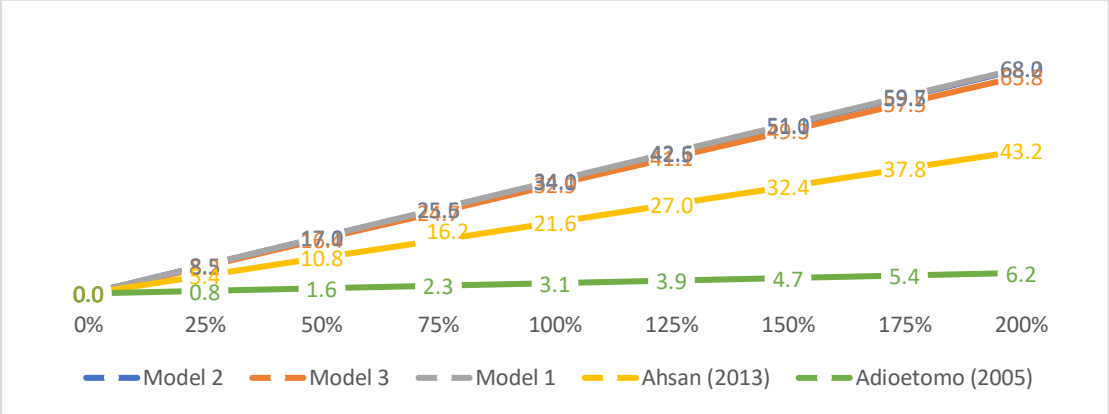
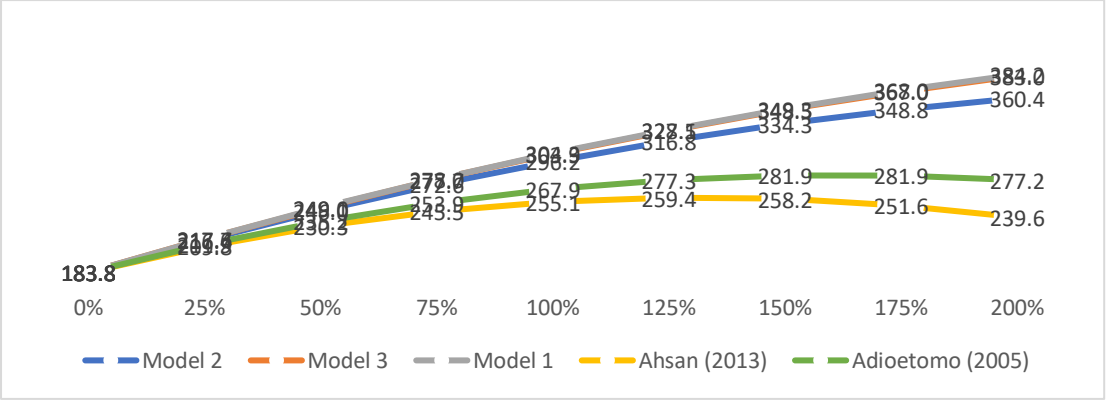


Figure 18. Sensitivity analysis of government revenue



CHAPTER V DISCUSSIONS

5.1. Demand for Cigarettes

This study revealed that the total cigarette price elasticity was approximately between -0.4277 to -0.4933. This finding was similar to the previous studies that the cigarettes price elasticity was around -0.5 in the Low and Middle-Income Countries (LMICs) (NCI and WHO, 2016). In this study, the smoking participation elasticity coefficient was also the same as the prior study conducted by Ahsan et al. (2013), which found that the smoking participation was between -0.10897 and -0.11639 (Ahsan et al., 2013). However, the smoking intensity elasticity was substantially different (-0.4 vs. -0.7) from the study in 2013 (Ahsan et al., 2013). This result may partly relate to the mechanization of the tobacco industry and tobacco tax administration in Indonesia, which have an effect on the availability of cigarettes. The ministry of finance revealed that domestic cigarettes production has elevated from 317.8 in 2011 to 356.5 billion sticks in 2019 (Soerojo et al., 2020). The tobacco industry has shifted from labor-intensive to more efficient capital-intensive, which can be seen from the reduction of hand-made clove/kreteks cigarettes production (Soerojo et al., 2020). In contrast, machine-made clove cigarettes production increased at the same time (Soerojo et al., 2020). Moreover, the tobacco tax structure in Indonesia incentivizes machine-made clove cigarettes producers as they are subject to a lower excise tax tariff than white cigarettes (Ahsan et al., 2016). Thus, companies producing machine-made clove cigarettes can offer more competitive prices, leading

to the rising market share of machine-made clove cigarettes from 63.8% in 2011 to 76.3% in 2019 (Soerojo et al., 2020).

The study found that smoking participation was less elastic to the price change than smoking intensity among smokers. This finding was similar to the previous study in 2013 and 2005 (Ahsan et al., 2013, Adioetomo et al., 2005). Most prior studies using the two-part model revealed that smoking participation and smoking intensity had a similar price elasticity coefficient (IARC, 2011). Unlike in many parts of the world, Indonesian smokers were more likely to respond to the price change by reducing the number of cigarettes smoked rather than quitting smoking. The World Health Organization reported that less than half of Indonesian smokers had quit smoking intention in the next 12 months (WHO, 2019).

There are some reasons why Indonesian smokers are difficult to stop smoking. First, a tiered tax system creates large variability in cigarettes price in the market (Shang et al., 2015). Currently, there are eight tiers of cigarettes tax tariff based on the minimum retail prices, production volume, and product type, with the lowest excise tax tariff at 155 rupiahs and the highest at 1,065 rupiahs per stick (Kemenkeu-Ministry of Finance, 2021). The lowest retail price was at least 505 rupiahs, while the most expensive was no less than 2,005 rupiahs per stick (Kemenkeu-Ministry of Finance, 2021). If the price of a particular cigarette brand increased, the smokers would easily switch to a lower-priced brand.

Second, the cigarette price is getting cheaper in Indonesia because the increase in tobacco tax tariff is still below the income growth and inflation level (WHO, 2020). A study by Southeast Asia Tobacco Control Alliance (SEATCA) found that the Relative Income Price (RIP) of cigarettes in Indonesia was around 5 in the early

2000s (SEATCA, 2021). However, the RIP value decreased to 3.9 in 2019 (SEATCA, 2021). The lower the value of RIP, the more affordable the cigarette price is. Moreover, the cigarette price in Indonesia is still considerably lower than in neighboring countries. For instance, the most popular foreign cigarette brand price is approximately 1.63 USD per pack in Indonesia, 4.34 USD in Malaysia, 5.11 USD in Brunei, 10.6 USD in Singapore, and 2.11 USD in Myanmar (SEATCA, 2021).

Third, the regulation in Indonesia still allows smokers to buy cigarettes on a single stick (Soerojo et al., 2020). A study in Denpasar City found that a total of 67% of retailers sold cigarettes in single sticks (Astuti et al., 2019). Evidence has shown that the availability of single-stick cigarettes was negatively associated with a quitting attempt (Hall et al., 2015). Therefore, Indonesian smokers relatively have no stimulus to stop smoking.

5.1.1. Cigarette Price Elasticity Different Between Age Groups

This study found that the demand for cigarettes among youth was more elastic than in adults. These results are not surprising because youth usually need to spend a higher share of disposable income to buy cigarettes (NCI and WHO, 2016). Thus, they are more responsive to the price change than adult smokers. In addition, the duration of smoking is associated with the severity of nicotine tolerance (USDHHS, 2014). The majority of current adult smokers in Indonesia start smoking before the age of 19, and less than half of them have an intention to quit (Soerojo et al., 2020, WHO, 2019). This implied that youth smokers have a relatively shorter duration of smoking and maybe less addicted to cigarettes than adults' smokers. Therefore, they may be more sensitive to the price change than adults.

5.1.2. Cigarette Price Elasticity Different Between Gender

This study found that sex was significantly associated with smoking participation and smoking intensity among smokers at $p<0.001$. This result is consistent with Vatankhah *et al.* (2021), who found that the male sex was more likely to smoke cigarettes than females (Vatankhah et al., 2020). A massive difference in smoking behavior between sex may partly relate to the Indonesian culture. Smoking is viewed as a symbol of masculinity and is common among males (Ng et al., 2007). On the other hand, people stigmatize and judge women smokers negatively (Barraclough, 1999). If the non-smoking women were married to smokers, they would tolerate their husband's behavior to maintain the relationship harmony (Ayuningtyas et al., 2021). Moreover, women generally have less bargaining power in the household expenditure decision in Indonesia (Pangaribowo et al., 2019). Hence, women have more barriers to access to cigarettes than men.

5.1.3. Cigarette Price Elasticity Different Between Education Level

The present study found that education was inversely associated with the chance of smoking and the number of cigarette consumption per week among smokers. The finding is in agreement with previous studies in Singapore, China, Malaysia, and European Countries (Pang et al., 2016, Hu et al., 2019, Lim et al., 2016, Lugo et al., 2013). This finding should be interpreted with caution. Previous empirical studies examining the link between education and smoking showed that education might have more role in building advantages during childhood than operating in adulthood (Maralani, 2014). Non-cognitive skills such as optimism, self-esteem, self-control, and decision-making are nurtured by family during childhood, long before education is acquired (Maralani, 2014). Those skills are more decisive to

predict smoking status in adulthood (Maralani, 2014). Meanwhile, cognitive skills in adulthood were not significantly associated with smoking behavior (Maralani, 2014).

Nevertheless, a hypothesis argues that people with more education are more aware and well-informed about the health risk of smoking and are thus less likely to smoke. This hypothesis also gains some support from the previous literature (Hamad et al., 2018, Layte and Whelan, 2009). For instance, a meta-analysis showed that one year increase in educational attainment could independently reduce 1% of the probability of being current smokers (Hamad et al., 2018).

5.1.4. Cigarette Price Elasticity Different Between Economic Status

Another important finding is that higher economic status increased the likelihood of smoking participation and the number of cigarettes smoked among smokers. The result is not surprising because cigarettes are legal, and smoking is normal and socially acceptable in Indonesia (Astuti et al., 2020). The economic theory suggests that as the income increases, the demand for normal products increases as well (IARC, 2011). In addition, The Indonesian government has increased the tobacco tax tariff in the last five years and simplified the tax structure from 15 in 2015 to 8 tiers in 2022 (Ahsan et al., 2016, Kemenkeu-Ministry of Finance, 2021). Although the tobacco tax system remains complex, these gradual reforms have increased cigarette prices and made it less affordable for lower-income households (Prasetyo and Adrison, 2020).

5.1.5. Cigarette Price Elasticity Different Between Place of Residence

This study showed that people living in rural were more likely to be smokers and consumed more cigarettes than their counterparts. The result was similar to the previous study using secondary data from the Indonesian Family Life Survey (IFLS),

which found that those who lived in rural were more likely to be smokers (Amalia et al., 2019). The differences in literacy may contribute to the inequality in smoking behavior in Indonesia. The statistical agency reported that the school enrollment ratio differed substantially between urban and rural (BPS-Statistics Indonesia, 2022d). Lack of health literacy among rural residents could lead to a low awareness of the adverse health effect of smoking, which is an important predictor of smoking behavior (Andiwijaya et al., 2022, Tee et al., 2016).

A previous study found that kretek and hand-rolled cigarette use were higher among rural residents than in urban areas, while white or manufactured cigarettes were more prevalent among urban (Palipudi et al., 2015). Kretek cigarette has a deep root in Indonesian culture. It has been produced since the 1870s in Indonesia. Kretek and hand-rolled cigarettes were predominantly consumed by males, farmers, and the poor (Tarmidi, 1996). Kretek and hand-rolled cigarettes are popular among rural residents because of having lower prices than white cigarettes (Tarmidi, 1996). In the current multitier excise tax structure, the tax tariff for kreteks and hand-rolled cigarettes was substantially lower than for white cigarettes (Kemenkeu-Ministry of Finance, 2021).

Kreteks cigarettes get a favorable tax treatment because the government wishes to protect them from foreign white cigarettes competition (Tarmidi, 1996). Unfortunately, this policy may raise significant public health challenges. A lower tax tariff allows kretek cigarettes companies to sell their products at lower prices, which is affordable to the vulnerable groups. Evidence has shown that the health risk of kreteks is at least as harmful as cigarettes (Nuryunarsih et al., 2021). Therefore,

curbing kreteks consumption, particularly among rural residents and the poor, would significantly reduce tobacco related-diseases burden in Indonesia.

5.1.6. Cigarette Price Elasticity Different Between Year of the Survey

In this study, the regression coefficient was developed into three specifications. Model 3 included an interaction term between the price with year of the survey. The results found that the variable with interaction term in the models 3 were significantly associated with smoking participation and smoking intensity among smokers. This finding implied that the cigarette price related to year of the survey. The results was unsurprising given the fact that the government has increased the tobacco excise tax tariff and simplified the tobacco tax structure in the recent years (Ahsan et al., 2016). Moreover, the ministry of finance also increased the value added taxes of tobacco products from 8.4% in 2015 to 8.7% in 2016 and 9.1% in 2017 (Ahsan et al., 2016).

The recent tobacco taxation policies might induce the real price of cigarette in the market. However, the price is still substantially lower than the price in neighbouring countries, such as Brunei, Malaysia and Singapore (SEATCA, 2021). SEATCA found that the market price of the most popular foreign cigarette brand was 5.11 USD in Brunei, 4.34 USD in Malaysia, 10.6 USD in Singapore and 1.93 USD per pack in Indonesia.

5.1.7. Cigarette Price Elasticity Different Between Geographical Region

The study found that geographical region was associated with the smoking participation and smoking intensity. There are several arguments supporting these findings. First, the level of human development index between the region was hugely different between the regions. For instance, the human development index scores in

Java-Bali region were around 80, while the easter region was less than 60 (BPS-Statistics Indonesia, 2022a). Low human development index may partly relate to the low level of education as well as lack of awareness of the harmful effect of tobacco use.

Second, the study also found that the interaction term between price and geographical region was significantly associated with smoking participation and smoking intensity. This finding might imply that the price different between the geographical region associated with the smoking behaviour. A recent consumer price survey found that filter cigarette prices in Sumatera was approximately 20,000 Rupiahs, while the price in Eastern region was around 22,000 Rupiahs per pack (BPS-Statistics Indonesia, 2022b).

5.1.8. Cigarette Price Elasticity Different Between Marital Status

On the question of marital status, this study found that those who had married were more likely to smoke than those unmarried. These results are consistent with the data obtained from Iran and China (Hamrah et al., 2013, Ma et al., 2009). A possible explanation for this might be related to marital stress. Smoking is frequently used for stress relief (Al-Naggar et al., 2012). A study in Malaysia found that the major reason for smoking was for relaxation and divert from stress (Al-Naggar et al., 2012). However, further studies will need to be undertaken for examining this hypothesis.

Another possible explanation for this is that unmarried participant has a less income stability compared to those who have married. in this study, most of never married participants was students or youth. Therefore, they might not have large disposable income to buy cigarettes. This also accord with the previous literature,

which showed that the disposable income was an important determinant of smoking behavior (NCI and WHO, 2016).

5.1.9. Cigarette Price Elasticity Different Between Working Status

The current study found that working status was associated with smoking participation and intensity among smokers. The finding reported here suggests that work stress might influence the smoking behavior. Those who are actively working may have a higher working related stress compared to non-worker (student, unemployed, and retired) in this study. A study in Finland found that higher job-related stress increased the likelihood of smoking intensity (Kouvonen et al., 2005).

Another explanation for this is that cigarettes was used as a communication tool. This hypothesis was supported by a previous study involving 59,355 workers in Niigata Prefecture, Japan, which found that light smokers received lower co-worker stress than non-smokers (Tashiro et al., 2022). In Indonesian culture, smoking is viewed as normal and an encourage behavior increase social engagement. The smoking culture has been rooted in Indonesia since the Dutch colonialization era back in early 20th century (Priyatna, 2017).

5.2. Impact of Tobacco Excise Tax Increase on Cigarettes Consumption

Tobacco tax is one of the most cost-effective tools to reduce tobacco consumption (Chaloupka et al., 2012). Australia increased the tobacco tax by 25% in 2010, followed by an annual 12.3% increase starting in December 2013 (Wilkinson et al., 2019). A study found that a 25% and 12.5% increase in tobacco tax was associated with an immediate and sustained reduction of factory manufactured cigarettes (Wilkinson et al., 2019). Another study in the Republic of Korea also

revealed a 2.1% reduction in smoking rates among Korean Welfare Panel Study (KWPS) participants following a substantial increase in tobacco taxes in 2015 (Kim and Khang, 2020).

The US government has regularly increased tobacco taxes since 2000 (Chaloupka et al., 2012). A study assessing tobacco consumption in the US found that cigarettes and other combustible tobacco consumption have substantially declined from 450.7 billion in 2000 to 326.6 billion cigarettes equivalence in 2011 (CDC, 2012). However, the prevalence of cigars and pipe tobacco consumption has elevated from 3.4% in 2000 to 10.4% in 2011 (CDC, 2012). Some smokers may switch their consumption to a lowered taxed non-cigarette combustible tobacco, including cigars and pipe tobacco (CDC, 2012). A similar pattern was also found in Australia that the consumption of Rolled-Your Owned (RYO) cigarettes elevated after introducing the 25% and 12.5% tobacco tax increases (Wilkinson et al., 2019). These findings implied that the elimination of tax disparities is crucial in developing an effective tobacco taxation policy.

The national development medium-term plan for 2019-2024 aims to decrease the prevalence of smoking among children from 9.1% in 2018 to 8.7% in 2024 (Soerojo et al., 2020). The model showed that 25% and 50% would reduce smoking prevalence by 0.3% and 0.6%. Plenty of evidence has shown that children are more sensitive to price change than adults (IARC, 2011). Hence, pricing intervention is highly effective in reducing smoking prevalence among children (NCI and WHO, 2016). Based on the scenario in our model, the development plan target could be achieved by increasing the tobacco excise tax by around 25% from the base rate.

5.3. Impact of Tobacco Excise tax Increase on Tobacco-Attributed Mortality

Tobacco is the single greatest cause of preventable mortality (WHO, 2020). It killed 7 million people globally, and about 1.2 million non-smokers died due to exposure to tobacco smoke (Lian and Dorotheo, 2021). About half a million people die from tobacco-related diseases annually in the ASEAN region (Lian and Dorotheo, 2021). These numbers surpass the total deaths due to AIDS, Tuberculosis, Malaria, Dengue, Diarrhea, maternal and neonatal disorder, conflict and terror, road accidents, and suicide combined (IHME, 2020).

The risk of tobacco-related deaths could be reduced by smoking cessation. A study in the US involving three large cohorts found that the relative risk of death from all causes was approximately 1.33-1.45 higher for former smokers and 1.35-2.76 higher for current smokers than non-smokers (Thun et al., 2013). Another cohort study in Japan revealed that the lung cancer mortality risk ratio of former smokers who had quit for 0-4, 5-9, 10-14, 15-19, and ≥ 20 years compared to non-smokers were approximately 4.84, 3.19, 2.03, 1.29, 1.29 and 0.99, respectively, while the current smokers were about 5.16 (Wakai et al., 2001).

Tobacco is the second leading risk factor for mortality in Indonesia (IHME, 2020). In 2019, a total of 290,444 people died a year due to tobacco attributed mortality (IHME, 2020). About 62% of these deaths occurred before 70 years. The average life expectancy at birth in Indonesia is 71.7 years (World Bank, 2020b, IHME, 2020). Tobacco attributed deaths are preventable (WHO, 2008). Few studies have directly examined the impact of tobacco tax on health outcomes and mortality (NCI and WHO, 2016). A panel data from 1970 to 2005 in the United States found

that a 1$ increase in tobacco tax could prevent overall mortality by 8% (Bowser et al., 2016). No study is available directly evaluating the impact of the tobacco tax on mortality in Indonesia. Nonetheless, this study estimated that a 25-200% increase in tobacco excise tax would reduce tobacco attributed mortality by 1.3% to 10.1%.

5.4. Impact of Tobacco Excise tax Increase on Life-Years Gained

It has been reported that smoking cessation has a substantial benefit, even in the later period of life (USDHHS, 2020). A cohort study in the US found that smokers who stopped using cigarettes at age 25-34 years had similar life years to those who never smoked (Jha et al., 2013). The study also revealed that smoking cessation at ages 35-44, 45-54, and 55-64 generated additional life-years by 9, 6, and 4 years (Jha et al., 2013). In addition, a cohort study among the elderly population in Beijing, China, found that smoking cessation was related to longer life expectancy (1.6-8.8 years) and longer active life expectancy (0.2-4.7 years) compared to current smokers (Tian et al., 2011).

Tobacco is the second leading risk of DALYs in Indonesia, accounting for 8 million or 11.43% of the total DALYs in 2019 (IHME, 2020). About 79% of these DALY losses occur in the population below 70 years (IHME, 2020). Empirical evidence estimating the impact of tobacco taxes on life-years is limited. A study in the US found that a 10% increase in tobacco tax would reduce premature deaths by 6,000 annually (NCI and WHO, 2016). The model suggested raising the tobacco tax by 12.5-200% would generate additional life years between 4.2 to 67.9 years.

5.5. Impact of Tobacco Excise tax Increase on Tobacco Attributed-Medical Treatment Costs

Indonesia has implemented universal health coverage since 2014, called *Jaminan Kesehatan Nasional* (JKN) (Agustina et al., 2019). As of December 2021, about 86.96% has been covered by the JKN (DJSN-National Social Security Council, 2022). The implementation of JKN positively impacts the equity of access to healthcare, particularly for people who live in rural areas and the poor (Agustina et al., 2019). However, the JKN is facing a major challenge of financial sustainability. In 2019, the ratio of medical cost to premium collection was 101.67%, with a net assets value of -50.66 trillion rupiahs (DJSN-National Social Security Council, 2022). About 25% of the JKN expenditure in 2020 was paid for chronic diseases treatment (Johana et al., 2021). Tobacco-related diseases were the leading contributors to this spending, such as heart diseases, cancer, and stroke (Johana et al., 2021).

The Center for Indonesia's Initiative for Strategic Development (CISDI) estimated that the direct health expenditure attributed to tobacco consumption was approximately 27.7 trillion Rupiah in 2019 (Meilissa et al., 2021). These amounts were substantially higher than the allocation of tobacco taxes for health sectors, which was only 7.4 trillion rupiahs in the same year (Meilissa et al., 2021). Our model found that a 25%, 50%, 100%, and 200% increase in tobacco excise tax would save tobacco attributed medical treatment costs by 2.8, 5.7, 11.3, and 12.7 trillion rupiahs, respectively. Increasing tobacco excise tax would save more costs if we took into account transportation costs, loss of productivity, and loss of wages.

5.6. Impact of Tobacco Excise tax Increase on Government Revenue

Raising tobacco taxes would generate additional revenue for the government. A case study in the Gambia found that the total revenue from the tax elevated by almost double after the government increased the excise tax tariff per pack by 52% in 2013 (Nargis et al., 2016). At the same time, total cigarette imports substantially decreased, suggesting a reduction in demand for cigarettes (Nargis et al., 2016). A study in South Africa found that the real net tax prices increased by 88% after the government raised the tax burden from 32% to 50% of retail prices during the 1970s to 1980s (NCI and WHO, 2016). Therefore, tobacco taxation is a win-win solution for public health and the economy.

The covid-19 pandemic has severely hit many parts of the world, including Indonesia. The Gross Domestic Products (GDP) growth shrunk to -2.2% in 2020 (World Bank, 2020a). Indonesia also faced a recession during the worst period of Covid-19 in 2020, the first time in the last two decades (World Bank, 2020a). In addition, about 24 million people lost their job due to the pandemic (World Bank, 2020a). As the economy slows down, the government inevitably needs additional revenue to control the COVID-19 pandemic and provide economic stimulus. Increasing the tobacco excise tax could be the cheapest solution for the government to generate additional revenue (NCI and WHO, 2016). Our model suggested that a 100% increase in tobacco excise tax would generate additional revenue of around 113 trillion rupiahs. These amounts are around 200% of the Ministry of Health (MoH) budget for the fiscal year 2020 (Kemenkeu-Ministry of Finance, 2020).

CHAPTER VI CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusion

The study offers the following conclusions. Firstly, the price was negatively and significantly associated with smoking participation and smoking intensity in Indonesia. The demand for cigarettes was inelastic to the price change, with the cigarette price elasticity coefficients between -0.7492 to -0.3498. Secondly, the Subgroups analysis found that smoking participation and smoking intensity among youth and the elderly were more sensitive to price change than adults.

Third, the study estimated that raising the tobacco excise tax would improve public health as well as generate additional revenue for the government. For instance, a 50% increase in tobacco excise tax would reduce the number of smokers by 2.0, decrease annual cigarette consumption among smokers by 22.6 billion cigarettes sticks, produce additional life-years by 17.0 million, reduce tobacco-attributed medical treatment costs by 5.7 trillion rupiahs, and generate additional revenue for the government by 62.2 trillion rupiahs. The study also found that the minimum cigarettes tax increase was at least 30%.

6.2. Strength and Limitations of the Study

This study is the first research estimating the cigarettes price elasticity using individual and multiyear datasets. However, this study is subject to some limitations. First, the study design was pooled-cross-sectional. This study assessed the effect of prices on cigarettes consumption. However, the *Susenas* do not follow the same

participants in order to see the change in consumption over time. The longitudinal study is more appropriate to evaluate cause and effect. The longitudinal data evaluating smoking behavior is limited in Indonesia. Another method for analyzing multiple cross-sectional data was using Age-Period Cohort (APC) (Rutherford and Lambert, 2010). This model can summarize the information form a routine registries or survey (Rutherford and Lambert, 2010). The APC treat the age, period and cohort as important factors (Rutherford and Lambert, 2010). However, the APC method was rarely used in the demand study, which main interest to examine the effect of price or income on demand for a certain commodity. Therefore, the use of pooled cross-sectional was the most appropriate method given the available data and information.

Second, the study used the location-specific average unit value to measure cigarette prices. The unit value is not precisely the same as the price because it is affected by quality shading and measurement error (John et al., 2019). Nevertheless, previous studies have used this approach to assess cigarette demand due to unavailable market price data, particularly in LMICs (WHO, 2010).

Third, in the model, we do not include other variables affecting smoking participation and intensity, such as tobacco advertising/promotion exposure, anti-smoking sentiment, anti-tobacco media exposure, peer influence, and access to cigarettes variables. Those variables are not available in the *Susenas* datasets.

Fourth, the current study did not applied survey weight in the regression The results of unweighted data may not be valid in descriptive statistics. However, the use of survey weight in the regression is not strightforward unlike in descriptive statistics. . It is a common practices to use survey weight for analyzing the data in most social science major. However, most of microeconometrics study do not use survey weight

in the regression (John et al., 2019). Both weighted and unweighted estimators generate an identical results in a homogenous population (John et al., 2019). On the other hand, the results of weighted and unweighted are not consistent in a heterogenous population, and weighting the data added no value (John et al., 2019). Therefore, John at al., (2019) emphasizes that the analyzing regression without survey weight is the norm in microeconometrics (John et al., 2019).

Fifth, the benefit of raising the tobacco tax may be underestimated as the model does not take into account the reduction of smoking intensity among remaining smokers. In fact, a large body of evidence has shown that the risk of tobacco-attributed morbidity and mortality was inversely associated with the number of cigarettes smoked (USDHHS, 2014). Fifth, this study used a static and deterministic model. The system dynamic model would be more useful to estimate the benefit of a tobacco tax increase in the long term as it accommodates the discounted rate and changes in some key parameters over time.

6.3. Recommendation

Demand for cigarettes in Indonesia is inelastic to the price change, implying that the cigarette' prices are still affordable. At the same time, the burden of tobacco use is high in Indonesia. Therefore, the first recommendation is for the ministry of finance annually raise the tobacco excise tax by at least 30%. Second, a multitier tobacco tax system yields a wide variety of cigarette prices in the market, which enable smokers to switch to a lowered taxed brand when the tax rate increases. Thus, another recommendation is that the Ministry of Finance simplifies the tobacco excise tax structure from multitier to single tier. Third, the national and subnational governments implement WHO "best buys" for preventing and controlling Non-

Communicable diseases burden, including the ban on tobacco advertisement, promotion, and sponsorship, eliminating exposure to secondhand smoke in the indoor workplace, public places, and public transportation and implementing plain packaging or large graphical health warning in the tobacco product packages.

SUPPLEMENTARY APPENDICES

Table 32. Model fit evaluations

	BoxCox Test (λ)	Modified-Park Test (lý)	Pregibon's Link Test (p value)
All participants			
Model 1	0.3668	0.8643	<0.001
Model 2	0.3668	0.9131	<0.001
Model 3	0.3670	0.9831	0.001
Youth			
Model 1	0.3541	0.7189	<0.001
Model 2	0.3542	0.8100	0.001
Model 3	0.3445	0.7596	0.186
Adults (25-34)			
Model 1	0.3872	0.7962	<0.001
Model 2	0.3872	0.9157	0.645
Model 3	0.3875	0.8524	<0.001

	BoxCox Test (λ)	Modified-Park Test (lý)	Pregibon's Link Test (p value)
Adults (35-44)			
Model 1	0.3751	0.8329	<0.001
Model 2	0.3751	0.9821	0.007
Model 3	0.3753	0.8860	<0.001
Adults (45-54)			
Model 1	0.3701	0.9788	<0.001
Model 2	0.3702	1.1332	0.098
Model 3	0.3704	1.0481	<0.001
Adults (55-64)			
Model 1	0.3411	0.9277	<0.001
Model 2	0.3413	1.0275	0.092
Model 3	0.3414	0.9763	<0.001
Elderly			
Model 1	0.2955	1.0119	<0.001
Model 2	0.2956	1.1052	0.071
Model 3	0.2955	1.0430	0.001

In the Generalized Linear Model (GLM), it is important to assign an appropriate link function and family distribution. Boxcox test is one of standard method to examine an appropriate link function in the GLM. Table 32 showed that the λ score was around 0.2-0.3. These λ score was near 0, meaning that log was more appropriate link function in this study.

The Modified-Park Test was employed to determine the family distribution of the GLM. From the table 32, the lý score was between 0.7 to 1.1. This value close to 1, which indicated that Poisson was more appropriate family distribution in this study. Therefore, the present study used log link function and Poisson family distribution for the GLM in smoking intensity regression.

The model fit of regression was evaluated using Pregibon's link test. This test aimed to assess goodness of fit of the specification. P value more than 0.05 implied that the model has been specifically correct.

Table 33. Number of smokers by age groups and tobacco excise tax increase scenarios

Age groups	Tobacco excise tax increase						
	0%	12.5%	25%	50%	75%	100%	200%
10-14	466,113	451,469	436,824	407,535	378,246	348,957	231,801
15-19	4,373,268	4,304,569	4,235,867	4,098,466	3,961,065	3,823,664	3,274,059
20-24	7,530,547	7,412,251	7,293,949	7,057,352	6,820,754	6,584,156	5,637,766
25-29	7,869,303	7,798,890	7,728,473	7,587,642	7,446,812	7,305,981	6,742,659
30-34	8,038,969	7,967,038	7,895,103	7,751,236	7,607,369	7,463,502	6,888,034
35-39	7,632,488	7,599,541	7,566,592	7,500,696	7,434,800	7,368,904	7,105,320
40-44	7,139,634	7,108,814	7,077,993	7,016,352	6,954,711	6,893,070	6,646,506
45-49	6,217,761	6,206,385	6,195,009	6,172,256	6,149,504	6,126,751	6,035,741
50-54	5,227,802	5,218,237	5,208,672	5,189,542	5,170,412	5,151,282	5,074,762
55-59	4,238,035	4,223,719	4,209,402	4,180,768	4,152,134	4,123,501	4,008,967
60-64	3,073,057	3,062,676	3,052,295	3,031,532	3,010,770	2,990,007	2,906,957
65+	4,041,680	3,993,943	3,946,202	3,850,724	3,755,246	3,659,768	3,277,856
Total	65,848,659	65,347,533	64,846,380	63,844,101	62,841,822	61,839,544	57,830,428

Table 34. Number of quitters by age groups and tobacco excise tax increase scenarios

Age groups	Tobacco excise tax increase						
	0%	12.5%	25%	50%	75%	100%	200%
10-14	0	14,644	29,289	58,578	87,867	117,156	234,313
15-19	0	68,699	137,401	274,802	412,203	549,604	1,099,208
20-24	0	118,296	236,598	473,195	709,793	946,391	1,892,781
25-29	0	70,413	140,831	281,661	422,492	563,322	1,126,644
30-34	0	71,932	143,867	287,734	431,601	575,468	1,150,935
35-39	0	32,947	65,896	131,792	197,688	263,584	527,168
40-44	0	30,820	61,641	123,282	184,923	246,564	493,127
45-49	0	11,376	22,753	45,505	68,258	91,010	182,020
50-54	0	9,565	19,130	38,260	57,390	76,520	153,040
55-59	0	14,316	28,634	57,267	85,901	114,534	229,069
60-64	0	10,381	20,763	41,525	62,288	83,050	166,101
65+	0	47,738	95,478	190,956	286,434	381,912	763,824
Total	0	501,126	1,002,279	2,004,558	3,006,837	4,009,116	8,018,231

Table 35. Number of cigarette sticks smoked in a year by age groups and tobacco excise tax increase scenarios

Age groups	Tobacco Excise Taxes Increased						
	0.0%	12.5%	25.0%	50.0%	75.0%	100.0%	200.0%
10-14	1,151,533,352	1,105,501,146	1,059,466,471	967,399,589	875,332,708	783,265,826	414,998,300
15-19	14,821,703,755	14,525,457,135	14,229,194,627	13,636,685,499	13,044,176,371	12,451,667,243	10,081,630,732
20-24	32,881,229,111	32,224,020,390	31,566,776,420	30,252,323,729	28,937,871,039	27,623,418,348	22,365,607,584
25-29	37,154,128,128	36,464,268,405	35,774,371,683	34,394,615,237	33,014,858,791	31,635,102,345	26,116,076,561
30-34	39,043,827,764	38,318,881,020	37,593,895,395	36,143,963,026	34,694,030,656	33,244,098,287	27,444,368,809
35-39	38,298,758,017	37,628,702,677	36,958,611,400	35,618,464,782	34,278,318,165	32,938,171,548	27,577,585,079
40-44	35,930,206,786	35,301,590,398	34,672,940,296	33,415,673,805	32,158,407,315	30,901,140,824	25,872,074,862
45-49	31,359,155,593	30,808,569,596	30,257,954,070	29,156,752,547	28,055,551,023	26,954,349,500	22,549,543,406
50-54	25,696,634,103	25,245,467,397	24,794,276,495	23,891,918,887	22,989,561,279	22,087,203,672	18,477,773,241
55-59	20,226,616,298	19,848,167,224	19,469,697,853	18,712,779,407	17,955,860,962	17,198,942,517	14,171,268,736
60-64	13,980,505,843	13,718,924,300	13,457,328,728	12,934,151,614	12,410,974,500	11,887,797,386	9,795,088,929
65+	16,301,389,774	16,005,936,743	15,710,467,866	15,119,545,958	14,528,624,050	13,937,702,142	11,574,014,510
Total	306,845,688,525	301,195,486,432	295,544,981,303	284,244,274,081	272,943,566,859	261,642,859,637	216,440,030,749

Table 36. Number of tobacco attributed mortalities by tobacco excise tax increase scenarios

	Tobacco excise tax increase						
	0%	12.5%	25%	50%	75%	100%	200%
Mortality	32,924,330	32,715,856	32,507,371	32,090,413	31,673,454	31,256,496	29,588,662
Mortality averted	0	208,474	416,958	833,917	1,250,875	1,667,834	3,335,668
Mortality averted (%)	0.0%	0.6%	1.3%	2.6%	3.8%	5.1%	10.1%

Table 37. Total life-years gained by tobacco excise tax scenarios

Age groups	Tobacco Excise Taxes Increased					
	12.5%	25%	50%	75%	100%	200%
10-14	146,441	292,891	585,781	878,672	1,171,563	2,343,125
15-19	686,987	1,374,010	2,748,020	4,122,031	5,496,041	10,992,082
20-24	1,182,956	2,365,976	4,731,953	7,097,929	9,463,906	18,927,811
25-29	704,134	1,408,305	2,816,611	4,224,916	5,633,221	11,266,443
30-34	719,315	1,438,669	2,877,338	4,316,007	5,754,676	11,509,353
35-39	296,524	593,064	1,186,129	1,779,193	2,372,257	4,744,515
40-44	277,377	554,768	1,109,536	1,664,305	2,219,073	4,438,146
45-49	68,256	136,515	273,031	409,546	546,061	1,092,123
50-54	57,389	114,780	229,560	344,340	459,120	918,241
55-59	42,949	85,901	171,802	257,702	343,603	687,206
60-64	31,143	62,288	124,576	186,863	249,151	498,303
65+	35,803	71,609	143,217	214,826	286,434	572,868
Total	4,249,274	8,498,777	16,997,554	25,496,331	33,995,107	67,990,215

Table 38. Number of tobacco related diseases cases by tobacco excise tax increase scenarios

Disease	Tobacco excise tax increase						
	0%	12.5%	25%	50%	75%	100%	200%
Heart disease	7,895,254	7,845,262	7,795,268	7,695,281	7,595,294	7,495,308	7,095,361
Stroke	7,230,183	7,184,402	7,138,619	7,047,055	6,955,491	6,863,926	6,497,670
Atrial fibrillation	46,094	45,802	45,510	44,927	44,343	43,759	41,424
Aortic Aneurysm	138,282	137,407	136,531	134,780	133,029	131,277	124,272
Diabetes mellitus	1,534,274	1,524,559	1,514,843	1,495,413	1,475,983	1,456,553	1,378,832
COPD	5,281,062	5,247,623	5,214,182	5,147,302	5,080,422	5,013,542	4,746,021
Asthma	618,977	615,058	611,139	603,300	595,461	587,622	556,267
Alzheimer	437,894	435,121	432,348	426,802	421,257	415,711	393,529
Gallbladder	42,802	42,531	42,260	41,718	41,175	40,633	38,465
Upper digestive	46,094	45,802	45,510	44,927	44,343	43,759	41,424
Lung cancer	3,743,496	3,719,793	3,696,088	3,648,680	3,601,272	3,553,864	3,364,231
Colorectal cancer	523,497	520,182	516,867	510,238	503,608	496,978	470,460
Stomach cancer	269,980	268,270	266,560	263,141	259,722	256,303	242,627
Liver cancer	108,650	107,962	107,274	105,898	104,522	103,146	97,643

Disease	Tobacco excise tax increase						
	0%	12.5%	25%	50%	75%	100%	200%
Esophageal cancer	256,810	255,184	253,557	250,305	247,053	243,801	230,792
Kidney cancer	69,141	68,703	68,265	67,390	66,514	65,639	62,136
Bladder cancer	167,914	166,851	165,788	163,661	161,535	159,408	150,902
Pancreatic cancer	233,763	232,283	230,802	227,842	224,882	221,921	210,079
Leukemia	230,470	229,011	227,552	224,633	221,714	218,795	207,121
Lip cancer	207,423	206,110	204,796	202,170	199,543	196,916	186,409
Nasopharynx cancer	108,650	107,962	107,274	105,898	104,522	103,146	97,643
Larynx cancer	184,376	183,209	182,041	179,706	177,371	175,036	165,697
Prostate cancer	141,575	140,678	139,782	137,989	136,196	134,403	127,231
Breast cancer	26,339	26,173	26,006	25,672	25,339	25,005	23,671
Cervical cancer	69,141	68,703	68,265	67,390	66,514	65,639	62,136
Lower respiratory infection	944,928	938,945	932,962	920,995	909,028	897,061	849,195
Tuberculosis	2,363,967	2,348,998	2,334,029	2,304,092	2,274,154	2,244,216	2,124,466

Table 39. Total tobacco related diseases cost by tobacco excise tax increase scenarios in IDR

Disease	Tobacco excise tax increase						
	0%	12.5%	25%	50%	75%	100%	200%
Heart disease	53,316,577,805,413	52,978,982,443,690	52,641,368,975,808	51,966,160,146,204	51,290,951,316,600	50,615,742,486,995	47,914,907,168,578
Stroke	41,540,892,084,385	41,277,859,214,183	41,014,812,236,812	40,488,732,389,238	39,962,652,541,664	39,436,572,694,091	37,332,253,303,796
Atrial fibrillation	295,166,454,929	293,297,489,774	291,428,424,381	287,690,393,833	283,952,363,284	280,214,332,736	265,262,210,542
Aortic Aneurysm	1,535,309,982,096	1,525,588,549,287	1,515,866,595,090	1,496,423,208,085	1,476,979,821,079	1,457,536,434,073	1,379,762,886,050
DM	8,535,310,396,659	8,481,265,645,113	8,427,217,995,000	8,319,125,593,340	8,211,033,191,681	8,102,940,790,022	7,670,571,183,385
COPD	22,228,473,437,627	22,087,724,915,505	21,946,968,844,656	21,665,464,251,685	21,383,959,658,715	21,102,455,065,744	19,976,436,693,860
Asthma	2,067,228,618,315	2,054,139,128,669	2,041,048,936,997	2,014,869,255,679	1,988,689,574,362	1,962,509,893,044	1,857,791,167,773
Alzheimer	4,156,494,795,302	4,130,176,276,341	4,103,856,345,846	4,051,217,896,390	3,998,579,446,934	3,945,940,997,477	3,735,387,199,652
Gallbladder	254,631,101,375	253,018,802,118	251,406,416,389	248,181,731,403	244,957,046,417	241,732,361,432	228,833,621,489
Upper digestive	112,947,044,947	112,231,875,293	111,516,667,283	110,086,289,619	108,655,911,954	107,225,534,290	101,504,023,633
Lung cancer	42,625,932,490,510	42,356,029,250,463	42,086,111,534,770	41,546,290,579,030	41,006,469,623,290	40,466,648,667,550	38,307,364,844,589
Colorectal cancer	7,364,001,674,479	7,317,373,535,327	7,270,742,895,381	7,177,484,116,282	7,084,225,337,184	6,990,966,558,086	6,617,931,441,693
Stomach cancer	3,751,854,925,779	3,728,098,546,939	3,704,340,893,980	3,656,826,862,181	3,609,312,830,381	3,561,798,798,582	3,371,742,671,384
Liver cancer	840,853,053,984	835,528,854,596	830,204,369,657	819,555,685,330	808,907,001,003	798,258,316,676	755,663,579,368
Esophageal cancer	1,886,237,287,420	1,874,293,817,199	1,862,349,706,416	1,838,462,125,412	1,814,574,544,408	1,790,686,963,403	1,695,136,639,387
Kidney cancer	301,278,737,995	299,371,070,461	297,463,300,613	293,647,863,230	289,832,425,848	286,016,988,465	270,755,238,935

Disease	Tobacco excise tax increase						
	0%	12.5%	25%	50%	75%	100%	200%
Bladder cancer	1,588,303,839,755	1,578,246,855,017	1,568,189,330,894	1,548,074,822,034	1,527,960,313,173	1,507,845,804,312	1,427,387,768,868
Pancreatic cancer	4,288,664,317,456	4,261,508,913,993	4,234,352,054,112	4,180,039,790,768	4,125,727,527,425	4,071,415,264,081	3,854,166,210,706
Leukemia	2,374,741,890,090	2,359,705,256,451	2,344,667,816,355	2,314,593,742,620	2,284,519,668,885	2,254,445,595,150	2,134,149,300,210
Lip cancer	2,036,003,444,933	2,023,111,670,034	2,010,219,203,714	1,984,434,962,495	1,958,650,721,275	1,932,866,480,056	1,829,729,515,179
Nasopharynx cancer	823,835,184,585	818,618,740,683	813,402,017,010	802,968,849,435	792,535,681,860	782,102,514,285	740,369,843,984
Larynx cancer	2,418,599,904,242	2,403,285,565,942	2,387,970,406,292	2,357,340,908,341	2,326,711,410,390	2,296,081,912,440	2,173,563,920,637
Prostate cancer	769,831,643,578	764,957,144,822	760,082,384,634	750,333,125,689	740,583,866,745	730,834,607,801	691,837,572,023
Breast cancer	231,161,699,755	229,698,006,457	228,234,234,656	225,306,769,557	222,379,304,457	219,451,839,358	207,741,978,961
Cervical cancer	474,271,516,658	471,268,475,750	468,265,273,781	462,259,030,904	456,252,788,026	450,246,545,149	426,221,573,641
Lower Res. Inf.	4,843,538,656,577	4,812,869,843,009	4,782,199,384,589	4,720,860,112,601	4,659,520,840,614	4,598,181,568,626	4,352,824,480,676
Tuberculosis	13,130,016,054,013	13,046,878,075,140	12,963,735,637,351	12,797,455,220,688	12,631,174,804,025	12,464,894,387,362	11,799,772,720,711
Total	223,792,158,042,859	222,375,127,962,253	220,958,021,882,465	218,123,885,722,072	215,289,749,561,678	212,455,613,401,285	201,119,068,759,710

Table 40. Total government revenue by tobacco excise tax increase scenarios in IDR

Taxes	Taxes Increased						
Revenue	0%	12.5%	25%	50%	75%	100%	200%
Excise	137,313,445,614,972	151,632,650,907,337	165,320,473,916,379	190,798,968,976,851	213,748,930,796,389	234,170,359,374,992	290,570,741,280,059
VA	32,781,552,287,888	33,711,056,633,811	34,583,085,157,805	36,154,521,502,798	37,495,861,322,865	38,607,104,618,007	40,751,112,549,325
Local	13,731,344,561,497	15,163,265,090,734	16,532,047,391,638	19,079,896,897,685	21,374,893,079,639	23,417,035,937,499	29,057,074,128,006
Total	183,826,342,464,358	200,506,972,631,881	216,435,606,465,822	246,033,387,377,334	272,619,685,198,892	296,194,499,930,498	30,378,927,957,389

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