THREE ESSAYS IN EMPIRICAL ECONOMICS

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Abstract

Three Essays in Empirical Economics

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This thesis consists of three essays in empirical economics. The first essay investigates how the smoking behavior of an individual changes when faced with a change in income and taxes on cigarettes in a price-tiered cigarette market structure. To explain the behavior of smokers a simple two-period model is developed. The model makes certain predictions which have been tested with a unique panel dataset from the International Tobacco Control (ITC) surveys. Findings from the regression models illustrate that a change in price is negatively correlated with cigarette consumption, whereas a change in income is positively correlated with the same variable. It is further observed from the regression results that higher income increases the probability to up-trade and reduces the probability to quit smoking. Besides, higher cigarette taxation raises the probability to down-trade and reduces the probability to up-trade. Interestingly higher taxes do not raise the probability to quit smoking. The findings of the paper hold strong policy relevance. It reveals the need for overall cigarette taxes to be raised to an extent so that it off-sets any positive effects of income growth. In addition, tier-taxes should be designed with caution so that higher taxes do not encourage smokers to down-trade but rather pushes them to quit smoking altogether.

The second essay studies how a change in the Perception of Tobacco Risk (PTR) affects the attitude of smokers and non-smokers towards smoking. Using the same panel data-set as the first essay, a Perception of Tobacco Risk Index (PTRI) is developed for all smokers and non-smokers. Results show that among all different types of smokers, quitters have the highest PTRI whereas bidi (cheap local alternative to cigarettes) smokers have the lowest. Among the different socio-demographic groups the higher income, more educated, and those living in urban areas display a higher PTRI than their respective counterparts. However, when looking at a change in PTRI, it is observed that the change is bigger among the lower income, less educated and those living in rural areas. Analysis of panel data reveals that the change in PTRI is positively correlated with the probability to quit smoking for most socio-demographic groups. However, increase in PTRI does not significantly affect initiation of smoking and reduces cigarette consumption per day only for the more educated group. Such results hold strong policy implications. First, they show that changing PTR holds promising implications for controlling tobacco consumption concerning raising quitting probability. Second, they bring into light, specific socio-demographic groups where policies to change PTR should be targeted.

The final essay is a joint paper. In this essay, we explore the concepts of provincial gross, net and share of net mobility rates across education and age groups using the Survey of Labor and Income Dynamics (SLID, 1993-2011) of Canada. Our results show that provincial mobility of

young and more educated are more than their counterparts. The share of net mobility rates reveals that young and less educated individuals mostly have one-way inter-provincial mobility. Moreover, inter-provincial migration using gravity model shows that the effects of border and population sizes of destination and original provinces have positive influences and distances have the negative influence on provincial migration. We also identify a positive correlation between provincial in- and out-migration in Canada. This shows that provinces that lose more people also seem to attract more people. Our analysis further illustrates that net provincial mobility has a stronger relationship with in-migration compared to out- migration.

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Contents

List of Tables

List of Figures

Essay 1

An Empirical Analysis of the Impact of Income Change and Cigarette Taxation in a Price-Tiered Cigarette Market

1.1 Introduction

The discourse on tobacco consumption is long-standing but regrettably still pertinent. According to Tobacco Atlas (2015) tobacco-related deaths will number around 1 billion in the 21st century if current smoking patterns continue. Moreover, among middle-aged persons, tobacco use is estimated to be the most important risk factor for premature death in men and the second most important risk factor in women (following high blood pressure) in 2010–2025. Even though success stories of curtailing the use of tobacco is evidenced in some countries such as the United Kingdom and Australia; alarming increases in the rate of tobacco consumption in other countries such as China and countries in Africa keep the issue fervid.

From an economic perspective, the effect of a change in price on tobacco consumption is well understood. By the law of demand, tobacco consumption should reduce in response to price increases. However, when viewing the tobacco market in totality the impact of price becomes blurred. In reality, the demand for tobacco is affected by price as well as income. The dynamics of tobacco consumption in relation to income change is less understood when the market is tiered with respect to prices. On the one hand, an increase in income may lead to an increase in tobacco consumption. On the other hand, an increase in income may cause smokers to switch to a different price-tier while maintaining the same smoking habit. Such an existence of a price-tiered market structure gives rise to a further concern. When agents are more conscious of the number of cigarettes smoked per day, they may choose to maintain their current smoking habit by switching to a different price-tier when prices change. All these issues are addressed in this paper.

The objective of this paper is to analyze smoking behavior in the face of income change along with price change when there exists a price-tiered market structure. Smoking behavior is measured in the following ways: a) change in cigarettes smoked per day, b) probability to quit, c) probability to up-trade (move to a higher price-tier); and d) probability to down-trade (move to a lower price tier).

To understand smokers' behavior, a panel data-set will provide greater insight than a cross-section data set. This is because the paper is trying to look at how the smoking behavior will change in the face of changing income and prices. Such change in behavior is better captured when the behavior of the same individual is observed across a length of time.

One such panel data set is available in the context of Bangladesh. The International Tobacco Control, Bangladesh (ITCBD) has conducted a survey from 2009 to 2012. This paper uses this data set to analyze the behavior of smokers. As tax increase is insignificant in Bangladesh, this paper focuses on income change along with price change. However focus has been given on income change in an attempt to assess that had price changes been significant enough to bring about a large income effect on the individual budget, how would smokers react.

In Bangladesh, for the purposes of taxation, the Government has segmented the market for cigarettes on the basis of prices – namely low, medium, high, and premium. Each tier is then taxed at a different rate. Typically, the lower tiered markets are taxed at lower rates than their higher counterparts. This type of tiered tax structure creates larger price differentials between high and low priced tobacco product, thus providing smokers with the opportunity to substitute to cheaper tobacco alternatives rather than to quit altogether, as tobacco taxes and prices rise. When faced with changing income, smokers have different choices such as to continue to

smoke, as usual, to quit, to change the number of cigarettes smoked per day or to switch to a different price tier of the market.

The study of the brand switching behavior of smokers is not new in literature. For instance, Tsai et al. (2005) pointed out that there were two types of compensation when smokers practiced brand-switching behaviors: biological compensation and economic compensation. Biological compensation behaviors occur when smokers switch brands to high-tar and/or high-nicotine tobacco brands to compensate for reducing the total quantity of cigarette purchases. Evans et al. (1998), Suranovic et al. (1999) and Sutton et al. (1978) showed this type of behavior is intended to offset the effects of negative utility from reduced smoking resulting from higher cigarette prices.

Furthermore, studies by Armitage et al. (1988), Bader et al. (2011), Guyatt et al. (1989), Russell et al. (1982), White et al. (2014), Li et al. (2015), Hasenfratz et al. (1993) and Woodman et al. (1987) concluded that smokers would substitute their preferred brands with lower-price brands in order to maintain the total number of cigarettes consumed when facing higher cigarette taxes. In fact, financial motivation is the key factor behind economic compensation. In another survey of Taiwanese smokers, Lee et al. (2009) found that smokers in low-income and/or low educational attainment categories were more attracted to cheaper, illegal cigarettes when the government increased cigarette taxes.

The studies above validate the notion of brand-switching when markets are tiered in terms of prices thus rendering policy directed exclusively at prices, to be ineffective. However, analysis of this kind is yet to be carried out in the context of Bangladesh.

To understand the behavior of smokers a simple two-period model is developed. Through the model, it is found that although price and income are important determinants of the number

of cigarettes smoked per day, there are two other important factors – addiction towards smoking and quality of cigarettes smoked. Addiction level reveals a consumers likeness for smoking which can be a factor of their individual addiction level. When addiction for smoking is high, consumers prefer to maintain the quantity of cigarette smoked unaltered even though it means switching to a cheaper brand of cigarette. In the model, this group of individuals is identified as quantity loyal smokers. In fact Evans et al. (1998) identified few external, uncontrollable factors (nicotine addiction), environmental factors (parents, peer pressure, tobacco advertising), and psychological factors (dependency) as motivation towards brand-switching behavior, as the income lost by paying taxes is most likely to be smaller than the discomfort of reducing one's smoking habits. On the contrary, there also exists another group of individuals, who are more conscious of the quality of cigarette smoked. It is predicted that in the face of higher taxes, they adjust their smoking behavior by reducing the quantity of cigarette smoked while maintaining the same quality. The model distinguishes this group as brand loyal smokers.

The model is then applied to the data. The analysis uses the panel data collected across three years by International Tobacco Control (ITC) Bangladesh Surveys. The data were collected in 2009, 2010 and 2011-12. The main advantage of analyzing a panel data is that it gives the opportunity to track the behavior of the same individual across time, thereby observing individual behavioral differences. The additional appeal to the data set is that it is relatively recent therefore revealing updated individual statistics.

Bangladesh is one of the largest tobacco-consuming countries in the world. In fact, it lies among the top ten countries in the world with the high current smoking prevalence of 44.7% among men (World Health Organization, 2009). Throughout the decade sporadic measures have been undertaken by the Government of Bangladesh in an attempt to arrest the growth of tobacco

consumption. These measures include taxing tobacco products, warning labels on cigarette packs in text form and smoking ban in public places. However, despite these measures, the use of tobacco in the country continues unabated.

In a recent paper, Nargis et al. (2015) found that the prevalence of exclusive cigarette smoking actually went up from 2009 to 2012 in Bangladesh despite a gradual yearly increase in tobacco taxation during the same period. In another paper, Nargis et al. (2014) derived that insignificant increase in tobacco taxation failed to deliver expected results in Bangladesh as the likely negative effect of a modest price increase on inelastic cigarette demand was more than offset by a strong positive effect on income growth in Bangladesh. Even though tobacco products have been taxed in the past, it is considered to be insufficient.

This paper accepts the results of Nargis et al. (2014) that cigarette taxes are insignificant compared to large income growth. It thus addresses the issue of change in smoking behavior in the face of income change. Second, it adds understanding of smoking behavior by a more detailed analysis of the price-tiered market structure and observing the mobility of consumers across the different tiers in the face of income and price changes.

The remainder of the paper is organized in the following manner. Section 1.2 develops the model. Section 1.3 gives an overview of the data and explains the methodology. Section 1.4 presents the descriptive statistics. Transition matrices are also developed to display the mobility of the individuals – that is the people who are switching to different brands of cigarettes. Section 1.5 describes the empirical analysis in light of model predictions. Finally, section 1.6 concludes.

1.2 The Model

1.2.1 The Basic Framework

The model considers a representative tobacco user faced with a utility maximization decision. To capture the behavior of tobacco users when faced with income and price changes (policy intervention), a two-period model is considered. Period one shows the pre-policy situation, whereas period two captures the post policy effects. The utility of the agent arises from consumption of tobacco products and non-tobacco goods, both of which are additively separable. At a given time, the agent maximizes his utility for both periods where the second period is discounted by a rate β. The tobacco user is considered to be time inconsistent. This means that he/she expects that his/her addiction towards tobacco consumption will be reduced in the second period; however, when the second period does arrive he/she continues to have the same level of addiction for tobacco consumption. Previous studies such as Gruber, J., & Kőszegi, B. (2004), Kan, K. (2007) and Machado, F. S., & Sinha, R. K. (2007) have already shown evidence of tobacco users' time inconsistent behavior. Given that the analysis is over a span of two periods, it is possible to distinguish the utility function for tobacco users. Thus the utility function of the tobacco user is given by:

$$U_T = logC + \gamma logT + \beta(\, logC' + \, \gamma'\delta \, log\, T') \qquad (1)$$

Where U_T represents the utility of a tobacco user. The bundles of non-tobacco products are represented by C and C' and T and T' represent the bundles of tobacco products consumed in the first and second period respectively. The parameters γ and γ' are the addiction parameters for period one and two respectively that are taking values between 0 and 1.The higher the value the higher is the level of addiction for consuming tobacco. The parameter β is the time discount

factor. Time inconsistency is captured through hyperbolic discounting which can be expressed mathematically as $= \frac{1}{1+kD}$. This is the discount factor that multiplies with the value of the γ' in the next period. *D* measures the delay, and *k* is a parameter between 0 and 1 governing the degree of discounting. In the setup above, *D = 1* as a two-period model is used the delay is just one period. The higher the value of *kD,* the more the consumer believes that his/her addiction towards tobacco will diminish over time. The law of diminishing marginal utility is captured through the logarithmic functional form.

Individuals spend on non-tobacco products, tobacco products or save in the first period. In the second period, they use up all of their income. Therefore, the budget constraints faced by the tobacco user in two periods are thus given by:

$$I = pT + C + S \qquad (2)$$

$$I' + S = p'T' + C' \qquad (3)$$

Where *I* and I' represent the tobacco users' income in first and second period respectively. The prices of tobacco product are represented by p and p' in the first and second period respectively. As tax is imposed on tobacco products in the second period, $p < p'$. Prices of the non-tobacco products are normalized to 1 in both periods for simplicity.

The tobacco user maximizes in the first period keeping both periods in mind. Taking into considerations the utility and the budget constraint, he/she maximizes utility with respect to tobacco and non-tobacco products for both periods. Optimizing provides the following consumption decision of tobacco products for the two periods respectively.

$$T^* = \frac{\gamma}{p(1+\gamma)} \frac{(I+I')(1-B)}{(1-\beta-\beta A-B)} \quad (4)$$

$$T'^* = \frac{\gamma'\delta}{p'(1+\gamma'\delta)} \frac{\beta(I+I')(1-A)}{(1+\beta-\beta A-B)} \quad (5)$$

Where $A = \frac{\gamma}{1+\gamma}$ and $B = \frac{\gamma'\delta}{1+\gamma'\delta}$. Above expressions of optimal quantities of tobacco consumption show that tobacco is a normal good, meaning it is positively related to income. Also, it is negatively related to the respective prices. It is also observed from the (5) that higher k (or lower δ) reduces tobacco consumption in the second period. This explains that in the current period if a tobacco user assigns higher k or lower value to his/her future level of addiction towards tobacco products then he/she believes that he/she will consume fewer tobacco products in the second period. The higher tax rate that raises the second period price also reduces tobacco consumption in the second period.

The following expressions can also be derived from (4) and (5) to see the effects of addiction on optimal quantities:

$$\frac{\partial T^*}{\partial \gamma} = \frac{(I+I')(1-B)}{p(1-\beta-\beta A-B)(1+\gamma)^2} > 0 \quad (6)$$

$$\frac{\partial T'^*}{\partial \gamma'} = \frac{\beta(I+I')(1-A)}{p'(1-\beta-\beta A-B)(1+\gamma'\delta)^2} > 0 \quad (7)$$

This demonstrates that tobacco consumption is positively related to the addiction parameter in both periods. Plugging in the optimal values in their respective utility functions the following indirect utility functions can be derived for tobacco users:

$$U_T^* = logC + \gamma log\left[\frac{\gamma}{p(1+\gamma)} \frac{(I+I')(1-B)}{(1-\beta-\beta A-B)}\right] + \beta\left[logC' + \gamma'\delta\, log\left\{\frac{\gamma'\delta}{p'(1+\gamma'\delta)} \frac{\beta(I+I')(1-A)}{(1+\beta-\beta A-B)}\right\}\right] \quad (8)$$

For tobacco users to continue smoking, his/her discounted utility from consuming tobacco

product in the second period needs to be positive. The condition for an agent to continue being a tobacco user thus becomes:

$$\beta\left[\gamma'\delta\, log\left\{\frac{\gamma'\delta}{p'(1+\gamma'\delta)}\frac{\beta(I+I')(1-A)}{(1+\beta-\beta A-B)}\right\}\right] > 0 \qquad (9)$$

Clearly, one can conclude that an effective tax rate will reduce the discounted utility so much so that the individual reduces tobacco consumption. It can also be concluded that higher income increases tobacco consumption in the second period and therefore also increases the discounted utility from consuming tobacco product. Therefore tax hikes have to be matched with income growth to have the desired effect of a reduction in tobacco consumption. The above condition also highlights that not only tobacco taxation, policies focused towards reducing addiction level towards tobacco products would also reduce overall utility of a tobacco user and can strengthen the impact of tobacco taxation.

1.2.2 The Framework Capturing the Tiered Price Structure of Bangladesh

In this subsection, the basic model is updated to accommodate a segmented tobacco market by introducing T^H and T^L representing the high and low quality of the tobacco product respectively. Availability of two types of tobacco products now creates a possibility to up-trade and down-trade across price tiers. Thus in the new set up, tobacco users can be of four kinds: high-quality tobacco users in both periods, low-quality tobacco users in both periods, up-traders and down-traders.

In order to observe the optimal quantities of high and low-quality tobacco products in both periods, (6) and (7) are modified in the following manner:

$$T^{H^*} = \frac{\gamma^H}{p^H(1+\gamma^H)} \frac{(I+I')(1-B^H)}{(1-\beta-\beta A^H-B^H)} \quad (10)$$

$$T^{H'^*} = \frac{\gamma^{H'}\delta}{p^{H'}(1+\gamma^{H'}\delta)} \frac{\beta(I+I')(1-A^H)}{(1+\beta-\beta A^H-B^H)} \quad (11)$$

$$T^{L^*} = \frac{\gamma^L}{p^L(1+\gamma^L)} \frac{(I+I')(1-B^L)}{(1-\beta-\beta A^L-B^L)} \quad (12)$$

$$T^{L'^*} = \frac{\gamma^{L'}\delta}{p^{L'}(1+\gamma^{L'}\delta)} \frac{\beta(I+I')(1-A^L)}{(1+\beta-\beta A^L-B^L)} \quad (13)$$

Where $p^{H'}$ and $p^{L'}$ are the prices of high quality and low quality tobacco products respectively and $p^{H'} > p^{L'}$ as higher tax rates are imposed on high quality tobacco products compared to their low quality counterparts. Addiction levels are also different between high and low quality tobacco products. Tobacco users who consume high-quality tobacco products in both periods, the following condition must be true:

$$U_T^{H^*} > U_T^{L^*} \quad \text{and} \quad U_T^{H'^*} > U_T^{L'^*} \quad (14)$$

The reverse is true for those smoking low-quality tobacco. The imposition of effective taxes that take into account income growth as well should reduce consumption of tobacco on each respective tier. However as other price tiers offer tobacco products at lower prices, a tax increase on specific price tier may give smokers incentives to switch to cheaper alternatives. In the presence of tiered tobacco market, two broad sets of possibilities emerge when tax increases for a given price tier of tobacco products. On the one hand, higher taxes on tobacco would lead to reduced level of tobacco consumption per day while smokers maintain the same quality of tobacco. This group of agents is defined as brand loyal smokers. On the other hand when taxes on tobacco rise, agents are unwilling to compromise on their level of tobacco consumption in a

day. Therefore they switch to a lower category of tobacco. This behavior is defined as the quantity loyal smokers. The discourse below elaborates on this idea.

Scenario 1: Reduce tobacco consumption for both high and low-quality tobacco users - the case for brand loyal smokers

In this case, the following conditions should hold:

$$T^{H^{*\prime}} < T^{H^{*}} \qquad \text{and} \qquad T^{L^{*\prime}} < T^{L^{*}} \qquad (15)$$

$$\text{Or} \quad \frac{\gamma^{H^{\prime}}\delta}{p^{H^{\prime}}(1+\gamma^{H^{\prime}}\delta)} \frac{\beta(I+I^{\prime})(1-A^{H})}{(1+\beta-\beta A^{H}-B^{H})} < \frac{\gamma^{H}}{p^{H}(1+\gamma^{H})} \frac{(I+I^{\prime})(1-B^{H})}{(1-\beta-\beta A^{H}-B^{H})} \quad \text{and}$$

$$\frac{\gamma^{L^{\prime}}\delta}{p^{L^{\prime}}(1+\gamma^{L^{\prime}}\delta)} \frac{\beta(I+I^{\prime})(1-A^{L})}{(1+\beta-\beta A^{L}-B^{L})} < \frac{\gamma^{L}}{p^{L}(1+\gamma^{L})} \frac{(I+I^{\prime})(1-B^{L})}{(1-\beta-\beta A^{L}-B^{L})} \qquad (16)$$

This shows that effective taxes can increase the tobacco prices to such levels that tobacco users prefer to reduce tobacco consumption. Tobacco users showing this kind of reaction to tobacco taxes can be characterized as brand loyal tobacco users. They do not consider switching to cheaper alternatives as a viable option. At the same time, their addiction towards tobacco are high enough for them to continue consuming tobacco products even after the price hike. If income increases by more than the increase in taxes then tobacco consumption can even increase despite higher tax rates.

Scenario 2: Switch to cheaper alternatives – the case for quantity loyal smokers

One of the main consequences of having a tiered tobacco market could be the possibility to switch downwards to cheaper alternatives in the face of a tax hike. The following inequality should hold to capture such a phenomena:

$$U_T^{L'^*} > U_T^{H'^*} \qquad (17)$$

Or $$\left[\gamma^{L'} log\left\{\frac{\gamma^{L'}\delta}{p^{L'}(1+\gamma^{L'}\delta)}\frac{\beta(I+I')(1-A^L)}{(1+\beta-\beta A^L-B^L)}\right\} - \gamma^{H'} log\left\{\frac{\gamma^{H'}\delta}{p^{H'}(1+\gamma^{H'}\delta)}\frac{\beta(I+I')(1-A^H)}{(1+\beta-\beta A^H-B^H)}\right\}\right] > 0 \quad (18)$$

The above expression signifies that as soon as the utility from low-quality tobacco products outweighs the utility of high-quality tobacco products, the tobacco user will switch downwards to cheaper alternatives. This can be triggered by imposing differential taxes on different price tiers where low-quality tobacco products are taxed less relative to their high-quality counterparts. Thus tobacco users get the incentives to move towards cheaper alternatives to enjoy relatively lower prices that are tied together with lower taxes. This intra price tier mobility allows high-quality tobacco users to down-trade and avoid any reduction in tobacco consumption. Appropriate tax policy needs to be in place to discourage tobacco users to continue smoking with the same or even higher intensity by down-trading to relatively cheaper tobacco products.

Scenario 3: Switch to higher quality tobacco products – the case for up-traders

Not only a tiered market create an opportunity for tobacco users to move downwards, but it can also very happen that the tobacco users may choose to climb upwards in the price tier given the following inequality holds:

$$U_T^{H'^*} > U_T^{L'^*} \qquad (19)$$

Or $$\left[\gamma^{H'} log\left\{\frac{\gamma^{H'}\delta}{p^{H'}(1+\gamma^{H'}\delta)}\frac{\beta(I+I')(1-A^H)}{(1+\beta-\beta A^H-B^H)}\right\} - \gamma^{L'} log\left\{\frac{\gamma^{L'}\delta}{p^{L'}(1+\gamma^{L'}\delta)}\frac{\beta(I+I')(1-A^L)}{(1+\beta-\beta A^L-B^L)}\right\}\right] > 0 \qquad (20)$$

The above scenario may seem unrealistic in the presence of effective taxation. However, this can be explained through positive income change that overcompensates any higher tax

impact. For tobacco users who experience an increase in income even after taking into account the presence of higher taxes for higher quality tobacco products, they switch to higher quality tobacco instead of continuing to consume a relatively lower quality product.

The conclusion of the model is clear. If the objective of taxes is to curb the level of tobacco consumption, the existence of such tiered markets will clearly add a new dimension when setting the tax policy framework to achieve such an objective. To effectively curb tobacco consumption, one must either converge the market (which is not very realistic in the face of such variations in quality of tobacco products) or tax each tier separately, by taxing the lower tiers more aggressively. Of course one will argue that such a policy will be regressive, but one should keep in mind that the objective of tobacco tax is not to bring about equality but to curb the use of tobacco. Evidence can be found in the literature that shows that such regressive taxes are indeed more beneficial for the poor (Remler, 2004). A point to note that the model presented in this section looks at possible change in behavior of smokers only. The possibility of quitting is not captured in this model.

1.3 Data and Methodology

1.3.1 Data

The paper is based on data collected by the International Tobacco Control (ITC) surveys in Bangladesh. The ITC Bangladesh Project was launched in 2008 to evaluate the impact of tobacco control legislation in Bangladesh. The ITC Bangladesh Survey is a face-to-face survey conducted by the Bureau of Economic Research at the University of Dhaka, Bangladesh, in collaboration with the ITC Project team at the University of Waterloo in Canada.

The paper uses data collected in the first three Waves of the survey, conducted in 2009, 2010 and 2011-12, respectively. The Wave 1 Survey consisted of a nationally representative probability sample of smokers and non-smokers aged 15 years and older selected through a multistage cluster sampling design (sampling with probability proportional to population size at the levels of administrative units such as District, Upazila/Thana and Village/Ward). For this national sample, 23 districts out of the 64 districts covering Bangladesh were selected, and of the 23, 21 were selected randomly, with probability proportional to population size. Two districts were purposively selected to include the tribal populations. A total of 40 upazilas from the 23 districts, and (usually) 2 villages (or wards) from each upazila (or thana) were selected, again with probability proportional to size. Thus, a total of 80 villages/wards were selected for the main survey. One village included roughly 300- 600 households. A maximum of 450 households could be enumerated in each village[1].

These respondents formed a cohort. They were contacted again to answer follow-up surveys in 2010 and 2011-12. Between Wave 1 and 2, the overall retention rate is 92.4%[2] whereas between Wave 2 and Wave 3 the rate is 90.2%[3].

The main objective of the study is to understand how smoker's behavior changes over time. To do that two data sets have been generated. In the first one, smokers and quitters from wave 1 and wave 2 are matched (2522 matched observations), and in the second one smokers and quitters from wave 2 and 3 are matched (2278 matched observations). These matched datasets provide scope to observe the change in smoker's behavior over the consecutive surveys. For the

[1] ITC Bangladesh Wave 1 technical report.
[2] ITC Bangladesh Wave 2 technical report.
[3] ITC Bangladesh Wave 3 technical report.

final analysis, both of these matched datasets are pooled. The total sample size thus becomes 4800.

International Tobacco Control Project conducts surveys in twenty-nine countries across the globe, covering both developing and developed countries. These surveys are internationally synchronized where a significant portion of the questionnaire is identical among all countries. The data from the survey were checked for out-of-range values, outliers for open-ended responses, and mismatches of individual identifiers and smoking status between waves. The mismatches between household level forms and individual level surveys were also identified and corrected. All the variables in each wave were checked for consistency and errors. Corrections of data entry and cases with out-of-range values were also carried out using appropriate rules.

Despite high retention rates, and internationally synchronized data, there are some limitations that the reader must keep in mind. First, data has been collected for only three waves, of which, two waves are used to observe change variables which represent change in smoking behavior. A longer time horizon would be more insightful in observing persistent change in smoking behavior. Second, all the key information are self-reported, therefore there is some possibility of self-reporting bias. With self-reported data, change can encompass true change and self-reporting errors between the different measurement periods (i.e., recall bias). Third, rather than asking specific individual income, the questionnaire required respondents to choose a given bracket within which their income lies. This is a practice, common in data collection, as individuals are often reluctant to report their exact income. However, for the purpose of economic analysis, it is difficult to capture the exact extent of income change across individuals over time.

1.3.2 Methodology

Data analysis is carried out in three parts. First, change in smoking behavior is captured through the change in cigarettes smoked per day (CPD). The outcome variable generated for this part of the analysis using panel data is change in CPD. For the second part of the analysis, three binary outcome variables have been generated using the panel data. They are a) whether to up-trade or not, b) whether to down-trade or not and c) whether to quit or not. An individual is said to up-trade when he switches to a higher price tier and down-trade when he switches to a lower one. Finally, the paper looks into a combination of price-tier mobility and change in CPD. For that, the following set of binary outcome variables are generated where 0 represents no change, and 1 represents a change. They are a) no change in quantity and up-trade, b) no change in quantity and down-trade, c) increase in quantity and unchanged price-tier, d) increase in quantity and up-trade, e) increase in quantity and down-trade, f) decrease in quantity and unchanged price-tier, g) decrease in quantity and up-trade, and h) decrease in quantity and down-trade.

On the explanatory side, there are three main explanatory variables: a) price, b) income change and c) change in smoking addiction. In data, prices have been reported by individuals that create the possibility of an endogeneity bias. To avoid this problem, tax rates based on the respective prices reported by the individual are used as instruments for prices. The coefficient of the tax variable in the reduced form regression for the price is 80.37, which implies that if the tax rate increases by one percentage point, the average price per pack of 10 cigarettes increases by BDT[4] 0.80.[5] Such statistically significant coefficient of the tax variable indicates that it is highly correlated with price. This tax variable was also tested as a valid instrument for

4 BDT refers to Bangladesh Taka which is the currency of Bangladesh.
5 See appendix A1.7.5.

the price, and a very large F statistic (greater than 10) is found in the reduced form regression for the price.[6] All prices are adjusted for inflation by calculating based on the base year. 'Change in price' and 'change in tax' variables are also generated by observing the differences between waves for reported prices and assigned taxes.

In the dataset, the individuals reported a particular range within which their income lies as opposed to the exact income in figures. To observe the real income, income categories have been assigned with mid-point values of the respective income category. These mid-points are adjusted for inflation. For the purpose of the study, a new variable 'change in income' is generated by calculating the difference between the mid-points in consecutive surveys. Positive values indicate an increase in real income whereas negative values signify a decrease in real income. This 'change in income' variable is then divided by 1000 to identify the effect of per BDT 1000 change on different tobacco behavior parameters.

To capture the impact of addiction, an additional variable is formed by observing how long after waking up in the morning the individual lights up the first cigarette. This indicates an individual's dependency on smoking. The quicker a person lights up, the more addicted he is. Two categories of smokers are formed for the analytical purpose. One as less addicted smokers who light up their first cigarette after sixty minutes and the other as more addicted smokers who light up within the first sixty minutes of waking up. A 'change in addiction level' variable is generated by observing the difference between two waves' addiction levels. A positive value represents an increase in addiction towards smoking, and a negative value represents the opposite.

[6] According to Stock and Watson, when there is one right-hand-side endogenous variable, the F statistic from the first-stage regression can be used to test for the significance of the instrument if the F-statistic should be greater than 10.

Finally, the impact of demographics on smoking behavior has been captured through the following variables: education, age, and residence (rural or urban). Individuals are assigned to three broad education category: illiterate, less educated (1-8 years of schooling) and more educated (9 and more years of schooling).

1.4 Descriptive Statistics

Bangladesh is a fast-growing economy that has maintained an annual per capita GDP growth rate of around 5% for the last decade (World Development Indicators). Cigarette consumption has also been on the rise in the country, both in the aggregate and per capita terms. From 1997 to 2010, cigarette consumption increased from 50.9 billion cigarettes to almost 71.4 billion cigarettes. This shows an increase by over 40%[7]. Bangladesh is a country that has a segmented tobacco market with respect to price as well as the type of tobacco. Two types of tobacco are widely smoked. They are cigarettes and bidi. Bidi is a cheap hand made smoked-tobacco largely consumed by the lower socio-demographic groups of the country. Bidi market does not have price-tiers similar in cigarette market. Given the objective of the paper – to analyze the behavior of smokers in a tiered market when faced with income and price changes – analysis of the paper is restricted to cigarette smokers and quitters only.

Bangladesh uses a tiered cigarette tax structure that imposes different ad valorem tax rates known as excise tax (supplementary duty) based on retail price slabs. In addition, there is a Value Added Tax (VAT) of 15% of the retail price. In Bangladesh, all different brands of cigarettes are divided into four tiers based on their prices; low, medium, high and premium.

[7] Barkat el al. (2012).

Between 2009 and 2012, there was a steady increase in cigarette prices for each of the four retail price slabs, but increases in the SD (supplementary duty) for each price slab were marginal (see Table 1.1). It should also be noted that because the range of price bands are not continuous, there are significant price gaps between brands in different price categories. This gap provides incentives for tax avoidance and evasion among manufacturers (e.g., by positioning brands in the gaps between price slabs, tobacco companies can pay lower taxes because the provision for penalties for selling beyond the maximum price in the slab is not currently being enforced)[8].

Table 1.1: Bangladesh Cigarette Tax Structure 2009-2012[9]

Year of observation	Price Tier	Taka/Pack of 10	Excise tax (% of retail price)
Wave 1 (2009)	Low	7.25-8.75	32
	Medium	16.25-17.25	52
	High	23.25-29.25	55
	Premium	46.25+	57
Wave 2 (2010)	Low	8.40-9.15	33
	Medium	18.40-19.00	53
	High	27.00-32.00	56
	Premium	52.00+	58
Wave 3 (2011-2012)	Low	11.00-11.30	36
	Medium	22.50-23.00	55
	High	32.00-36.00	58
	Premium	60.00+	60

The table above illustrates the tax on cigarette packs across the three waves. Tax rates imposed on the lower tiers are significantly lower than, the higher ones. Excise taxes on

8 ITC Project. (May 2014).
9 National Board of Revenue, Government of Bangladesh.

cigarettes account for just over one-half of retail prices on average. This falls well below the level in countries with strong tobacco control policies where excise taxes typically account for more than 70% of retail price (World Health Organization, 2010).

Table 1.2: Smokers' Distribution in Different Cigarette Price Tiers over the Waves

Cigarette Price tier	Percentages of different types of smokers in different Waves		
	2009	2010	2011-12
Low	29.64	39.06	42.82
Medium	46.15	33.50	31.30
High	16.51	19.88	17.11
Premium	7.71	7.56	8.77

Table 1.2 shows the distribution of smokers across different price tiers over the three years. It is apparent that smokers' presence in different price tiers changed drastically over the years. Smokers belonging to lowest price tier increased from 29.64% to 42.82% in just two years. In contrast, medium price tier experienced a significant reduction in terms of smokers' proportion from 46.15% to 31.30%. However, the top two price tiers did not witness any major shifts over the years. It is this evidence that feeds interest to the question of smokers' mobility across price tiers over the years.

Observations from Table 1.2 prompted to give more structure to changing patterns in smokers' mobility across price tiers. To that direction, transition matrices were generated to identify mobility within different price tiers for cigarette smokers.

Table 1.3: Transition Matrices - Cigarette Smokers' Movements within Different Price Tiers

		Wave 2			
		Low	Medium	High	Premium
Wave 1	Low	67.42	22.95	8.78	0.85
	Medium	27.27	57.21	11.53	3.99
	High	11.01	14.22	58.72	16.06
	Premium	2.59	8.62	28.45	60.34

		Wave 3			
		Low	Medium	High	Premium
Wave 2	Low	74.08	18.03	6.76	1.13
	Medium	34.12	52.23	8.01	5.64
	High	13.66	19.67	49.18	17.49
	Premium	5.13	2.56	28.21	64.10

Several interesting observations come out of the transition matrices. First of all, compared to all the price tiers, smokers belonging to the 'low' category were least mobile. From the first to the second wave 67.42 % of the lowest price tier smokers remained in the same category (first transition matrix) compared to 57%, 59% and 60% in the higher categories. From the second to the third wave 74.08% of the lowest price tier smokers remained immobile (second transition matrix).

Second, the rate of mobility is much higher among 'medium' and 'high' category. Among those who migrated, the tendency to down-trade is much higher than the tendency to up-trade. For example, 27.27% of smokers who smoked the medium type cigarettes in wave 1 switched to the low type in wave 2. In contrast, only 11.53% up-traded to the high and 3.99% to premium

categories. Similar observations hold true in the second transition matrix as well. Thus in the two middle price tiers, it seems that the tendency to down-trade dominates over the tendency to up-trade. This might be in response to increasing prices that encouraged switching to lower-priced brands instead of quitting. Finally, looking at the two extreme price tiers, it is apparent in both transition matrices that the tendency for premium smokers to down-trade is higher than low priced smokers to up-trade.

Some intuition can be offered to the behavior of smokers' mobility across price tiers from the data at hand. Table 1.1 shows that the tax rates are much higher among the higher price tiers. This conforms to lower priced smokers being immobile and the tendency of medium and high priced smokers to down-trade more than to up-trade. However, the transition matrices provide other observations that cannot be explained by the tax structure. First, even though lower in magnitude, a group of individuals does up-trade over the years. Also, even though the tax structure of premium priced smokers is highest, 60% and 64% of them remain immobile. One plausible explanation of such behavior is changing income.

In the data-set individuals were required to report their income category, as opposed to actual income. Despite that, large variations in income can be found when generating transition matrices for income.

Table 1.4: Transition Matrices – Cigarette Smokers' Movement within Different Income Groups

		Wave 2		
		Low	Medium	High
Wave 1	Low	77.38	18.05	4.56
	Medium	38.80	46.40	14.80
	High	15.85	37.20	46.95

		Wave 3		
		Low	Medium	High
Wave 2	Low	67.13	29.18	3.70
	Medium	25.49	54.67	19.84
	High	7.19	40.72	52.10

Above transition matrices clearly showed that income change had been a common phenomenon in Bangladesh. A high proportion of smokers experienced a change in income category in just one year. Some of their income increased while some faced reduced income as well. From the medium tier, it is observed that more individuals' incomes are reduced to low-income tier compared to increase to high-income tier. It can also be found in Table A1.7.1 in the appendix, the percentage of respondents experiencing a decrease in income is higher than those experiencing increased income. This change in income can have a consequential effect on smokers' behavior towards smoking. Such change in income adds strength to the rationale of the study where the author wishes to investigate the change in smoking behavior in the face of change in income. Bangladesh is the perfect study area in this regard.

In the summary statistics table in A1.7.2, it is revealed that on average higher price tier cigarette smokers consume marginally fewer cigarettes per day and experience higher income

growth. Mean values of these relatively more expensive cigarette smokers also show that they are more educated, younger, more likely to live in urban areas and also relatively less addicted to smoking. These results signify few interesting differences within smokers' of different price tiers.

Table A1.7.3 illustrates some of the characteristics of up-traders and down-traders. While comparing mean values, it is revealed that up-traders consume fewer cigarettes per day and enjoy higher income growth as expected. Moreover, up-trader are more educated and living in urban areas. Down-traders show higher addiction towards smoking compared to up-traders. This implies that down-traders can be quantity loyal. Therefore they choose to down-trade and maintain their quantity of cigarettes which satisfy their addiction level. These results help us identify few demographic differences between up-traders and down-traders. It is also important to recognize few notable features of quitters. Table A1.7.4 reveals that quitters are likely to enjoy lower income growth, lower education; they also tend to be older and living in rural areas.

1.5 Empirical Analysis

In this paper, data analysis is carried out in three parts. First, a regression equation is formed to illustrate how cigarette consumption is affected by price, income, and addiction level. In Bangladesh, such exercise is mostly done using the cross-sectional dataset. However, the use of panel data provides scope for a more rich analysis. The first part of the analysis is done through the following regression equation.

$$\Delta CPD = \alpha_1 + \alpha_2 \Delta p_T + \alpha_3 \Delta I + \alpha_4 \Delta A + \alpha_5 X + \varepsilon \qquad (1)$$

The dependent variable is change in CPD. Change in price (Δp_T) for which change in tax rate is used as an instrument, change in income (ΔI), change in addiction level (ΔA) along with demographic variables such as education groups, age, and residence (all are represented by X) are used as independent variables in the above regression. Results from the table below show that when smokers are faced with higher prices, they reduce cigarette consumption per day. Moreover, when smokers' experience higher income, it raises their daily cigarette consumption. Findings also illustrate that higher addiction towards smoking increases cigarette consumption per day. All the results, confirm the predictions of the model in section 1.2.1. Full results are provided in the appendix A1.7.6

Table 1.5: Effects of Change in Price, Income and Addiction Level on Change in CPD

	Change in CPD (Smokers only)
Change in Cigarette Price Per Pack	-0.090***
	(0.024)
Change in Income	0.129***
	(0.035)
Change in Addiction Level	2.988***
	(0.304)

Notes: Standard errors are given in parentheses, * indicates significance at the 10% level, ** indicates significance at the 5% level, *** at the 1% level.

Next, for the second part of the analysis, a series of regression equations are formed to observe smokers' behavior concerning price-tier mobility and quitting probability when facing changes in prices and income. In equation 2, the dependent variable is the probability to up-

trade or remain unchanged between two surveys. In a similar way, regression equation 3 looks at the probability to down-trade or remain unchanged. Lastly, regression equation 4 tests the probability to quit.

All the following regression equations consist of the same number of independent variables as in equation 1. The only difference is that in equation 2 to 4, cigarette price per pack[10] is used as one of the independent variables instead of the change in p_T.

$$Prob\ (up - trade) = \beta_1 + \beta_2 p_T + \beta_3 \Delta I + \beta_4 \Delta A + \beta_5 X + \tau \quad (2)$$

$$Prob\ (down - trade) = \gamma_1 + \gamma_2 p_T + \gamma_3 \Delta I + \gamma_4 \Delta A + \gamma_5 X + \eta \quad (3)$$

$$Prob\ (quit) = \delta_1 + \delta_2 p_T + \delta_3 \Delta I + \delta_4 X + \mu \quad (4)$$

The table below gives the results of the three probit regressions. Findings from regression 2 reveal that higher prices of cigarettes decreases the probability to up-trade for smokers rather than remain in the same price tier. Results also show that positive income change increases the likelihood for smokers to up-trade to higher price tiers of cigarettes compared to remaining unchanged. More addicted smokers are less likely to up-trade. However, higher education increases the likeliness to up-trade compared to the base group, illiterate and smokers who live in urban areas are also more likely to up trade.[11]

[10] Tax rates are used as instruments of cigarette prices per pack.
[11] See appendix A1.7.7 for details.

Table 1.6: Effects of Change in Price, Income and Addiction Level on Prob. to Up-trade, Prob. to Down-trade and Prob. to Quit

	Whether to Up-trade or Not (Smokers only)	Whether to Down-trade or Not (Smokers only)	Whether to Quit or Not (Smokers and quitters)
Cigarette Price Per Pack	-0.014**	0.061***	-0.004
	(0.007)	(0.007)	(0.004)
Change in Income	0.026***	-0.010	-0.015***
	(0.009)	(0.009)	(0.006)
Change in Addiction Level	-0.026	-0.205**	-
	(0.077)	(0.083)	

Notes: Standard errors are given in parentheses, * indicates significance at the 10% level, ** indicates significance at the 5%level, *** at the 1% level.

Regression equation 3 attempts to answer the other side of the story by examining the factors that explain smokers' down trading behavior. It is found that higher prices of cigarettes increase the likeliness of smokers to down trade. It is also evident that increase in income reduces the probability to down-trade, however, the coefficient is not statistically significant. There is a negative coefficient attached to the change in addiction variable; this implies that smokers who show an increase in addiction towards smoking is less likely to down trade. Results also show that more educated along with urban smokers are less likely to down trade.[12]

In regression 4 another probit model is used where quitting or not is the dependent variable. It is found that an increase in price does not increase the probability to quit among smokers in Bangladesh. This proves the ineffectiveness of the insignificant price hikes in Bangladesh compared to the overall income growth of the country. Also, from regression 3 we find that

[12] See appendix A1.7.7 for full results.

increase in price leads consumers to down-trade. Therefore, an ineffective tax, coupled with a tiered market leads to failure of tax policy to encourage consumers to quit. Findings also reveal that increase in income reduces the probability to quit. However, it is seen that more educated, older individuals and rural residents are more likely to quit smoking compared to their respective counterparts.[13]

Finally, the last part of the analysis combines the change in CPD with the change in price-tier to capture a full view of different behaviors when faced with price and income. The analysis is carried out using eight different probit models where the left-hand side shows a change in CPD with a possible change in price-tier. The explanatory variables remain the same as in equations 2 to 4. The more relevant part of the results of this analysis is summarized in Table 1.7.

Table 1.7: Effects of Change in Price, Income and Addiction Level on Different Types of Changes in Smokers' Behavior (only smokers are considered)

	No Change in Quantity and Up-trade	No Change in Quantity and Down-trade	Increase in Quantity and Unchanged Price Tier	Increase in Quantity and Up-trade	Increase in Quantity and Down-trade	Decrease in Quantity and Unchanged Price Tier	Decrease in Quantity and Up-trade	Decrease in Quantity and Down-trade
Cigarette Price	-0.001	0.058***	-0.011	-0.006	0.068***	-0.006	-0.026*	0.056***
	(0.020)	(0.021)	(0.010)	(0.014)	(0.014)	(0.010)	(0.014)	(0.014)
Change in Income	0.013	-0.004	0.010	0.044**	-0.008	-0.004	0.026*	-0.035*
	(0.027)	(0.028)	(0.014)	(0.019)	(0.020)	(0.014)	(0.019)	(0.019)
Change in Addiction Level	0.014	-0.437	0.349***	0.369*	-0.111	-0.338***	-0.424**	-0.741***
	(0.275)	(0.300)	(0.127)	(0.191)	(0.193)	(0.131)	(0.176)	(0.205)

Notes: Standard errors are given in parentheses, * indicates significance at the 10% level, ** indicates significance at the 5%level, *** at the 1% level.

[13] See appendix A1.7.7 for full results.

Findings from Table 1.7 are coherent with the second part of the analysis (Table 1.6). It is found that increase in prices of cigarettes increases smokers' chance of down trading with an unchanged quantity of cigarette consumption per day. This provides support to the argument that quantity loyal smokers are likely to adjust to higher taxes by down-trading. The table also shows that in the face of rising prices smokers' down-trade along with adjusting their CPD (in both directions), although, the probability to down-trade with an increase in CPD is the highest. This result completely contradicts the objective of tax as an instrument to curb the use of tobacco. On the other hand, rising prices reduces smokers' probability to up-trade while reducing the number of CPD.

Results show again that increase in income raises the possibility for smokers' to up-trade while the change in CPD can be in both directions. Again, this is consistent with model predictions. Moreover, it is found that smokers' with a positive change in addiction towards smoking are more likely to increase CPD and less likely to decrease CPD. Interestingly, those with a positive change in addiction are less likely to switch tiers indicating that they are the more brand loyal smokers.

1.6 Discussion and Concluding Remarks

In this paper, a simple two-period model is formulated to understand smokers' behavior in a tiered cigarette market structure. The model made certain predictions which have been tested with empirical data from ITC surveys of Bangladesh. First, the model predicts a negative relationship between cigarette prices and the number of cigarettes smoked per day, and a positive relation between cigarette consumption and income. Both predictions are supported by

data. The model identifies a third factor – the addiction parameter which positively affects smoking behavior.

Also, the focus of this paper is to observe the impact of tax increase in a tiered cigarette market. One possibility predicted by the model was that those smokers that are more sensitive to the quantity of cigarettes smoked would maintain the same quantity by down-trading when cigarette prices are raised through taxes. This phenomenon of down-trading was also observed in the transition matrices. Findings from the probit model provide evidence in support of such reactions from the smokers. Results show that higher prices resulting from higher taxes increase the probability to down-trade as well as decrease the probability to up-trade when controlling for other variables. In fact, it is found that when prices increase the probability for smokers' to down-trade and increase the number of cigarette smoked per day is significant and carries the highest coefficient compared to all other possible changes in smoking behavior. Such conclusions feed to the argument presented from the beginning of the paper that price change is insufficient in the context of a tiered market such as Bangladesh. As a further exercise, it is observed in the regression results that higher price through higher cigarette taxation does not increase the probability to quit smoking.

Thus meaning to smoking behavior is given through an analysis of change in income. The model presented in the paper predicts the possibility that smokers might up-trade when income increases. There is also a positive relationship between income and CPD. Transition matrices presented in Table 1.3 show a significant percentage of up-trading among smokers to higher price tiers. Finding from the regression models reveal that higher income can be observed as an explanation for up-trading. Table 1.5 also shows that change in income is positively related to change in CPD. Results show that when income changes the probability for smokers' to up-

trade with increasing daily cigarette consumption is the outcome with the largest coefficient. Such findings help conclude that any situation where positive income change prevails, the increase in tax on tobacco must be greater to off-set the positive impact of an increase in income.

The results from this paper clearly demonstrate that cigarette taxation in Bangladesh needs to be increased to bring a meaningful positive change in smokers' behavior. To begin with, the rise in taxation should be high enough to off-set any positive effects of income growth. Also, in order to prevent smokers from switching tiers (as opposed to quitting), the level of tax should be higher on the lower tiered brands. Proponents of the current structure (where the lower price tiers are taxed at a lower slab) argue that reversing the system would be highly regressive in nature. After all, data reveals that the lower income groups are the main consumers of cigarettes in the lowest price tiers. Raising the tax rates in these groups would in affect tax the poor. However, it must be kept in mind that the objective of taxing tobacco is not income equality, rather it is to prevent consumption of a social bad. Thus when accounting for the health benefits that arise from quitting and reduced expenditures that the poor will enjoy from quitting; a harsh but effective tax on the lower tiers of the market may well prove to be socially desirable. Furthermore, tax gaps need to be reduced between different cigarette price bands. Results from this paper highlight the importance of implementing a uniform specific tax system that will maximize price increases and decreases in consumption.

Finally, the model identifies addiction parameter as a factor affecting smoking behavior. The model shows that when addiction towards smoking is strong (high), it will be more difficult to reduce utility from smoking through higher taxes. Therefore policy makers should design strategies to target and reduce addiction for smoking. Examples of such policies can be to increase awareness of harmful effects of smoking, introduce graphic warnings on cigarette

packs, impose a public ban on smoking, create role models/personalities that publicly debauch smoking, etc. To reduce consumption as well as increase the number of successful quitters, a more holistic approach to policy design needs to be implemented.

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1.7 Appendix

Table A1.7.1: Summary Statistics of All the Variables

Variables		Percentage (Standard Errors)
Change in income	Income increased	34.848
		(0.018)
	Income decreased	65.152
		(0.018)
Education	Illiterate	28.100
		(0.017)
	Less educated (1-8 years of schooling)	48.347
		(0.019)
	More educated (9 or more years of schooling)	23.554
		(0.016)
Rural	Rural	68.871
		(0.017)
	Urban	31.129
		(0.012)
Addiction Level	Less addicted (first smoke after one hour of waking up)	38.979
		(0.008)
	More addicted (first smoke within one hour of waking up)	61.02
		(0.008)

Table A1.7.2: Summary Statistics (Mean and Standard Errors) for Full Sample and by Cigarette Price Tier

Variables	All	Low	Medium	High	Premium
Cig. Consumption Per Day	9.500	10.266	9.477	9.017	9.429
(range: 0-75)	(0.120)	(0.214)	(0.227)	(0.328)	(0.453)
Change in Income	-250.287	-685.925	-69.088	755.233	536.213
(range: -22706 – 20436)	(0.090)	(0.161)	(0.220)	(0.330)	(0.499)
Education	1.915	1.712	1.998	2.423	2.700
(1 - illiterate, 2 - 1-8 years of schooling, 3 - 9 or more years of schooling)	(0.010)	(0.018)	(0.022)	(0.028)	(0.032)
Age	39.710	39.470	37.358	32.992	33.091
(range: 15-107)	(0.227)	(0.447)	(0.493)	(0.532)	(0.674)
Urban	0.344	0.202	0.369	0.665	0.844
(0 - rural, 1 - urban)	(0.007)	(0.012)	(0.016)	(0.021)	(0.022)
Addiction Level (0 - less addicted, 1 – more addicted)	0.610	0.660	0.632	0.507	0.419
	(0.008)	(0.014)	(0.016)	(0.023)	(0.032)

Table A1.7.3: Summary Statistics (Mean and Standard Errors) for Full Sample and by Price Tier Switch

Variables	All	Unchanged	Up-trade	Down-trade
Cig. Consumption Per Day	9.500	10.311	8.952	10.171
(range: 0-75)	(0.120)	(0.210)	(0.361)	(0.370)
Change in Income	-250.287	-386.284	1566.281	-845.185
(range: -22706 – 20436)	(0.090)	(0.174)	(0.354)	(0.322)
Education	1.915	2.000	2.281	2.042
(1 - illiterate, 2 - 1-8 years of schooling, 3 - 9 or more years of schooling)	(0.010)	(0.020)	(0.033)	(0.032)
Age	39.710	37.493	36.236	35.086
(range: 15-107)	(0.227)	(0.398)	(0.717)	(0.663)
Urban	0.344	0.400	0.546	0.404
(0 - rural, 1 - urban)	(0.007)	(0.0134)	(0.025)	(0.024)
Addiction Level (0 - less addicted, 1 – more addicted)	0.610	0.626	0.556	0.619
	(0.008)	(0.014)	(0.026)	(0.024)

Table A1.7.4: Summary Statistics (Mean and Standard Errors) for Full Sample and by Quitter or Not

Variables	All	Smoker	Quitter
Change in Income	-250.287	-140.231	-1087.888
(range: -22706 – 20436)	(0.090)	(0.111)	(0.422)
Education	1.915	2.026	2.038
(1 - illiterate, 2 - 1-8 years of schooling, 3 - 9 or more years of schooling)	(0.010)	(0.012)	(0.043)
Age	39.710	37.044	40.560
(range: 15-107)	(0.227)	(0.252)	(1.010)
Urban	0.344	0.411	0.268
(0 - rural, 1 - urban)	(0.007)	(0.008)	(0.026)

Table A1.7.5: Estimates of the Reduced Form Equation for Cigarette Price

	Cigarette Price Per Pack
Tax (%)	80.467***
	(4.365)
Change in Income	-0.133**
	(0.059)
Change in Addiction Level	-1.374**
	(0.640)
Less educated	1.881***
	(0.469)
More educated	3.927***
	(0.705)
Age	-0.032**
	(0.014)
Urban	1.885***
	(0.666)

Notes: Standard errors are given in parentheses, * indicates significance at the 10% level, ** indicates significance at the 5%level, *** at the 1% level. For the education category, illiterate is the reference group and for urban, rural is the reference group.

Table A1.7.6: Effects of Change in Price, Income and Addiction Level on Change in CPD

	Change in CPD (Smokers only)
Change in Cigarette Price Per Pack	-0.090***
	(0.024)
Change in Income	0.129***
	(0.035)
Change in Addiction Level	2.988***
	(0.304)
Less educated	0.078
	(0.554)
More educated	0.940
	(0.646)
Age	-0.010
	(0.014)
Urban	0.167
	(0.470)
Number of Observations	1440

Notes: Standard errors are given in parentheses, * indicates significance at the 10% level, ** indicates significance at the 5% level, *** at the 1% level. For the education category, illiterate is the reference group and for urban, rural is the reference group.

Table A1.7.7: Effects of Change in Price, Income and Addiction Level on Prob. to Up-trade, Prob. to Down-trade and Prob. to Quit

	Whether to Up-trade or Not (Smokers only)	Whether to Down-trade or Not (Smokers only)	Whether to Quit or Not (Smokers and quitters)
Cigarette Price Per Pack	-0.014**	0.061***	-0.004
	(0.007)	(0.007)	(0.004)
Change in Income	0.026***	-0.010	-0.015***
	(0.009)	(0.009)	(0.006)
Change in Addiction Level	-0.026	-0.205**	-
	(0.077)	(0.083)	
Less educated	0.594***	0.090	0.068
	(0.148)	(0.128)	(0.087)
More educated	0.989***	-0.669***	0.192*
	(0.175)	(0.128)	(0.107)
Age	-0.007**	0.001	0.008***
	(0.004)	(0.004)	(0.002)
Urban	0.344***	-0.547***	-0.259***
	(0.119)	(0.128)	(0.080)
Number of Observations	858	874	3029

Notes: Standard errors are given in parentheses, * indicates significance at the 10% level, ** indicates significance at the 5%level, *** at the 1% level. For the education category, illiterate is the reference group and for urban, rural is the reference group.

Table A1.7.8: Effects of Change in Price, Income and Addiction Level on Different Types of Changes in Smokers' Behavior (only smokers are considered)

	No Change in Quantity and Up-trade	No Change in Quantity and Down-trade	Increase in Quantity and Unchanged Price Tier	Increase in Quantity and Up-trade	Increase in Quantity and Down-trade	Decrease in Quantity and Unchanged Price Tier	Decrease in Quantity and Up-trade	Decrease in Quantity and Down-trade
Cigarette Price	-0.001	0.058***	-0.011	-0.006	0.068***	-0.006	-0.026*	0.056***
	(0.020)	(0.021)	(0.010)	(0.014)	(0.014)	(0.010)	(0.014)	(0.014)
Change in Income	0.013	-0.004	0.010	0.044**	-0.008	-0.004	0.026*	-0.035*
	(0.027)	(0.028)	(0.014)	(0.019)	(0.020)	(0.014)	(0.019)	(0.019)
Change in Addiction Level	0.014	-0.437	0.349***	0.369*	-0.111	-0.338***	-0.424**	-0.741***
	(0.275)	(0.300)	(0.127)	(0.191)	(0.193)	(0.131)	(0.176)	(0.205)
Less educated	0.655	-0.186	-0.199	0.285	-0.048	-0.315*	0.408	-0.440
	(0.522)	(0.395)	(0.189)	(0.311)	(0.275)	(0.178)	(0.293)	(0.268)
More educated	1.387**	-0.506	0.351	1.058***	-0.409	-0.085	1.120***	-0.564
	(0.559)	(0.520)	(0.250)	(0.370)	(0.354)	(0.243)	(0.338)	(0.350)
Age	-0.015	-0.000	-0.012**	-0.014*	-0.008	-0.006	-0.020***	-0.008
	(0.012)	(0.012)	(0.006)	(0.008)	(0.008)	(0.005)	(0.007)	(0.008)
Urban	-0.015	-0.955**	-0.077	0.108	-0.952***	-0.150	0.301	-0.722***
	(0.363)	(0.414)	(0.205)	(0.269)	(0.271)	(0.183)	(0.246)	(0.271)
Number of Observations	111	107	352	152	178	365	181	169

Notes: Standard errors are given in parentheses, * indicates significance at the 10% level, ** indicates significance at the 5%level, *** at the 1% level. For the education category, illiterate is the reference group and for urban, rural is the reference group.

Essay 2

Does Change in Perception of Tobacco Risk Affect Smokers' Behavior? – An Empirical Analysis

2.1 Introduction

Information dissemination on harmful effects of tobacco has always been a major tool for reducing tobacco consumption in all countries. The World Health Organization's Framework Convention on Tobacco Control (FCTC) states as its first guiding principle that: "Every person should be informed of the health consequences, addictive nature and mortal threat posed by tobacco consumption and exposure to tobacco smoke'' (Article 4.1)[14]. It is widely believed that exposing smokers to the right information on tobacco risk will eventually lead them to quit smoking or at least reduce tobacco consumption Hammond et al., 2006, Cheng et al., 2015, Yang et al., 2010 and Lin et al., 2010). However, literature reveals mixed results that sometimes even contradicts such belief. While some studies concluded that higher knowledge on negative effects of tobacco did not have positive effects on quitting others have found positive effects of knowledge on quitting (Xu et al., 2015 and Leidner et al., 2015). Most of these studies are based on cross-sectional data-sets. Therefore they fail to reveal how the behavior of the same individual would change in lieu of a greater understanding of the harmful effects of tobacco consumption.

In this study, the panel data from International Tobacco Control (ITC) Bangladesh is used. By observing individuals over a length of time, this paper examines whether changing the perception of tobacco risk (PTR) brings about a change in the attitude of smokers and non-smokers towards tobacco consumption. Perception of tobacco risk (PTR) is a term coined in this paper for the purpose of capturing the understanding that people hold about the harmful effects of tobacco consumption. Overtime, perception changes. With the development of

14 WHO Framework Convention on Tobacco Control (2005).

awareness or knowledge creation the perception that tobacco is a harmful product may become stronger; again, with time despite possessing information, the perception may become weaker perhaps due to stronger addiction towards smoking, advertisement by tobacco companies, etc. This paper investigates how important PTR is in changing peoples' attitude towards smoking. For smokers, this means whether they reduce the number of cigarettes smoked in a day, or quit or continue unabated. For non-smokers, this means whether they stay away from cigarettes or consider initiation.

Two main issues are addressed in this paper. First, this paper wants to observe how PTR varies among different types of smokers (cigarettes, bidi[15] and quitters) and non-smokers across different socio-demographic backgrounds. Second, it examines among the cigarette smokers across different socio-demographic groups how changing PTR over the years influences their behavior towards smoking. The latter issue is studied through analysis of change in cigarette consumption per day (CPD) and the probability to quit. The paper also explores how a change in PTR influences the initiation of the smoking decision. Such analysis will enhance understanding of the effectiveness of information dissemination component of the tobacco control policy framework.

In literature, there are two broad categories of studies that address the knowledge or perception of tobacco risk. In the first category, studies focus on understanding smokers' level of knowledge across different socio-demographic status. For example, Dreizen et al. (2016) used the ITC-Bangladesh dataset and found that smaller percentages of women, the illiterate, urban slum residents, and low-income Bangladeshis were aware of the health harms of tobacco.

[15] Bidi is a cheap hand made smoked-tobacco largely consumed by the lower socio-demographic groups of the country.

These vulnerable groups had lower odds of awareness compared to the more advantaged groups. Sansone et al. (2012) revealed important differences in India according to socioeconomic factors and state: higher levels of knowledge were found in Maharashtra than in Bihar, in urban compared to rural areas, among males, and among smokers with higher education. Similar results are also found in papers by Garg et al. (2012) where the authors observed significant differences in knowledge regarding hazards of smoking across different socio-demographic groups in the same country. Fakhfakh et al. (2002) found a disparity in the level of knowledge on the harmful effects of smoking among smokers in Tunisia.

Siahpush et al. (2006) studied four developed countries namely United States of America, Canada, United Kingdom and Australia to see how awareness on harmful effects of smoking varies across different socioeconomic status. They found that in these countries lower socioeconomic status was associated with lower awareness of the harms of smoking and misunderstanding around nicotine.

In the second category, studies emphasize on how information on harmful effects of smoking is associated with the smoking behavior. In a paper by Hammond et al. (2006) a study was conducted in the same four developed countries mentioned earlier (USA, UK, Canada and Australia) and found that health knowledge was strongly associated with intentions to quit among smokers in all four countries. The authors argued that although awareness and acceptance of the health risks of smoking may not be a sufficient condition for quitting, it is likely a necessary one for most smokers and serves an important source of motivation.

The paper by Cheng et al. (2015) using China's Global Adult Tobacco Survey (GATS) revealed that compared with those who have never smoked and those who have ceased smoking, current smokers in China are more likely to believe that low-tar cigarettes are less harmful than

regular cigarettes. Yang et al. (2010) found that the overall awareness of health risks of smoking in China was low compared to developed countries. Current smokers in China were less likely than non-smokers and former smokers to acknowledge the consequences of smoking. Moreover, current smokers who were more aware of the health consequences of smoking were more likely to intend to quit smoking. Similar results were observed by Lin et al. (2010) where individuals with greater knowledge about smoking displayed a lower risk of smoking in Taiwan. Palipudi et al. (2012), Dawood et al. (2016) and Shomar et al. (2014) reaffirm in their studies that smokers, in general, have low knowledge about harmful effects of smoking and highlighted the need for an expansion of awareness programs.

Aryal et al. (2015) found that the risk of current smoking behavior significantly increased with those who has a positive perception about smoking. Sansone et al. (2012) showed that smokers in India with higher knowledge were significantly more likely to have plans to quit smoking. Ebirim et al. (2014) established that poor knowledge of health effects of smoking was statistically associated with cigarette smoking. Knowledge of health problems associated with smoking proved to be the major reason for not smoking by never smoked adolescents in Nigeria.

Almost all of the papers display positive results. That is enhancing knowledge and understanding of the harmful effects of tobacco reduces tobacco consumption, or at least motivates individuals to quit smoking. However, there are some exceptions. For example, in a paper by Xu et al. (2015) it is found that in China young adult males with higher education have a better knowledge of smoking hazards. However, this knowledge does not necessarily translate into behavioral health outcomes such as not smoking.

Leidner et al. (2015) looked into the historical trend in smoking in the US. Authors found that the proportions of individuals who were self-reported smokers fell between 1949 and 1981.

Among smokers, the proportion who believed smoking was harmful increased from 1949 to 1981. However surprisingly, the proportion of the total population who were smokers and who believed smoking was harmful remained fairly stable across the period of the data set. This group of smokers consumed cigarettes despite the known health risks and harms, which they acknowledged.

Findings from literature reveal that knowledge of the harmful effects of smoking varies considerably across socio-demographic groups. It also shows that whether this knowledge gets translated to any desirable action outcomes is ambiguous. A point to note is that most of the studies mentioned above use cross-sectional data-set for analysis. They thus give a static snap-shot, i.e., how a stock of knowledge affects smoking behavior across individuals. This paper adds to the understanding by conducting a similar study over a panel data set. This paper looks at how the stock of knowledge varies across different socio-demographic groups. It then uses the panel data to identify how this stock of knowledge changes over time for these socio-demographic groups. Finally, it analyses how this change in the stock of knowledge (PTR) affects the smoking behavior of the same individual in the given time frame. For the context of Bangladesh, such analysis with a panel data-set is new.

The remainder of the paper is organized in the following manner. Section 2.2 gives an overview of the data and methodology. Section 2.3 presents the descriptive statistics. Section 2.4 explains the econometric models and presents the results. Finally, section 2.5 concludes.

2.2 Data and Methodology

2.2.1 Data

The paper is based on data collected by the International ITC surveys in Bangladesh. The ITC Bangladesh Project was launched in 2008 to evaluate the impact of tobacco control legislation in Bangladesh. The ITC Bangladesh Survey is a face-to-face survey conducted by trained interviewers from the Bureau of Economic Research at the University of Dhaka, Bangladesh, in collaboration with the ITC Project team at the University of Waterloo in Canada. The ITC Bangladesh Survey is a cohort survey consisted of a nationally representative probability sample of smokers and non-smokers aged 15 years and older selected through a multistage cluster sampling design (sampling with probability proportional to population size at the levels of administrative units such as District, Upazila/Thana and Village/Ward). For this national sample, 23 districts out of the 64 districts covering Bangladesh were selected, and of the 23, 21 were selected randomly, with probability proportional to population size. Two districts were purposively selected to include the tribal populations. A total of 40 upazilas from the 23 districts, and (usually) 2 villages (or wards) from each upazila (or thana) were selected, again with probability proportional to size. Thus, a total of 80 villages/wards were selected for the main survey. One village included roughly 300- 600 households. A maximum of 450 households could be enumerated in each village[16].

The paper uses data collected in the second and third waves of the survey, conducted in 2010 and 2011-12, respectively. Between wave 2 and 3, the overall retention rate is 90.2%[17].

[16] ITC Bangladesh Wave 1 technical report.
[17] ITC Bangladesh Wave 3 technical report.

For the descriptive statistics, this paper focuses to differentiate different types of tobacco users: cigarette, bidi, and quitters as well as non-smokers. However, for the regression analysis, the focus is limited to cigarette smokers, quitters, and non-smokers. Bidi smokers have been left out as the sample size for this group is too small. As the study intends to analyze individual's behavior across time, data relating to smokers and non-smokers have been matched in wave 2 and 3, and 3733 observations have been generated. Unmatched individuals are dropped from the analysis. In the analytical part, a set of cross-sectional regression models is also used to compare results with the existing literature and strengthen the justification of using a panel data set. For that purpose, data from both waves are pooled together to generate a cross-sectional data-set.

International Tobacco Control Project conducts surveys in twenty-nine countries across the globe, covering both developing and developed countries. These surveys are internationally synchronized where a significant portion of the questionnaire is identical among all countries. The data from the survey were checked for out-of-range values, outliers for open-ended responses, and mismatches of individual identifiers and smoking status between waves. The mismatches between household level forms and individual level surveys were also identified and corrected. All the variables in each wave were checked for consistency and errors. Corrections of data entry and cases with out-of-range values were also carried out using appropriate rules.

Despite high retention rates, and internationally synchronized data, there are some limitations that the reader must keep in mind. First, only two waves are used to observe change variables which represent change in smoking behavior. A longer time horizon would be more insightful in observing persistent change in smoking behavior. Second, all the key information

are self-reported, therefore there is some possibility of self-reporting bias. With self-reported data, change can encompass true change and self-reporting errors between the different measurement periods (i.e., recall bias). Third, rather than asking specific individual income, the questionnaire required respondents to choose a given bracket within which their income lies. This is a practice, common in data collection, as individuals are often reluctant to report their exact income. However, for the purpose of economic analysis, it is difficult to capture the exact extent of income change across individuals over time.

2.2.2 Methodology

As the main focus of the paper is to understand smokers' PTR, a Perception of Tobacco Risk Index (PTRI) has been constructed. In the survey, there are nine binary (yes/no) questions on smokers' perception on whether smoking causes certain diseases or not. The list of selected questions is presented in appendix A2.6.1. To create the PTRI, these binary answers are used. In data value 1 is assigned if the respondent answers 'YES' to a given question and 0 if the respondent answers otherwise. Then, for a given respondent the answers to all the nine questions have been summed up to generate a perception index. The index thus can take the highest value of 9 corresponding to 'perfect' PTR, and the lowest value of 0 is indicating a complete lack of PTR. This is considered as the PTRI (Perception of Tobacco Risk Index) of a given respondent in the survey.

Such an index is constructed for every respondent in both wave 2 and wave 3. Each individual thus may have the same index (if perception remains unchanged) or two different

indices (if perception changes) in the two consecutive waves. Using the matched dataset[18], 'change in PTRI' variable is constructed. This is the variable that is used in the analysis to estimate the effectiveness of the change in PTRI in changing the attitude of smokers and non-smokers towards smoking.

For the purpose of analysis, three outcome variables are used. They are a) whether to commence smoking or not, b) whether to quit or not and c) change in CPD. The first two out of the three choice variables are binary. On the explanatory side, there are three principal explanatory variables: price, change in income and change in PTRI.

In data, prices are reported by individuals which create the possibility of an endogeneity bias. To avoid this problem, tax rates based on the respective prices reported by the individual are used as instruments for prices. The coefficient of the tax variable in the reduced form regression for the price is 79.70, which implies that if the tax rate increases by one percentage point, the average price per pack of 10 cigarettes increases by BDT[19] 0.80.[20] Such statistically significant coefficient of the tax variable indicates that it is highly correlated with price. This tax variable was also tested as a valid instrument for the price, and a very large F statistic (greater than 10) is found in the reduced form regression for the price.[21] All prices are adjusted for inflation by calculating real prices where 2010 is the base year.

The data required respondents to report a given range within which their income lies, as opposed to the exact income in figures. To observe the real income, income categories have

[18] Where all the smokers, quitters, and non-smokers in wave 2 and 3 are matched.
[19] BDT refers to Bangladesh Taka which is the currency of Bangladesh.
[20] See appendix A2.6.6 for details.
[21] According to Stock and Watson, when there is one right-hand-side endogenous variable, the F statistic from the first-stage regression can be used to test for the significance of the instrument if the F-statistic should be greater than 10.

been assigned with mid-point values of the respective income category range. Then mid-points are adjusted for inflation by calculating incomes where 2010 is the base year. For the purpose of the study, a new variable ‘change in income' is generated by calculating the difference between the income mid-points reported in consecutive surveys. Positive values indicate an increase in income whereas negative values signify a decrease in income. This ‘change in income' variable is then divided by 1000 to identify the effect of per BDT 1000 change on different tobacco behavior variables.

Finally, the impact of demographics on smoking behavior has been captured through the following variables: education, age, and residence (rural or urban). Inclusions of such demographic variables are well accepted in literature. Education is subdivided into three categories: illiterate, less educated (1-8 years of schooling) and more educated (9 and more years of schooling). An illustration of how these variables appear in the dataset is given in the appendix A2.6.3 through frequency distributions of respective responses.

2.3 Descriptive Statistics

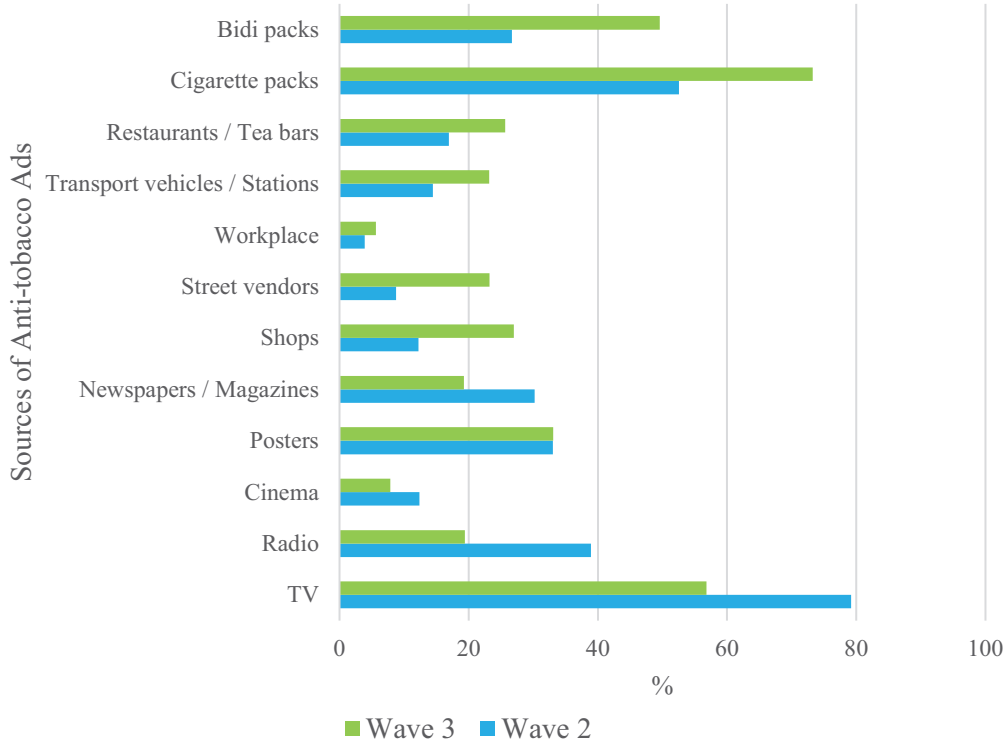
Bangladesh is a fast-growing economy that has maintained an annual per capita GDP growth rate of around 5% for the last decade (World Development Indicators). Cigarette consumption has also been on the rise in the country, both in the aggregate and per capita terms. From 1997 to 2010, cigarette consumption increased from 50.9 billion cigarettes to almost 71.4 billion cigarettes. This shows an increase by over 40%[22]. In Bangladesh, smoking is considered as one of the cheapest forms of recreation for the mass population. Smoking is also considered as a

[22] Barkat el al. (2012).

popular complementary good to tea – another standard drink for social associations and recreation. From a cultural perspective, smoking is widely accepted among peers and especially among men – although it is considered to be disrespectful to smoke in front of elders. For women to smoke publicly is also frowned upon from a social stand-point. Such traditions imply that even though smoking is widely accepted as a social norm, the perception that it is not a social good lies in the undercurrents of social behavior.

Information on harmful effects of tobacco can be found in a variety of forms. The different sources of information on harmful effects of tobacco listed in the data are summarized in the figure below:

Figure 2.1: Sources of Anti-tobacco Advertisements over the Waves



The figure above shows that the largest source of information on the harmful effects of smoking in 2011/12 is warning labels on cigarette packs. One must note that in Bangladesh, the warning labels on cigarette packs are all in text form (without any graphic images). Bangladesh is a country that had literacy rates below 60% in 2010[23]. Also, the warnings simply state that cigarette smoking is harmful to health without stating exactly what or how severe the possible forms of harm may be. The third point in regards to the matter is that in Bangladesh, more than half[24] of all the smokers buy lose sticks of cigarettes as opposed to whole packs. Thus this group of individuals does not get any exposure to the warning labels at all. Given the high illiteracy rates in the country, the lack of graphics on cigarette packs and the trend to sell cigarettes as lose sticks, the effectiveness of such warning labels in raising awareness effectively can be brought to question. Finally, maintaining maximum stress on warning labels as a source of information has a drawback. When information is coming from purchasing cigarettes, those that have not smoked before will not get access to this information. In other words, non-smokers who may consider starting smoking will not get the information needed to deter their decision.

The figure also shows that over the span of just one year, the use of media as a means to spread the message has declined. The share of information contained in TV, radio, cinema and newspapers in percentage points has gone down. Rather the focus is more on places of social associations such as cigarette shops, vendors, work places, etc. Perhaps from a policy point of view, stress has been moved away from media and towards warning labels and word of mouth to spread the knowledge on harmful effects of smoking. Such measures may be in response to an attempt to disseminate information at lower costs. Again, in a country with high rates of

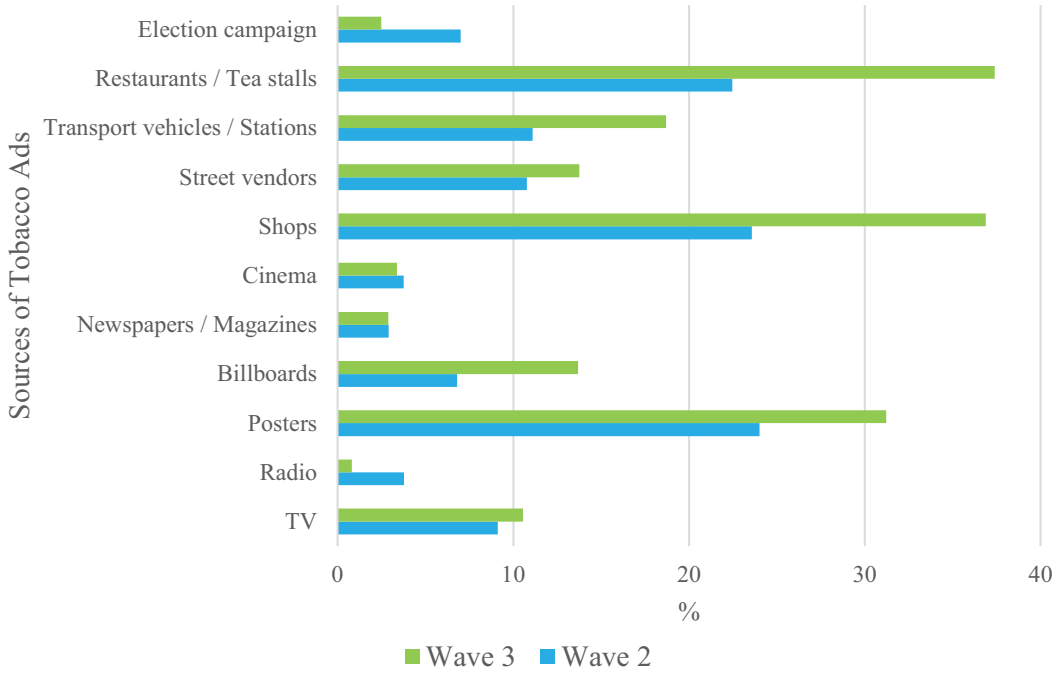
[23] Unicef – Bangladesh Statistics
[24] Based on the survey data. See appendix A2.6.2 for details.

illiteracy, removing focus from visual sources such as TV, Radio, and cinema may not prove to be such a good idea. After all, these forms of media have the largest outreach nationwide. When the focus is placed on vendors, shops, and workplaces, the message may be more personalized but limited to a local audience.TV and Radio are the most popular means of media for rural Bangladesh.

In Bangladesh, tobacco advertisement is still not completely banned. As a result, individuals are simultaneously confronted with information that is anti- tobacco as well as pro-tobacco. Figure 2.2 highlights different sources of tobacco advertisements that the respondents were exposed to over the same span of time.

It can be observed from the figure below that respondents noticed more tobacco advertisements from most of the sources. The leading sources of tobacco advertisements are posters, shops, and restaurants/tea stalls. Ironically, when it comes to advertising tobacco, stress on visual sources has increased.

Figure 2.2: Sources of Tobacco Advertisements over the Waves



Having given an overview of how information on tobacco – good or bad – are disseminated the paper next focuses on how they are received. Table 2.1 summarizes PTRI of wave 3 across different types of smokers. The different types considered are cigarette and bidi smokers, quitters as well as non-smokers. Bidi is known to be the 'poor man's cigarette' which is locally produced, low quality and much cheaper than cigarettes. In the table, perception indices are displayed across different socio-demographic groups. This exercise will provide the required initial understanding on how perception varies across different types of smokers as well as across different socio-demographic groups.

Table 2.1: Wave 3 Mean PTRI of Different Types of Smokers and Different Socio-demographic Groups

	Cigarette smokers	Bidi smokers	Quitters	Non-smokers
All	7.70 (1.98)	6.33 (3.15)	7.95 (1.56)	7.56 (1.80)
Low income	7.62 (2.03)	6.72 (2.86)	7.96 (1.55)	7.57 (1.76)
High income	7.80 (1.91)	5.85 (3.43)	7.84 (1.61)	7.71 (1.70)
Less educated	7.54 (2.09)	6.42 (3.09)	7.82 (1.67)	7.37 (1.89)
More educated	8.26 (1.40)	5.51 (3.59)	8.24 (1.18)	8.04 (1.44)
Rural	7.59 (2.10)	6.85 (2.86)	7.91 (1.61)	7.71 (1.72)
Urban	7.82 (1.83)	4.85 (3.45)	8.07 (1.40)	7.41 (1.87)

Note: Standard errors are presented in the parentheses.

In the above table, the PTRI is generated on a scale of 0-9 for every category. It is observed from the table that among all different types of smokers, quitters display the highest average PTRI. Higher PTR may influence smokers to become quitters eventually. Bidi smokers demonstrate the lowest average perception index. In Bangladesh, bidis are sold at a much lower price than cigarettes, therefore bidis are mostly consumed by poor rural smokers who are in most times not well-informed about the harmful effects of smoking. In most cases, higher education, higher income, and urban residence show higher average PTRI than their respective counterparts except among bidi smokers.

Smokers can also be categorized based on their smoking intensity and addiction level. Observing mean values of PTRI based on such categories reveal that light[25] and less addicted[26] smokers have higher mean PTRI compared to heavy and more addicted smokers respectively.

[25] Light smokers who smoke less than 10 CPD whereas heavy smokers are those who smoke at least 10 CPD.
[26] Smokers who light up their first cigarette one hour after waking up are considered less addicted, more addicted are those who light up their first cigarette within the first hour of waking up.

Also, it is observed that dual[27] smokers have lower mean PTRI compared to exclusive cigarette smokers. Results are provided in appendix A2.6.4.

The rest of the analysis of this paper focuses on the perception of health risk related solely to cigarette smoking. In the table 2.2, eight different socio-demographic groups based on their income, education, and residence are displayed. The groups have been arranged in ascending order of socio-demographic standing. For example, the group under 'low income-less educated-rural' is considered to be the group with the lowest socio-demographic rank where as the one with 'high income-more educated-urban' is the one with the highest socio-demographic rank.

Table 2.2: Mean Values of PTRI in Wave 2 and Wave 3 across Different Socio-demographic Groups

Socio-demographic groups	Wave 2	Wave 3
Low income-less educated-rural	5.45 (3.01)	7.43 (2.09)
Low income-less educated-urban	5.24 (2.47)	7.46 (1.88)
Low income -more educated-rural	7.00 (2.64)	7.83 (1.97)
Low income -more educated-urban	6.57 (2.47)	8.07 (1.41)
High income-less educated-rural	6.50 (2.74)	7.39 (2.24)
High income-less educated-urban	7.22 (2.02)	7.89 (1.59)
High income-more educated-rural	8.17 (1.40)	8.24 (1.32)
High income-more educated-urban	7.22 (2.02)	8.43 (1.22)

Note: Standard errors are presented in the parentheses.

The first observation from the above table is that all the groups demonstrate higher perception index compared to the previous wave. Thus in the span of one year, PTR has improved. Furthermore, it is observed that groups belonging to lower socio-demographic tiers

[27] Smokers who smoke both cigarettes and bidis.

have experienced larger changes in PTRI compared to groups belong to higher socio-demographic tiers. Although smokers that belong to lower socio-demographic groups have lower initial PTRI values, their change in perception index is faster than their higher tier counterparts. This explains that there is still information on tobacco risk that has not yet reached the least fortunate ones of the society. Disseminating information targeted to these groups is enabling them to gain grounds faster than the more fortunate ones who have nearly reached the highest perception value.[28]

It is crucial to acknowledge that individuals receive information from both pro and anti-tobacco campaigners. Perception based on information received from anti-tobacco initiatives are constantly challenged by the advertisements of tobacco products. Therefore perception can change over time in both directions. The table below demonstrates the proportion of changes in PTR across different groups.

Table 2.3: Change in PTRI across Different Groups

		Proportion (%)		
Variables	Categories	Decrease	Unchanged	Increase
	All	20.62	26.90	52.48
Income	Low	17.71	22.93	59.36
	High	23.27	32.28	44.45
Education	Illiterate	17.98	19.32	62.70
	Less educated	19.95	22.89	57.16
	More educated	22.87	38.22	38.91
Age	Young	21.16	29.24	49.60
	Old	20.15	24.84	55.01
Residence	Rural	20.89	27.09	52.02
	Urban	20.10	26.52	53.38

[28] See appendix A2.6.5.

It is interesting to observe from the table that the perception index decreased for around 21% of all the respondents whereas it increased for 52%. This proves the very fact that PTR does not necessarily change in one direction. Tobacco advertisements can be responsible for the decrease in PTRI. While observing the proportion of such changes across groups, there are some interesting observations as well. For example, in the income group, high-income individuals display a higher negative change in perception index than their low-income counterparts. Furthermore, the more educated group has the highest proportion of negative PTRI change compared to less educated or even illiterate group. Such finding requires due attention. It is found in the previous results that individuals belong to lower socio-demographic groups have lower average PTRI compared to high socio-demographic groups. Then again the high income and more educated groups tend to lead other groups in reversing their relatively high PTRI. Therefore, strategies need to be targeted at these groups to counter such negative change.

2.4 Empirical Analysis

In the literature, most of the studies are based on the cross-sectional dataset. Although cross-sectional dataset reveals valuable information on how selected variables are related to each other, this does not capture changes in individuals' behaviors over time. Repeated observations of the same individuals are required for examining behavioral changes. To be consistent with the existing literature as well as to comprehend the importance of using panel data, first, the following regression equations are run on the cross-sectional dataset where both waves are pooled together for analysis.

$$Prob.to\ smoke\ or\ not = \alpha_1 + \alpha_2 p_T + \alpha_3 I + \alpha_4 PTRI + \alpha_5 X + \mu \quad (1)$$

$$Prob.to\ quit\ or\ not = \beta_1 + \beta_2 p_T + \beta_3 I + \beta_4 PTRI + \beta_5 X + \varepsilon \quad (2)$$

$$CPD = \gamma_1 + \gamma_2 p_T + \gamma_3 I + \gamma_4 PTRI + \gamma_5 X + \eta \quad (3)$$

Three possible outcomes are tested in the analysis above. The first one is the probability to commence smoking or not. This tests the strength of different variables in influencing a non-smoker to commence smoking. The second possible outcome is the probability of quitting or not and the third one is CPD. Understanding how perception affects all three dependent variables are crucial in evaluating information dissemination on tobacco risk initiatives. On the other side, there are three main explanatory variables; p_T that signifies cigarette pack prices, I that represents income and $PTRI$ that denotes the perception index. These equations do not have any change variable, therefore, unable to capture smokers' change in behavior.

All the equations also have X that represents a set of socio-demographic variables. X is comprised of education, age, and residence (rural or urban). Individuals are assigned to three broad education category: illiterate, less educated (1-8 years of schooling) and more educated (9 and more years of schooling).

The results of the three above regressions are presented below. Findings display that real income has a positive relationship with probability to smoke or not whereas cigarette price has a negative relationship. Interestingly, results reveal that higher PTRI also raises the likeliness to smoke. Such result requires more attention. As revealed in Figure 2.1, in Bangladesh, one of the prime sources of information on harmful effects of smoking is the warning text labels on cigarette packs themselves. A large source of information also comes from street vendors and tea bars. In Bangladesh, tea is a common beverage and often considered as a complementary

product to cigarettes. When information comes from sources such as these, they reach only those who are already smoking. Therefore such result can be explained through the presumption that only smokers are faced with more specific information on harmful effects of smoking compared to non-smokers. However, cross-sectional dataset does not explain how this higher perception is affecting smokers' behavior after acquiring such information from the cigarette packs or other sources. A panel dataset can be useful in clarifying such queries. Moreover, individuals living in urban residence are more likely to smoke compared to individuals from rural areas, and less educated are more likely to smoke compared to illiterates.[29]

Table 2.4: Effects of Price, Income and PTRI on Prob. to Smoke, Prob. To Quit and CPD – Using Cross-sectional Dataset

	Probability to Smoke (Smokers and non-smokers)	Probability to Quit (Smokers and quitters)	CPD (Smokers only)
Cigarette Price Per Pack	-0.006***	0.003	-0.094***
	(0.002)	(0.003)	(0.015)
Income	0.013***	-0.016***	0.136***
	(0.003)	(0.006)	(0.024)
PTRI	0.050***	-0.021	-0.057
	(0.007)	(0.013)	(0.062)

Notes: Standard errors are given in parentheses, * indicates significance at 10%, ** indicates significance at 5%, *** indicates significance at 1%.

Results from the cross-sectional data-set also reveal that higher income reduces the probability to quit smoking. However, higher price does not have a statistically significant effect

[29] See appendix A2.6.7 for full results.

on the probability to quit. This highlights the ineffectiveness of cigarette taxes in increasing the number of effective quitters in Bangladesh. Besides, more educated, older and rural smokers are more likely to quit compared to their respective counterparts.[30]

Interestingly, higher PTRI is not statistically significant in increasing the probability to quit. Once again, such result demands further investigation. Having more information on harmful effects of smoking ideally should prompt smokers to quit. But when analyzing a cross-sectional data-set, it is observed that individuals with a higher level of PTR are not significantly more likely to quit. What the panel data helps us evaluate is that if the PTR of the same individual is changed then is s/he more likely to quit or not. Thus to assess the actual effectiveness of information dissemination, evaluation of panel data-set seems more justified.

Results from the third regression model illustrate that higher cigarette price reduces CPD. Conversely, higher income raises CPD. The PTRI once again does not have any statistically significant effect on CPD. Only by observing the change variable in PTRI from the panel data, a complete understanding of the effects of PTR on smoking behavior can be derived. Urban residents increase CPD compared to their rural counterparts. Full results of the above regressions are given in the appendix A2.6.7.

For the next series of regression equations, a similar analysis is carried out but with the panel dataset. To capture the essence of a panel data, CPD has been changed to change in CPD as the dependent variable. The two other dependent variables remain the same. Among independent variables, change in income and change in PTRI are used instead of income and

[30] See appendix A2.6.7 for details.

PTRI. Such change variables are introduced to investigate smokers' and non-smokers' behavioral change over time.

$$Prob.to\ smoke\ or\ not = \alpha_1 + \alpha_2 p_T + \alpha_3 \Delta I + \alpha_4 \Delta PTRI + \alpha_5 X + \mu \quad (4)$$

$$Prob.to\ quit\ or\ not = \beta_1 + \beta_2 p_T + \beta_3 \Delta I + \beta_4 \Delta PTRI + \beta_5 X + \varepsilon \quad (5)$$

$$Change\ in\ cig.consumption = \gamma_1 + \gamma_2 p_T + \gamma_3 \Delta I + \gamma_4 \Delta PTRI + \gamma_5 X + \eta \quad (6)$$

In order to see how these variables affect the smoking behavior of non-smokers and smokers across different socio-demographic backgrounds, groups are formed based on income, education, age, and residence. Definitions, as well as frequencies of each group, are presented in the appendix (see A2.6.4 for details).

The next set of tables present results from the above set of regression equations where change variables are generated using the panel dataset. Change in income and change in PTRI are included in the models. First, the general models are observed on all individuals to see how a change in PTR affects smokers' behavior. Then, in this section different sub-groups have been formed based on income, education, age and residence to observe if smokers' belonging to different groups behave differently in response to change in PTR. This exercise adds to the contribution of the paper as it helps to highlight the behavioral differences that exist within groups. It enables policy makers to better identify target areas for information dissemination. Detail results of the regressions are given in the appendix.

Table 2.5: Effects of Price, Change in Income and Change in PTRI on Prob. to Smoke (non-smokers in both waves and non-smokers who initiate smoking in the following wave)

	All	Low income	High income	Less educated	More educated	Young	Old	Rural	Urban
Cigarette Price	0.027	-0.005	0.012	0.001	0.165	0.033*	0.001	0.052**	-0.019
	(0.017)	(0.042)	(0.019)	(0.021)	(0.120)	(0.019)	(0.036)	(0.024)	(0.024)
Change in Income	0.031*	-	-	0.039*	0.005	0.022	0.076*	0.005	0.097**
	(0.016)			(0.020)	(0.030)	(0.018)	(0.041)	(0.020)	(0.040)
Change in PTRI	-0.038	-0.116	0.008	-0.052	0.068	-0.042	-0.048	-0.060	-0.041
	(0.38)	(0.071)	(0.048)	(0.042)	(0.120)	(0.045)	(0.081)	(0.048)	(0.086)

Notes: Standard errors are given in parentheses, * indicates significance at 10%, ** indicates significance at 5%, *** indicates significance at 1%.

Results from the first regression equation fail to find any statistically significant relation between change in PTRI and probability to smoke. Conversely, there exists a negative correlation between PTRI and probability to smoke from the analysis of the cross-sectional dataset. The change in PTRI and probability to smoke seem to have a negative relationship for most groups, but it is not statistically significant for any of them. The decision to start smoking or not is more complex and dominated by several factors that cannot be controlled only by information dissemination. For example, the largest factor that pushes individuals to start smoking is the natural curiosity factor. Thus despite being aware of the harmful effects, individuals may still wish to "try it out." Also, there is the wish for individuals to ‘fit-in' with the crowd when friends and peers are already smoking. For the young, the ‘bravado' factor might play an important role in making such decisions. Thus, there may be other factors playing a stronger role than PTR when it comes to taking the decision. For these reasons PTR must be made more forceful such that it overcomes the other factors.

Results also reveal that an increase in income raises the probability to smoke for certain groups. Among which urban group displays the highest probability. Interestingly, increase in cigarette prices does not keep future smokers away from initiating smoking rather the signs show a positive correlation. Individuals from every generation tend to try out tobacco products no matter what the prices are and the perception is the level of curiosity outweighs these effects in most cases. However, how an increase in information on tobacco risk alters smokers' choice between continuing smoking or quitting is the question that the next table delves with.

Table 2.6: Effects of Price, Change in Income and Change in PTRI on Prob. to Quit (smokers in both waves and smokers who quit in the following wave)

	All	Low income	High income	Less educated	More educated	Young	Old	Rural	Urban
Cigarette Price	0.000	0.020***	-0.011*	0.007	-0.014*	-0.011	0.006	-0.006	0.015*
	(0.005)	(0.008)	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.006)	(0.008)
Change in Income	-0.010	-	-	-0.005	-0.017	-0.008	-0.009	-0.002	-0.027**
	(0.007)			(0.009)	(0.013)	(0.012)	(0.010)	(0.009)	(0.014)
Change in PTRI	0.033**	0.045**	0.009	0.046***	-0.019	-0.012	0.060***	0.033*	0.058*
	(0.015)	(0.020)	(0.022)	(0.017)	(0.036)	(0.027)	(0.019)	(0.017)	(0.035)

Notes: Standard errors are given in parentheses, * indicates significance at 10%, ** indicates significance at 5%, *** indicates significance at 1%.

Findings from the second regression model disclose that higher PTRI increases the probability to quit for most groups. Only groups that do not have any statistically significant effect of PTRI on quitting probability are high income, more educated and the young. All other groups show a positive effect of PTR. This signifies that information dissemination on harmful effects of smoking plays a substantial role in helping smokers to quit for most groups. The old displays the highest probability compared to other groups. This reaction can be explained as older smokers most likely already having health issues which help them form relatively more

effective PTR, and therefore they act on such perception more boldly than the other groups. In contrast, young does not even have a positive relationship with change in PTRI and the probability to quit. This can be due to their inexperience with actual health issues related to smoking, and thus a positive change in their PTRI does not get materialized in raising the probability to quit. Results also show that higher price does not have a consistent result for most of the groups. For low-income and urban smokers, higher price increases the probability to quit whereas high income and more educated smokers display a negative relationship between cigarette price and probability to quit. For the high-income group, cigarette price comprises of a small proportion of their income. Therefore, it does not affect their decision to quit or not as much as it would a low-income individual. Therefore, it can be derived from the above results that cigarette prices overall does not have a substantial impact on quitting probability. Although it is found in Table 2.4 that higher income reduces the probability to quit while using the panel dataset such result does not hold for any groups except for urban smokers.

Table 2.7: Effects of Price, Change in Income and Change in PTRI on Change in CPD (smokers only)

	All	Low income	High income	Less educated	More educated	Young	Old	Rural	Urban
Cigarette Price	-0.053**	-0.051	-0.066**	-0.533*	-0.063**	-0.065*	-0.040	-0.125***	0.053
	(0.023)	(0.043)	(0.030)	(0.031)	(0.030)	(0.034)	(0.030)	(0.031)	(0.035)
Change in Income	0.085**	-	-	0.105*	0.062	0.097*	0.073	0.081	0.087
	(0.041)			(0.057)	(0.054)	(0.059)	(0.058)	(0.057)	(0.060)
Change in PTRI	-0.073	-0.166	0.077	0.005	-0.356	-0.018	-0.096	0.013	-0.078
	(0.103)	(0.154)	(0.136)	(0.112)	(0.241)	(0.161)	(0.129)	(0.134)	(0.149)

Notes: Standard errors are given in parentheses, * indicates significance at 10%, ** indicates significance at 5%, *** indicates significance at 1%.

Results from the third regression model show that PTRI has no impact on smokers' change in CPD. According to the results, exposing to more information on harmful effects of smoking does not necessarily translate into the lower consumption of cigarettes. Although results from the previous table show that positive change in PTRI raises the probability to quit, findings from this table confirm that higher PTRI does not have any effects on continuing smokers. This is not necessarily undesirable. It can be deciphered from these two results that improving PTR successfully leads smokers to quit rather than to adjust smoking behavior. From a policy point of view, this means that information dissemination is indeed a successful tool in controlling the use of tobacco.

Furthermore, results show that higher price reduces CPD for high income, less and more educated, young and rural smokers. Rural smokers react the most in reducing CPD when price increase. Changes in income have a positive relationship with change in CPD for only two groups; less educated and young. Reactions to price and income change are consistent with the findings from the cross-sectional dataset.

2.5 Discussion and Concluding Remarks

The main motivation of this paper is to understand and analyze smoker's behavior as their perception of tobacco risk (PTR) changes. To assess individuals' understanding of tobacco risk, a perception index (PTRI) is formulated in this paper, and then by observing such index, change in individuals' PTR is captured. Consistent with the existing literature, it is found that PTRI is low among the low socio-demographic groups in Bangladesh. However results also reveal that the change in PTRI is faster among the low socio-demographic groups compared to their high

socio-demographic counterparts. The high income-more educated group already have a high value in the PTRI, therefore, their change is slower.

An alarming fact emerged from the data that high income, more educated groups are slipping away faster with a growing negative change in PTR compared to low socio-demographic groups. In the literature, it is mostly observed how PTR exists in different groups. Nonetheless, who is gaining and who is slipping away in terms of PTR is rarely addressed. This paper identifies the patterns of perception change in this regard. As a policy recommendation, such result demands strategies that are targeted towards poor to raise their awareness on tobacco risk, but at the same time, there should be different approach to addressing the rich and more educated so that their higher perception remains at that level. Perhaps from a policy perspective, controlling positive propaganda on the use of tobacco should be equally strengthened along with spreading information on the harmful effects of tobacco.

This paper observes smokers' behavior through three variables; whether to start smoking or not, whether to quit or not and change in CPD. By using three different regression models, each of these variables are analyzed. Results using the cross-sectional dataset show that PTRI and probability to smoke have a positive relation whereas PTRI has no statistically significant relation with the probability to quit or even CPD. Although cross-sectional dataset provides certain valuable information on how perception is related to these behavioral variables in a given period, a thorough understanding of behavioral change requires panel dataset.

Using the panel dataset, the change in PTRI variable is created and then used in the regression models to examine behavioral changes as a response to perception change. Results reveal that change in PTRI has no effect on non-smokers' decision to start smoking. This signifies that initiation of smoking cannot be managed by just informing non-smokers more

about the harmful effects of smoking. It requires additional tools such as smoking ban in public areas, home ban and graphic warnings on cigarette packs which can reinforce the negative perception of smoking.

Most of the smokers start smoking due to curiosity. But to continue smoking involves different driving forces. According to the results, PTRI change is positively related to probability to quit. It means that an increase in PTRI can successfully outweigh all the driving forces behind smoking. By knowing more about the harmful effects of smoking, the smokers' become more convinced to quit. An analysis based on different socio-demographic groups is also introduced in this paper to see how different groups behave to perception change. It is observed that higher PTRI increases the probability to quit for most groups. On the other hand, higher price does not have a typical impact of raising the probability to quit. This could be due to insignificant price rise together with the relatively low price of cigarettes in Bangladesh. Therefore cigarette taxation fails to have any significant impact on smokers that can eventually change their behavior towards smoking. The increase in income has a negative relationship with the probability to quit for all groups. However, the coefficients are not statistically significant.

Although increases in PTRI successfully raises the probability to quit for most groups, it fails to have any meaningful impact on the change in CPD. On the other hand, an increase in cigarette pack price becomes a significant contributor in reducing CPD. This reaffirms the need for a coordinated approach in tackling tobacco consumption in Bangladesh. Raising awareness increases the probability to quit however fails to reduce consumption for the continuing smokers. On the other hand, raising cigarette pack prices through taxes has an insignificant impact on raising the probability to quit, but it effectively reduces CPD.

Policies directed to controlling the use of tobacco take two forms: monetary motivation and non-monetary motivation. The tool for monetary motivation is the tax on cigarettes. However, given the addictive appeal of cigarettes, non-monetary motivations need to be equally forceful. Examples of non-monetary motivation include a ban on public smoking, creating public images that debauch smoking, etc. But the most important form of non-monetary motivation is raising awareness on the harmful effects of smoking. In this paper, the term PTR is used to measure exactly that. The paper shows that the most effect that PTR has on smokers is on their quitting probability. This shows that the correct form of information dissemination is the most useful tool in convincing individuals to quit.

However, an important segment of the population – those who consider initiation of smoking – are not yet captured by information dissemination. Factors affecting this group are a little more complex. There is the natural curiosity factor, the ‘bravado' factor associated with young age and also the wish to fit in when friends and peers are also smoking. Often, overcoming these issues with just information may be more difficult. Thus the paper concludes that to have any meaningful effect, PTR should be more targeted and coupled with aggressive taxes.

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2.6 Appendix

Table A2.6.1: List of questions used from the survey to construct the perception index for cigarette and bidi smokers, quitters and non-smokers

Questions (only two answer options: YES or NO)
Smoking causes stroke
Smoking causes impotence
Smoking causes mouth cancer
Smoking causes lung cancer
Smoking causes coronary heart disease
Smoking causes tuberculosis
Smoking causes bronchitis
Second-hand smoking causes asthma in children
Nicotine causes most of the cancer

Table A2.6.2: Different Forms of Cigarette Purchase

Cigarette Purchase in What Form	Survey year	
	2010	2011-12
Loose	73.48	55.50
Pack	26.52	44.50

Table A2.6.3: Proportions of Different Socio-demographic Groups

Variables	Categories	Proportion (%)
Income	Low (less than or equal to BDT 10000)	59.84
	High (more than BDT 10000)	40.16
Education	Illiterate	34.33
	Less educated (1-8 years of schooling)	46.34
	More educated (9 and more years of schooling)	19.33
Age	Young (less than or equal to 30)	43.55
	Old (more than 30 years)	56.45
Residence	Rural	54.64
	Urban	45.36

Table A2.6.4: PTRI across Different Types of Smokers in Wave 3

Different Types of Smokers	Mean Value of PTRI (Standard errors)
Exclusive cigarette smokers	7.70 (1.98)
Dual smokers (smoke cigarette and bidi)	6.79 (2.32)
Light smokers (CPD < 10)	7.45 (1.97)
Heavy smokers (CPD ≥ 10)	7.14 (2.21)
Less addicted smokers (light up the first cigarette after one hour of waking up)	7.92 (1.61)
More addicted smokers (light up the first cigarette within one hour of waking up)	7.07 (2.20)

Table A2.6.5: Change in Mean Values of PTRI over the Waves across Different Socio-demographic Groups

Socio-demographic Groups	Change in PTRI (Standard errors)
All	1.26 (2.87)
Low income-less educated-rural	1.87 (3.17)
Low income-less educated-urban	2.43 (2.91)
Low income -more educated-rural	0.85 (2.39)
Low income -more educated-urban	1.01 (2.13)
High income-less educated-rural	0.91 (2.95)
High income-less educated-urban	1.01 (2.52)
High income-more educated-rural	0.26 (2.07)
High income-more educated-urban	0.43 (1.92)

Table A2.6.6: Estimates of the Reduced Form Equation for Cigarette Price

	Cigarette Price Per Pack (Standard errors)
Tax (%)	79.704*** (3.146)
Change Income	-0.152** (0.072)
Less educated	0.629 (0.441)
More educated	4.292*** (0.796)
Age	-0.053*** (0.015)
Urban	-2.240*** (0.676)

Notes: Standard errors are given in parentheses, * indicates significance at 10%, ** indicates significance at 5%, *** indicates significance at 1%. Illiterate is the reference group for education and rural is the reference group for urban.

Table A2.6.7: Effects of Price, Income and PTRI on Prob. to Smoke, Prob. to Quit and CPD – Using Cross-sectional Dataset

	Probability to Smoke (Smokers and non-smokers)	Probability to Quit (Smokers and quitters)	CPD (Smokers only)
Cigarette Price Per Pack	-0.006***	0.003	-0.094***
	(0.002)	(0.003)	(0.015)
Income	0.013***	-0.016***	0.136***
	(0.003)	(0.006)	(0.024)
PTRI	0.050***	-0.021	-0.057
	(0.007)	(0.013)	(0.062)
Less educated	0.146***	0.044	0.380
	(0.034)	(0.067)	(0.279)
More educated	0.022	0.308***	-0.180
	(0.045)	(0.087)	(0.369)
Age	0.011***	0.011***	-0.012
	(0.001)	(0.002)	(0.008)
Urban	0.140***	-0.555***	1.292***
	(0.033)	(0.064)	(0.258)
Number of observations	8621	4585	3932

Notes: Standard errors are given in parentheses, * indicates significance at 10%, ** indicates significance at 5%, *** indicates significance at 1%. Illiterate is the reference group for education and rural is the reference group for urban.

Table A2.6.8: Effects of Price, Change in Income and Change in PTRI on Prob. to Smoke (non-smokers in both waves and non-smokers who initiate smoking in the following wave)

	All	Low income	High income	Less educated	More educated	Young	Old	Rural	Urban
Cigarette Price	0.027	-0.005	0.012	0.001	0.165	0.033*	0.001	0.052**	-0.019
	(0.017)	(0.042)	(0.019)	(0.021)	(0.120)	(0.019)	(0.036)	(0.024)	(0.024)
Change in Income	0.031*	-	-	0.039*	0.005	0.022	0.076*	0.005	0.097**
	(0.016)			(0.020)	(0.030)	(0.018)	(0.041)	(0.020)	(0.040)
Change in PTRI	-0.038	-0.116	0.008	-0.052	0.068	-0.042	-0.048	-0.060	-0.041
	(0.38)	(0.071)	(0.048)	(0.042)	(0.120)	(0.045)	(0.081)	(0.048)	(0.086)
More educated	-0.267	-	-0.168	-	-	-0.295	-0.065	-0.185	-0.375
	(0.223)		(0.230)			(0.247)	(0.508)	(0.266)	(0.537)
Age	-0.013*	-0.006	-0.020**	-0.011	-0.036	-	-	-0.014	-0.007
	(0.008)	(0.014)	(0.010)	(0.009)	(0.027)			(0.010)	(0.015)
Urban	-0.279	-	0.005	0.071	-2.027**	-0.451**	0.042	-	-
	(0.249)		(0.301)	(0.281)	(0.942)	(0.297)	(0.547)		
Number of observations	1158	395	618	797	361	663	495	764	394

Notes: Standard errors are given in parentheses, * indicates significance at 10%, ** indicates significance at 5%, *** indicates significance at 1%. Less educated is the reference group for education and rural is the reference group for urban.

Table A2.6.9: Effects of Price, Change in Income and Change in PTRI on Prob. to Quit (smokers in both waves and smokers who quit in the following wave)

	All	Low income	High income	Less educated	More educated	Young	Old	Rural	Urban
Cigarette Price	0.000	0.020***	-0.011*	0.007	-0.014*	-0.011	0.006	-0.006	0.015*
	(0.005)	(0.008)	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.006)	(0.008)
Change in Income	-0.010	-	-	-0.005	-0.017	-0.008	-0.009	-0.002	-0.027**
	(0.007)			(0.009)	(0.013)	(0.012)	(0.010)	(0.009)	(0.014)
Change in PTRI	0.033**	0.045**	0.009	0.046***	-0.019	-0.012	0.060***	0.033*	0.058*
	(0.015)	(0.020)	(0.022)	(0.017)	(0.036)	(0.027)	(0.019)	(0.017)	(0.035)
Less Educated	0.004	0.011	0.030	-	-	-0.071	0.006	-0.060	0.290
	(0.134)	(0.180)	(0.196)			(0.257)	(0.159)	(0.150)	(0.326)
More educated	0.120	0.097	0.206	-	-	0.080	0.139	0.102	0.175
	(0.155)	(0.217)	(0.217)			(0.288)	(0.187)	(0.175)	(0.361)
Age	0.006**	0.003	0.010**	0.005	0.008	-	-	0.003	0.016***
	(0.003)	(0.004)	(0.004)	(0.003)	(0.006)			(0.003)	(0.006)
Urban	-0.308***	-0.391***	-0.099	-0.333***	-0.139	-0.346*	-0.264**	-	-
	(0.103)	(0.148)	(0.137)	(0.121)	(0.203)	(0.183)	(0.128)		
Number of observations	1560	758	879	1131	429	641	919	1038	522

Notes: Standard errors are given in parentheses, * indicates significance at 10%, ** indicates significance at 5%, *** indicates significance at 1%. Illiterate is the reference group for education and rural is the reference group for urban.

Table A2.6.10: Effects of Price, Change in Income and Change in PTRI on Change in CPD (smokers only)

	All	Low income	High income	Less educated	More educated	Young	Old	Rural	Urban
Cigarette Price	-0.053**	-0.051	-0.066**	-0.533*	-0.063**	-0.065*	-0.040	-0.125***	0.053
	(0.023)	(0.043)	(0.030)	(0.031)	(0.030)	(0.034)	(0.030)	(0.031)	(0.035)
Change in Income	0.085**	-	-	0.105*	0.062	0.097*	0.073	0.081	0.087
	(0.041)			(0.057)	(0.054)	(0.059)	(0.058)	(0.057)	(0.060)
Change in PTRI	-0.073	-0.166	0.077	0.005	-0.356	-0.018	-0.096	0.013	-0.078
	(0.103)	(0.154)	(0.136)	(0.112)	(0.241)	(0.161)	(0.129)	(0.134)	(0.149)
Less educated	-0.516	-1.424*	-0.266	-	-	-1.267	-0.070	-0.376	-0.947
	(0.709)	(0.818)	(1.155)			(1.220)	(0.860)	(0.896)	(1.075)
More educated	0.804	-1.227	1.004	-	-	0.678	0.801	0.458	0.186
	(0.790)	(1.223)	(1.187)			(1.371)	(0.983)	(1.014)	(1.226)
Age	-0.022	-0.005	-0.027	-0.019	-0.026	-	-	-0.031*	0.011
	(0.015)	(0.021)	(0.022)	(0.018)	(0.025)			(0.018)	(0.028)
Urban	0.827	-0.912	1.581**	0.063	2.619***	0.419	1.143*	-	-
	(0.526)	(0.831)	(0.700)	(0.633)	(0.874)	(0.870)	(0.648)		
Number of observations	1139	519	673	807	332	496	643	721	418

Notes: Standard errors are given in parentheses, * indicates significance at 10%, ** indicates significance at 5%, *** indicates significance at 1%. Illiterate is the reference group for education and rural is the reference group for urban.

Essay 3

Gross and Net Provincial Mobility of Canada

3.1 Introduction

Individuals move across provinces in Canada for various reasons. To understand the relocation process of individuals across provinces in Canada, it is essential to study both gross and net provincial mobility. Provincial gross mobility measures the sum of inflow and outflow of individuals of a province whereas provincial net mobility measures total inflow minus outflow of individuals of a province. Taking account of such numbers allow for quantitative assessment of labor mobility in Canada.

In this paper, we have three main objectives. Our first objective is to estimate three different measures of mobility rates across various age and education profiles to understand the dynamic structures of the provincial labor market. The second objective of this paper is to study provincial migration considering gravity model framework and estimate gravity-adjusted gross mobility rates. The third objective of this paper is to understand the relationships among in-migration, out-migration and net mobility rates in Canada. This highlight how in- and out-migration are correlated and also the strength of in- and out-migration in explaining net migration in Canada.

Provincial gross mobility rates can be affected by both in- and out-migration. A province can experience high numbers of both inflow and outflow that result in high gross mobility. However, due to movement in opposite directions, eventually they cancel each other out, and net mobility can be very low. At the same time, a province's net-migration can be positive either from high inflow or from low outflow given inflow. Therefore, empirical analysis solely based on either gross or net mobility cannot clearly explain the dynamic nature of the labor market (Lkhagvasuren, 2014). The combined consideration of provincial gross flows and net flows

along with inter-provincial net mobility allows us to sharpen our understanding of the mechanism by which some provinces are gaining compared to others in terms of in-migrants.

According to Statistics Canada, net mobility is negative in Quebec and Ontario. However, Western part of Canada is showing some gain in recent years[31]. Without identifying whether this negative net flow is due to less inflow or more outflow, it is difficult for the government to take any appropriate policy. A combined study of gross and net mobility can be effective in this regard. Previous studies (Bernard et al., 2008; Chen and Fougere, 2009; Osberg et al., 1991; Vanderkamp and Grant, 1987; Robinson and Tomes, 1982) are based on the estimation of net mobility and limited to overall gain and loss due to migration in-and-out of a province.

Different educational attainments generally have different job prospects which can demonstrate different patterns of labor mobility. Individual's age also plays an important role in deciding someone's willingness to move as well as in adjusting capability after a provincial move. The analysis based on age and education has enormous importance in understanding provincial demographic composition and relevant policy issues. It is well established in the literature that migration propensities differ considerably by age and education level (Greenwood, 1997). Recent works by Lkhagvasuren (2014), Machin, Pelkonen, and Salvanes (2012), and Malamud and Wozniak (2012) show that education has a large causal effect on mobility and young workers are more mobile compared to the old in the U.S. (Hansen and Lkhagvasuren, 2015). Also, to measure gross and net mobility, the estimation of the share of net mobility[32] allows us to recognize whether the mobility displayed by a province is one directional or both directional.

31 Net inter-provincial migration by province, Statistics Canada, Demography Division, Population Estimates Program.

32 Share of net mobility rate is the ratio of the net and gross mobility rates.

In identifying major determinants of migration, there exists a large volume of literature based on the Gravity model. Greenwood (2005) mentions the basic framework of the gravity model that explores how gross migration is influenced by population sizes of origin and destination and also by the distance between them. Many of the studies focus on migration at the provincial level and sub-provincial level in Canada (Coulombe 2006[33], Foot and Milne 1984[34], Flowerdew and Amrhein 1989, Cheng and Wall 2005[35]). Amirault et al. (2013) uses the gravity model framework to explain aggregate gross migration flows between economic regions by using Canadian census data from 1991-2006[36].

Most of the studies in migration literature used census data which has an inherently fixed migration interval (Greenwood, 2005). Thus census data only allows us to observe the partial history of such migrants. In our paper, we use SLID which is a panel data set and therefore we are able to calculate the year to year bilateral mobility across provinces in Canada. Such dataset enables us to calculate bilateral provincial gross mobility with better precision and avoids the problems that are attached to census data.

One of the common findings in literature of labor mobility is that there is a positive correlation between in- and out-migration. Previous works by Coen-Pirani (2010)[37], Tervo (2001) and Mueser and White (1989) estimated in- and out-migration rates among US states

[33] Coulombe (2006) explores the determinants and consequences of Canadian inter-provincial migration in the context of the *structural* and *cyclical* aspects of migration.

[34] In the study by Foot and Milne (1984), Canadian inter-provincial migration is estimated using the gravity model. The data used was obtained from the 1961-79 Family Allowance data set. They concluded that the gravity model of migration was an insightful model in explaining migration patterns across Canadian provinces.

[35] Cheng and Wall (2005) discusses econometric techniques related to gravity models of international and inter-provincial trade. The techniques discussed in their paper also were very useful to us in our study of inter-provincial migration.

[36] The data used in this study are Statistic Canada's Censuses from 1991, 1996, 2001 and 2006 which are aggregated to the economic region level.

[37] Coen-Pirani (2010) used US census data from 1970-2000.

and found a positive relationship between them. In this paper, we also measure the three different types of correlation; in- and out-migration, net and in-migration and net and out-migration to contribute to the discussion.

The remainder of the paper is organized in the following manner. In section 3.2, we describe the data and methodology. In section 3.3, we estimate different inter-provincial mobility rates across education and age groups. Section 3.4 explores the gravity model framework. Then in section 3.5, we reveal the relationships among in-migration, out-migration, and net mobility rates. Lastly, section 3.6 concludes the paper.

3.2 Data and Methodology

3.2.1 Data

The data used in the analysis are drawn from the Survey of Labor and Income Dynamics (SLID from 1993 to 2011). SLID is a household survey that provides long-range longitudinal follow-up on Canadian families and individuals' demographic background, income, education level, labor market activities and financial situation. SLID interviews the same individuals for six consecutive years who are 16 years old or above and covers all persons living in Canada except: persons living in Yukon, the Northwest Territories, and Nunavut, persons living on Reserves, persons living in institutions, and military personnel living in barracks. SLID uses computer-assisted telephone interviewing (CATI) for collecting data, and interviews are conducted by telephone and the results are simultaneously entered in a computer that guides the interviewer through the questionnaire. Note that, in each panel, one individual is surveyed for six consecutive years, and these individuals are randomly chosen from the monthly Labor Force

Survey (LFS). In our mobility estimation, we do not consider international migration as we only observe individuals who remain in the panels for six consecutive years[38]. This is a balanced panel data set. The SLID survey is a collection of seven panels, and a new panel is introduced every three years. Except for the first panel from 1993-1995, all the remaining panels are overlapped for three years, and panel-7, which is the last panel of the survey, contains just one year (2011). Each panel includes roughly 15,000 households, including about 30,000 adults.[39] The figure in the appendix A3.7.1 explains span of one panel and how each panel is overlapping with another panel. Moreover, based on panel 5, the response rate of this data set is 72.8% and the permission rate is 88.2%. In appendix A3.7.2, we also provide an overview of the SLID survey and highlight some data quality matters.

For our analysis, we formed two education groups - less educated and more educated and two age groups - young and old. For less educated group, we include individuals who only completed high school or dropped out from high school. For high educated group, we add all individuals with college and university degrees. Regarding age, we label all individuals from 16 to 30 as young and from 31 to 55 as old. We use the information on individuals' residence province every year to identify their current province. By observing any difference in the province of residence between years, we identify them as movers. After identifying the movers, we recognize their residence province before and after the move so that we can measure the magnitude of in-migration and out-migration of a specific province in a specific year. Our calculations also confirm that aggregate in-migration matched with aggregate out-migration to

[38] Since, we only observe individuals who remain in the panel for all six consecutive years, it may underestimate the mobility rates estimation.
[39] Data Quality in the 2002 Survey of Labour and Income Dynamics (SLID) – written by Barbara Armstrong and Georgina House, Income Statistics Division and Social Survey Methods Division, published by Statistics Canada.

all provinces which validates our measurement accuracy in identifying provincial mobility (details are given in appendix A3.7.3 as Technical Analysis).

3.2.2 Defining Provincial Mobility Rates

We have measured different types of provincial mobility rates in our study. We estimate gross mobility, net mobility, and share of net mobility across education and age groups at the provincial level. We also estimate economy-wide gross mobility rate. In fact, in the case of economy-wide mobility, the sum of in-migration from all provinces should be equal to the sum of out-migration, as the people who move out from a given province will definitely move into some other province. However, in the case of economy-wide gross mobility, we have to consider either sum of in or the sum of out-migration for a specific period. We calculate the in-migration rate of a specific province in a particular year by dividing the total number of in-migration by the total population of that given province in a specific year. Similarly, we calculate the out-migration rate of a specific province in a particular year. For provincial gross mobility rate, we add both gross inflow rate and outflow rate to identify the overall gross mobility rate in a province over a specified period.

We compute provincial net mobility rates by calculating the differences between in-migration rates and out-migration rates across provinces (Davis and Haltiwanger, 1992; Lkhagvasuren, 2014). We also use differences between in- and out-migration rates when we measure correlations between net and in-migration and net and out-migration. Also, in our study, we measure the share of net mobility rate for a particular group by dividing net mobility rate with the gross mobility rate of the given group to understand the magnitude of net mobility

relative to gross mobility. In appendix A3.7.4, we present all the formulas for all different mobility rates.

3.3 Gross and Net Mobility

Mobility has always been an essential feature of understanding labor dynamics in Canada. Regional diversity, in conjunction with diverse industries with different job opportunities that are always evolving encourage individuals to move and explore other places for better economic returns. In this section, we measure provincial gross, net and share of net mobility for all provinces in Canada.

3.3.1 Gross and Net Mobility Rates

Naturally, gross flows are larger relative to net flows (Lkhagvasuren, 2014; Coen-Pirani, 2010). If inflow and outflow are same for a region, then net mobility of that region is zero, but there is a positive gross mobility in that location. Overall economy-wide gross mobility rates are declining over the years from 1993-2011, and the average economy-wide gross mobility is 0.87% in Canada.[40] However provincial gross and net mobility rates vary across provinces in Canada. The following table represents the provincial gross and net mobility rates.

[40] See appendix A3.7.5

Table 3.1: Gross and Net Mobility Rates

Province	Gross Mobility Rates	Net Mobility Rates
NFL	2.45%	-0.43%
PEI	2.07%	-0.35%
NS	2.61%	-0.07%
NB	2.42%	-0.23%
QC	0.58%	-0.01%
ON	1.13%	0.08%
MN	1.85%	-0.27%
SK	2.30%	-0.38%
AL	3.92%	0.62%
BC	2.36%	0.16%
Average	2.17%	-0.09%

Based on the results from Table 1, Alberta, British Columbia, and Ontario have the positive net mobility rates whereas all other provinces have negative net mobility rates. Furthermore, Alberta is experiencing the largest positive net mobility rate which indicates a strongly dominating in-migration flows into this province. However, provinces such as Newfoundland and Labrador, New Brunswick, Manitoba, Prince Edward Island and Saskatchewan show substantial negative net mobility rates meaning out-migration outweighs in-migration in these provinces. Moreover, Quebec, Ontario, and Nova Scotia display very low net mobility rates in absolute terms.

To understand labor mobility it is also important to focus on both in- and out-mobility along with net mobility. From the year 1993-2011, based on year to year mobility the average province experiences a combined inflow and outflow of individual of about 2.17% of its

population. From SLID, we also calculate average in-migration, out-migration, net mobility rates from 1993 to 2011 are 1.00%, 1.17% and -0.09% respectively.

3.3.2 Mobility by Education

To explore the relationship between educational attainment and mobility, we form two education groups: less educated and more educated. By observing mobility rates across these education groups, we recognize the effect of education on individuals' mobility decisions.

Table 3.2: Gross, Net, and Share of Net Mobility – Education Groups

	Gross Mobility Rates		Net Mobility Rates (Absolute values)		Share of Net Mobility Rates	
Education Group	Less Edu	More Edu	Less Edu	More Edu	Less Edu	More Edu
Mean	1.86%	2.70%	0.25%	0.31%	12.05%	10.56%

In the above table, we show the estimations of gross, net and share of net mobility rates in Canada. The average gross and net mobility rates both are higher for more educated individuals. However, the share of net mobility rate is higher for less educated individuals. This highlights the fact that more educated individuals exhibit greater magnitudes of in- and out-migration than less educated. This reflects that overall labor market conditions across provinces produce more opportunities for more educated individuals which work as the driving force for greater both way traffics for this education group.

We also deconstruct different mobility rates across education groups based on different provinces that are provided in appendix A3.7.6. This signifies variability in mobility rates across educational groups in different provinces with diverse economic activities. We show that more educated are more mobile than less educated individuals across all provinces however the magnitudes vary. It is observed that New Brunswick has the largest difference while comparing gross mobility between less and more educated groups. Mostly provinces in the Eastern region (Atlantic part of Canada) are losing individuals from both education groups. However, it is interesting to point out that less educated individuals are demonstrating higher magnitudes of one-way traffic than their more educated counterparts in all provinces except Quebec and British Columbia.

Moreover, we have identified contributions of both education groups in explaining population growth through migration of a province. In most of the provinces, the contributions of both less and more educated individuals in changing net mobility rates are roughly equal. In Nova Scotia, we find that less educated individuals made up 0.58% of every 1% change in net mobility rates. Interestingly, the result is strikingly different in Quebec where as high as 0.86% of every 1% change in net mobility rate is contributed by more educated individuals. A complete table is presented in the appendix A3.7.8.

3.3.3 Mobility by Age

To investigate the relationship between age groups and mobility, we form two age groups: young and old where young age group consists of individuals between age 16 and 30 and old age group contain individuals from 31 to 55.

Table 3.3: Gross, Net, and Share of Net Mobility – Age Groups

	Gross Mobility Rates		Net Mobility Rates (Absolute values)		Share of Net Mobility Rates	
Age Group	16-30	31-55	16-30	31-55	16-30	31-55
Mean	4.94%	1.77%	0.66%	0.19%	11.63%	9.86%

In the above table, we observe that on average gross and net mobility rates are higher among the young compared to the old. Moreover, the share of net mobility is higher among the young which implies that mobility among the young is relatively more one directional.

In appendix A3.7.7, we have also provided all types of mobility rates across provinces based on different age groups. We find that young individuals are more mobile than older individuals across all provinces. Similar to our results from the education groups, we find that provinces in the Eastern region are losing individuals from both age groups. Newfoundland and Labrador have the highest negative net mobility rates whereas Alberta has the highest positive net mobility rate among the young. An interesting observation is that among all provinces only Quebec and Manitoba demonstrate higher magnitudes of one-way traffic among the old.

While observing contributions of different age groups in changing net mobility rates, our findings show that mostly the young contributed to the change in the population of a province. In Newfoundland and Labrador, the young contributed 0.79% of every 1% change in net mobility rate. However, only in Quebec and Manitoba the old demonstrate higher contributions to change. In Quebec, the old contributed 0.86% in every 1% change in net mobility rate. All the findings are provided in appendix A3.7.8.

In summary, we find in this section that the more educated and the young are more mobile than the less educated and the old respectively. Also, by calculating the share of net mobility rates we observe that the less educated and the young are demonstrating higher one directional movement relative to their respective counterparts.

3.4 Measuring Provincial Migration Using Gravity Model Framework

In literature, migration is widely explained through the gravity model. Although the Gravity model was initially used in understanding the effects of population sizes of origins and destinations and distances between them on volumes of trade[41], later such model was adopted in economics in explaining volumes of migration between two regions. The basic gravity model illustrates that gross migration is positively related to the sizes of the origins and the destination populations, and negatively associated with the distances that separate them (Greenwood, 2005). Empirical studies by Courchene (1970), Finnie (2004), Robinson and Tomes (1982), and Helliwell (1997) found that inter-provincial mobility is negatively related to the home province's population size and distance. Finnie (2000) also identified that residents of smaller cities, towns and especially rural areas have been less likely to move than individuals in larger cities. In our modified gravity model, we add ‘presence of common border' as an additional variable. The presence of border also plays a significant role in explaining migration flows between two regions. In our study, we use the following gravity model framework where the gross migration can be represented as:

[41] One of the initial empirical papers in this literature is Pöyhönen (1963). Now there exists a large literature using gravity models to understand trade flows.

$$GM_{AB} = F(ln\, Pop_A, Pop_B, ln\, Dist_{AB,} Border_{AB})$$

Where, *F* represents the distribution function to be specified below, and GM_{AB} equals the total number of Canadians who move between province *A* and *B.* We use the size of the population in the origin, Pop_A, population in the destination, Pop_B, the distance in kilometres between the capitals of two provinces *A* and *B,* $Dist_{AB}$. $Border_{AB}$ is a dummy variable that takes the value one if two provinces share a common border between them and zero otherwise.

In our analysis, we have calculated bilateral gross mobility for all Canadian provinces. Now we use the following gravity model to explore the relationships mentioned above.

$$l\, n\, GM_{AB} = \alpha_1 + \alpha_2\, lnPop_A + \alpha_3 lnPop_B + \alpha_4\, lnDis_{AB} + \alpha_5 Border + \varepsilon \qquad (1)$$

Our findings from regression equation (1), show that population of both origins and destinations are positively affecting the bilateral gross mobility of two provinces. This highlights that larger population attract a higher volume of migration flows. Bigger economies with large population always correspond to higher economic activities and therefore promote higher movements of people both in- and out-directions.

We illustrate the coefficient of gross mobility for the population at the origin with the following example: Suppose Quebec is the original province. The population of Quebec was 100,000, and gross mobility was 1,000 in 2015. Now suppose the population has grown by 10%. Therefore the new population of Quebec is 110,000 in 2016. Now if we want to know how this additional population will contribute to the gross mobility of Quebec in 2016, we can find that by using the gross mobility coefficient from the above table. The coefficient of the population at the origin is 0.642. This implies that if the population of Quebec increases by 10%, then gross mobility of Quebec will increase by 6.42% for a representative pair of

provinces (that is, between Quebec and nine other provinces) over one year period. Thus gross mobility of Quebec will increase by 64 units due to 10% population growth in the province. Similarly, if we think of Ontario as a destination province, then using the coefficient of destination province from the table, we find that when the population in Ontario increase by 10% then gross mobility of Ontario will also increase by 6.89%.

These results highlight bilateral gross mobility is affected by both population of origin and destination. However, regarding the effect on bilateral gross mobility there is no significant difference between the population of origin and destination populations. So, the relationship is weak to conclude that the big is getting bigger and small is getting smaller. Rather, provinces with smaller population sizes are still attracting people. Regression results are presented below. Amirault (2013) found similar results using the census data where he defined gross mobility across Canadian economic regions.

Table 3.4: Results from the Gravity Model

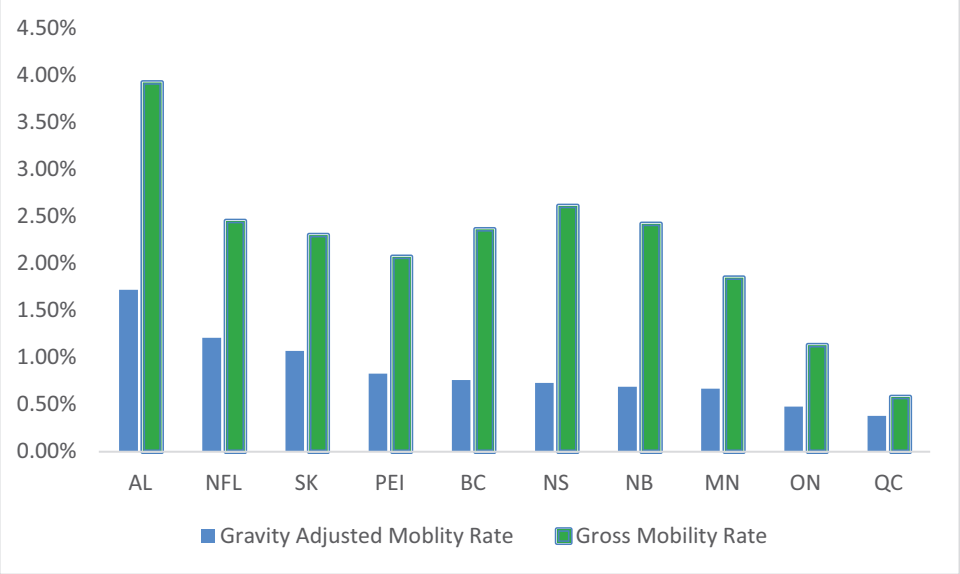
	Bilateral Provincial Gross Mobility
Population Origin	0.642***
	(0.152)
Population Destination	0.689***
	(0.151)
Distance	-0.373**
	(0.184)
Border	0.678*
	(0.363)

Notes: There are 90 observations. $R^2 = 0.39$. Standard errors are given in parentheses, * indicates significance at 10%, ** indicates significance at 5%, *** indicates significance at 1%.

Moreover, our results demonstrate that when two provinces are further away from each other, it has a negative effect on bilateral gross mobility between these provinces. For a representative pair of provinces, a 10% increase in distance (number of kilometers) between them decrease the gross mobility decreases by 3.73% over a one-year period. Distances are associated with different natures of moving costs. On the outset, higher distance is directly related to higher transportation costs. Furthermore, higher distance could have an emotional cost; this is attached to the fact that migrants are moving away from family and friends and due to higher distance moving back is always costly and time-consuming. Therefore leaving the dear ones has an added negative element to mobility when distances are greater. Results from the above table reveal that the presence of border between provinces raises bilateral gross mobility between them as expected. Neighboring provinces usually have many similarities such as resources, economic structure, weather, culture and thus these commonalities could also contribute to higher bilateral gross mobility. Using the coefficient of the border, we can say that the presence of border raises gross mobility by 67.8%. However, R^2 of our gravity model regression is 0.39 which highlights that the explanatory variables in this regression weakly explain the bilateral gross mobility rates.

By following the study by Coen-Pirani (2010), we also estimate gravity-adjusted gross mobility rates along with gross mobility rates at provincial levels. Gravity-adjusted gross mobility rates are estimated after controlling variables that are used to explain magnitudes of migration in the gravity model framework. The detail process of the measurement is included in appendix A3.7.9.

Figure 3.1: Provincial Gross Mobility Rates and Gravity-adjusted Gross Mobility Rates



As we can observe from Figure 3.1, all the provinces revealed lower gravity adjusted gross mobility rates compared to unadjusted rates.[42] The relative difference between gravity-adjusted and unadjusted gross mobility rates also vary across provinces. Such difference is the highest in Nova Scotia and lowest in Quebec. Higher relative difference signifies that population sizes of origin and destination, distances and presence of borders between them play important role in explaining bilateral gross mobility rates.

[42] All the provincial gravity-adjusted gross mobility rates are presented in appendix A3.7.10.

3.5 Relationship among In-migration, Out-migration and Net-migration Rates

In this section, we explain the relationship among provincial in-migration, out-migration, and net-migration. First, we observe the relationship between in-migration and out-migration. Next, we examine the relationship between provincial in and net-migration and provincial out and net-migration to identify whether in or out dominates provincial net-migration.

Table 3.5: Correlation Coefficients

	Inflow-Outflow	Inflow-Net Mobility Rate	Outflow-Net Mobility Rate
Correlation Coefficients	0.3680	0.6373	-0.4820

Our findings from table 3.5 show that there exists a positive correlation between provincial in- and out-migration. The correlation coefficient is 0.37. This positive correlation is also evidential from Coen-Pirani (2010) using the U.S. census data where he estimated the correlation coefficient between inflow and outflow as 0.63. When a province experiences favorable economic conditions, it is believed that more individuals would move into the province compared to individuals moving out of that province. However, in contradiction to such belief, the positive correlation between inflow and outflow rate is well established in the labor mobility literature. Many different explanations for such relationship were given by different authors in literature. Morrison (1971), Tervo et al. (2001), Bailey (1993), Long (1988)

and Gleave and Cordey-Hayes (1977) concluded in their works that compositional effect[43] Play a significant role in explaining the positive relationship between in- and out-migration. Another explanation called 'vacancy chain'[44] was proposed to explain such positive correlation by Gleave and Cordey-Hayes (1977) and Tabuchi (1985). Mueser and White (1989) argued that positive correlation between in- and out-migration is due to the dynamic adjustment process[45]. Among other possible reasons, Mueser and White (1989) and Bogue et al. (1953) explained such positive relationship through the structure of location boundaries in their respective works. In addition, Sjaastad (1961) suggested idiosyncratic matching[46] as one of the possible reason.

Figure 3.2[47] represents the relationship between provincial in and net-migration and provincial out and net-migration. From Table 3.5, the correlation coefficient between in and net-migration is 0.64 whereas the correlation coefficient between out and net-migration is -0.48.

[43] According to the compositional effect, a province that attracts migrants grow to have a population which is more migration prone, thus also increasing out-migration from the province.

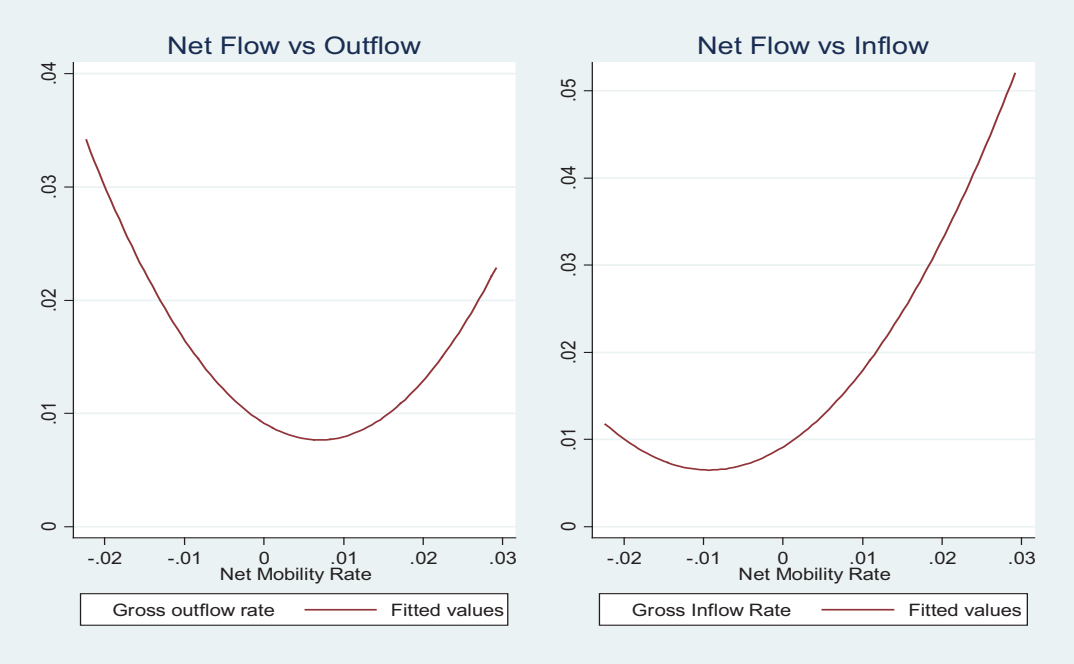
[44] The idea of "vacancy chain" is such where the departure of residents leave vacated positions such as jobs and houses for new-comers, thus increasing in-migration. It is also possible that economic activities which make an area attractive may also increase turnover and thus out-migration. Where jobs are easily available, such phenomena not only attracts in-migrants but may also make workers leave the jobs easily, thus adding out-migration.

[45]. They termed this process as dynamic adjustment according to which population tends to redistribute itself in such a way so that it equalizes rates of in- and out-migration.

[46] Idiosyncratic matching refers to a worker's match with the location where he/she lives.

[47] However, these two figures are also showing the quadratic fit of the data.

Figure 3.2: Relationships among Net Flow, Inflow and Outflow Rates



However, the magnitude of the correlation coefficient of in and net-migration is higher than the coefficient of out and net-migration. It follows that provinces that tend to lose workforce due to internal migration do so by experiencing lower than average inflow, rather than higher than average outflows. A similar exercise was carried out by Coen-Pirani (2010) based on U.S. census data where he found a positive correlation (0.85) between in and net-migration. However he found mixed (both positive and negative) and weak correlation between out and net-migration across different census periods[48].

[48] Coen-Pirani (2010) census 1970 (-0.04), 1980 (0.24), 1990 (-0.23) and 2000 (0.29) and pooled data 1970-2000 (0.03).

3.6 Concluding Remarks

In this paper, we have measured different types of provincial mobility to have a clear understanding regarding the labor dynamics in Canada. We have used the Survey of Labour and Income Dynamics (SLID) of Canada for our analysis. Detailed questions of this panel dataset allowed us to capture various kinds of yearly provincial mobility rates. Observing provincial gross mobility together with net and share of net mobility allow us to sharpen our understanding of provincial labor mobility. As we calculate different mobility rates based on different education and age groups, results from this paper can be critical for policymakers in taking a more targeted approach in managing labor mobility.

Findings from our analysis show that young and more educated move more across provinces in Canada. In addition, our results from the share of net mobility rates reveal that the young and less educated individuals mostly have one-way inter-provincial mobility whereas the old and more educated individuals show inter-provincial mobility at both directions. When a specific group demonstrates one way mobility, this signifies opportunities being generated or destroyed for that specific group in that specific province that result in such one way traffic of migration either in or out migration.

According to our results from the modified gravity models, the effects of border and population sizes of destination and original provinces has positive influence and distance has a negative influence on provincial migration. Such results signify the importance of shared borders as well as the physical closeness of provinces in understanding migration. At the same time, our results also show that it is not necessarily the case that provincial migration is

attracting individuals away from smaller provinces towards bigger ones. Both big and small provinces are attracting migrants.

We also identify a positive correlation between provincial in - and outmigration in Canada. This shows that provinces that lose more people also seem to attract more people. Our findings further clarify that net provincial mobility has a stronger relationship with in-migration compared to out-migration. Such relationship can be crucial for policymakers in designing policies that enhance labor market balance across provinces in Canada.

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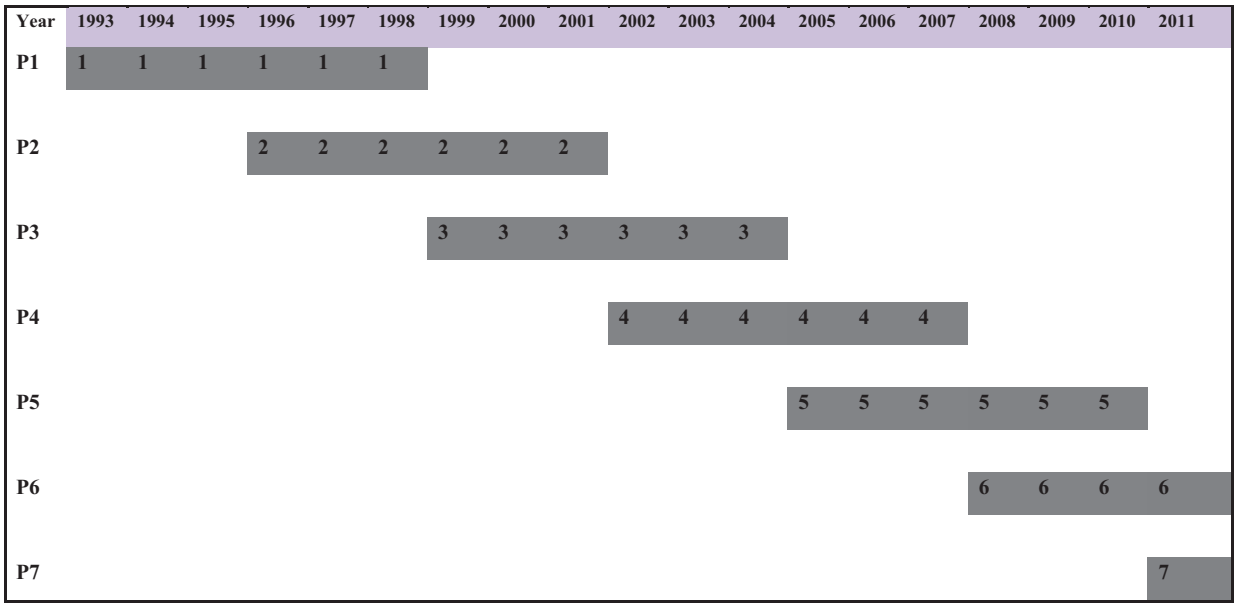
3.7 Appendix

A3.7.1: Panel Distribution



A3.7.2: Quality of SLID Data

A preliminary interview takes place at the beginning of each panel to collect background information. Each of the six years has a split-interview format, with labor topics covered in January and income topics in May. In both cases, questions refer to the previous calendar year. The income interview occurs in May to take advantage of income tax time when respondents are more familiar with their records. Also, many respondents permission to consult their income tax file, and avoid the income interview. Since 2004, however, the May interview was dropped to save on collection costs. If a respondent does not grant permission to link to the T1 tax file, the income questions were asked in January. Selected data quality indicators are presented in the table[49] below.

[49] Data Quality for the 2009 Survey of Labour and Income Dynamics (SLID) – written by Jean-François Bastien, Household Survey Methods Division, published by Statistics Canada.

Indicator	Statistic
Longitudinal sample size	
□ Panel 5	42,330
□ Panel 6	40,912
Response rate: Longitudinal - person Response rate: number of eligible respondent / total number of respondents. Non-respondent: If all persons in a household are non-respondent to both labor and income questions, then these persons (and households) are non-respondents. Respondent: A household is considered to be a respondent household if at least one person in that household is a respondent.	
□ Panel 5	72.8 %
□ Panel 6	71.0 %
Permission rate	
□ Panel 5	88.2%
□ Panel 6	72.2%
The respondent was asked for permission to access tax records. January refusal initiate may interview for income related questions.	
Tax linkage rate (SIN found)	95.9 %
Imputation Rate – person	3.2 %

A3.7.3: Technical Issues

In order to measure different mobility rates with precision such as gross, net and share of net mobility rates it is extremely important to confirm that overall numbers of provincial in migration matches with provincial out-migration in Canada. Such findings are mandatory pre-requisites for our entire analysis. In this study, we calculate yearly provincial in- and out-migration for 1993-2011 as shown in the table below. The number of provincial in-migrants must be same as the number of out-migrants. Moreover, when we calculate in- and out-migration for each province naturally we find that in- and out-migration varies for each province. However, when we find the total number of in-migrants in all provinces we are reassured to see that it is exactly same as the total number of out-migrants in all provinces (see the table below). This gives us the required validation that our in- and out-migration rates are measured with accuracy.

PROVINCE	STAYERS	IN	OUT
NFL	40,854	328	683
PEI	23,559	162	329
NS	55,687	693	777
NB	51,458	510	748
QC	161,782	460	485
ON	254,438	1,655	1,240
MN	61,035	404	731
SK	61,588	480	948
AL	78,422	2,077	1,075
BC	77,997	1,056	809
Total	866,820	7,825	7,825

A3.7.4: Formulas for Measuring Mobility Rates

$$In - Migration\ rate\ (INR_{rt}) = \frac{IN_{rt}}{\mathrm{POP}_{rt}}$$

$$Out - Migration\ rate\ (OUTR_{rt}) = \frac{OUT_{rt}}{\mathrm{POP}_{rt}}$$

$$Economy - wide\ Gross\ Mobility\ Rate = Average\ of\ IN_{rt}$$

$$Provincial\ Gross\ Mobility\ Rate = INR_{rt} + OUTR_{rt}$$

$$Provincial\ Net\ Mobility\ Rate = \frac{|INR_{rt} - OUTR_{rt}|}{2}$$

$$Or,\ Provincial\ Net\ Mobility\ Rate = \frac{(INR_{rt} - OUTR_{rt})}{2}$$

$$Share\ of\ Net\ Mobility\ Rates = \frac{|Net\ Mobility\ Rate|}{Provincial\ Gross\ Mobility\ Rate}$$

Table A3.7.5: Economy-wide Gross Mobility Rate over the Years

Year	Mobility Rate
1993	-
1994	0.99%
1995	0.99%
1996	1.05%
1997	1.24%
1998	1.13%
1999	0.40%
2000	1.23%
2001	1.14%
2002	0.99%
2003	0.88%
2004	0.83%
2005	0.68%
2006	0.93%
2007	0.84%
2008	0.80%
2009	0.60%
2010	0.54%
2011	0.39%
Average	0.87%

Table A3.7.6: Gross, Net, and Share of Net Mobility rates by Education across Provinces

	Gross Mobility Rates		Net Mobility Rates		Share of Net Mobility Rates	
PROVINCE	Less Educated	More Educated	Less Educated	More Educated	Less Educated	More Educated
NFL	2.10%	3.23%	-0.43%	-0.56%	-20.64%	-17.37%
PEI	1.88%	2.50%	-0.35%	-0.46%	-18.85%	-18.20%
NS	2.12%	3.15%	-0.09%	-0.08%	-4.19%	-2.46%
NB	1.82%	3.16%	-0.22%	-0.32%	-12.05%	-10.07%
QC	0.45%	0.77%	-0.01%	-0.02%	-2.22%	-2.26%
ON	0.97%	1.44%	0.08%	0.09%	8.57%	6.20%
MN	1.46%	2.43%	-0.20%	-0.29%	-13.86%	-11.88%
SK	1.91%	2.93%	-0.33%	-0.43%	-17.50%	-14.55%
AL	3.76%	4.46%	0.68%	0.67%	18.08%	14.99%
BC	2.11%	2.88%	0.13%	0.22%	6.34%	7.64%

Table A3.7.7: Gross, Net, and Share of Net Mobility Rates by Age across Provinces

	Gross Mobility Rates		Net Mobility Rates		Share of Net Mobility Rates	
PROVINCE	16-30	31-55	16-30	31-55	16-30	31-55
NFL	6.56%	1.78%	-1.56%	-0.20%	-23.79%	-11.13%
PEI	5.26%	1.60%	-0.92%	-0.28%	-17.57%	-17.35%
NS	6.28%	2.09%	-0.37%	-0.06%	-5.85%	-2.85%
NB	5.26%	2.06%	-0.60%	-0.21%	-11.48%	-10.14%
QC	1.28%	0.55%	-0.01%	-0.01%	-0.78%	-1.82%
ON	2.34%	1.02%	0.19%	0.07%	7.97%	6.69%
MN	3.73%	1.66%	-0.35%	-0.26%	-9.51%	-15.45%
SK	5.05%	1.87%	-0.77%	-0.28%	-15.19%	-14.78%
AL	8.21%	3.08%	1.45%	0.46%	17.67%	14.89%
BC	5.43%	1.97%	0.39%	0.09%	7.18%	4.51%

A3.7.8: Contributions of different groups in overall provincial net mobility

$$\text{Contribution of a specific group in overall provincial net mobility} = \left|\frac{\text{net mobility of the specific group}}{\text{total net mobility of the province}}\right| * 100$$

	Education		Age	
PROVINCE	LE	ME	16-30	31-55
NFL	0.539	0.461	0.793	0.207
PEI	0.466	0.534	0.605	0.395
NS	0.581	0.419	0.743	0.257
NB	0.493	0.507	0.587	0.413
QC	0.136	0.864	0.143	0.857
ON	0.521	0.479	0.578	0.422
MN	0.502	0.498	0.419	0.581
SK	0.518	0.482	0.606	0.394
AL	0.532	0.468	0.636	0.364
BC	0.395	0.605	0.685	0.315

A3.7.9: Methodology for Estimating Gravity-adjusted Gross Mobility Rates

In our analysis, we have calculated the gravity adjusted gross mobility rates. For such calculation, we used the basic gravity model that is explained in equation (1).

Step 1: Run the regression based on equation (1)

In this regression, we will have 90 observations. Because, for a specific year, an individual of a specific province can move to other nine provinces. So our total sample is 90. For example, in Quebec, there will be in-migrants from other nine provinces and out-migrants to other nine provinces.

Step 2: After running the above regression, we identify the residuals which explain bilateral gross mobility that cannot be explained using the above explanatory variables. Here, we have 90 residuals.

Step 3: To identify gravity adjusted gross mobility for each province, we aggregate (9 possible values) the absolute values of the residuals for each province. To find the gravity adjusted gross mobility rates, we then divided gravity adjusted gross mobility with the aggregate population of A and B.

Table A3.7.10: Provincial Gravity-adjusted Gross Mobility Rates

PROVINCE	Gravity-adjusted Gross Mobility Rates
NFL	1.21%
PEI	0.83%
NS	0.73%
NB	0.69%
QC	0.96%
ON	0.48%
MN	0.67%
SK	1.07%
AL	1.72%
BC	0.76%