THREE ESSAYS ON THE ECONOMICS OF HEALTH BEHAVIORS

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THREE ESSAYS ON THE ECONOMICS OF HEALTH BEHAVIORS

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This dissertation investigates the economics of health behaviors. It focuses on the ways health behaviors, specifically smoking and fertility, respond to economic factors such as price and income, as well as non-economic factors such as health-related knowledge and health policy. The first chapter, "The effect of contraceptive knowledge on fertility: the roles of mass media and social networks," explores the effect of contraceptive knowledge on fertility using an instrumental variables approach. It draws upon the "Knowledge, Attitudes, and Practice of Contraception in Taiwan" (KAP) dataset and focuses on the period when Taiwanese family planning programs were in effect. The results indicate that mass media and social networks play important roles in disseminating contraceptive knowledge. This study finds that women transform their knowledge into behavior--that is, contraceptive knowledge reduces fertility, no matter which fertility metric is measured (life-time fertility or probability of giving birth). The second chapter (coauthored with Donald Kenkel), "U.S. cigarette demand: 1944 – 2004," uses data from 23 national cross-sectional surveys conducted by the Gallup Poll from 1944 through 2004 to investigate the changes in cigarette demand in the United States from the 1940s through 2004, individual and government attitudes toward smoking changed dramatically. It estimate standard two-part models of cigarette demand as a function of demographics, income, and cigarette prices. The results show that from 1944 to 2004: the gender difference in smoking rates almost disappears; the black-white difference reverses; a strong gradient with schooling emerges; and the negative income elasticities

strengthened in magnitude. The third chapter, “WTO Entry, a New Cigarette Tax Scheme, and the Tobacco Market in Taiwan,” analyzes the impacts of Taiwan’s entry into the WTO, which was accompanied by a series of policy changes on both the supply and demand sides of the tobacco market. It investigates the link between cigarette tax and price by imputing the tax pass-through rates, and confirms the hypothesis that free trade induces an increase in advertisements and the introduction of new brands and products. Regarding smokers’ reactions to price changes, this study finds some evidence that smokers not only react to price changes, but also react to relative price changes by switching brands. It also takes into account other scenarios accompanying the WTO entry that influence the brand choices.

BIOGRAPHICAL SKETCH

Kai-Wen Cheng was born in Keelung, Taiwan on November 19, 1978. She obtained her bachelor and master degrees in Economics at National Taipei University, Taipei, Taiwan in 2000 and 2002, respectively. She then worked as a research assistant in the department of Economics at National Taiwan University, Taipei, Taiwan. In 2004, she joined the Ph. D program in the department of Policy Analysis and Management at Cornell University. In the summer of 2009, she defended her dissertation. She then joins the post-doctoral fellowship program in the Center for Tobacco Control Research and Education at University of California at San Francisco.

To my parents: Chin-Huang Cheng(鄭金煌) and Chiung-Chu Huang(黃瓊珠)

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Introduction

Health behaviors or lifestyle factors have tended for decades to be regarded as the major determinants of premature mortality. Healthy behaviors directly improve the overall public health of a nation while reducing the cost of health care systems. Public and private agencies have, accordingly, conducted interventions such as increasing taxes, providing health-risk knowledge, implementing restrictions, etc. as attempts to alter citizens' unwanted behaviors and encourage their healthy behaviors.

This dissertation investigates the economics of health behaviors. It focuses on the ways health behaviors, specifically smoking and fertility, respond to economic factors such as price and income, as well as non-economic factors such as health-related knowledge and health policy. It also examines health behaviors across different socio-economic statuses.

The first chapter, "The effect of contraceptive knowledge on fertility: the roles of mass media and social networks," investigates the ways people respond to new health-related knowledge. It focuses on the period when Taiwan's family planning programs were in effect and examines the relationship between contraceptive knowledge and fertility. The implementation of family planning programs is an example of providing information intended to change behaviors: information about contraceptive techniques is provided to women of childbearing age so that they will increase the practice of contraception and thus control fertility. The chapter examines how individuals build their contraceptive knowledge from these programs; how socioeconomic characteristics, mass media exposure, and an individual's social network influence the forming of that contraceptive knowledge; and whether the obtained contraceptive knowledge *reduces* fertility.

The second chapter and third chapter focus smoking behavior in the U.S. and Taiwan. The second chapter, "U.S. cigarette demand: 1944 – 2004," investigates the

changes in cigarette demand in the United States from the 1940s through 2004, individual and government attitudes toward smoking changed dramatically. It examines the changing influences of smoking determinants on smoking behaviors over time. Because the data cover a long time span, we are able to study cigarette demand before and during the early years of tobacco control efforts, as well as during the most recent period.

The third chapter is “WTO entry, new cigarette tax scheme, and the tobacco market in Taiwan”. This study analyzes the impacts of Taiwan’s entry into the WTO in 2002 and the accompanying policy changes, on both the supply (cigarettes producers) and demand sides (cigarettes consumers) of the market. In particular, it studies the tax pass-through rates for each individual brand and product. It investigates the non-price competition of tobacco companies reflected in new introduced products and brands, and marketing promotion as well. Finally, it studies smokers’ reactions to price changes in terms of brand switching.

CHAPTER 1: THE EFFECT OF CONTRACEPTIVE KNOWLEDGE ON FERTERTILITY: THE ROLES OF MASS MEDIA AND SOCIAL NETWORKS

Abstract

This study explores the effect of contraceptive knowledge on fertility using an instrumental variables approach. It draws upon the "Knowledge, Attitudes, and Practice of Contraception in Taiwan" (KAP) dataset and focuses on the period when Taiwanese family planning programs were in effect. This study differs from previous studies examining the effectiveness of family planning programs on fertility by focusing on individuals' obtained contraceptive knowledge and fertility. The results indicate that mass media and social networks play important roles in disseminating contraceptive knowledge. Women who are regularly exposed to mass media, or who have a wider social network, have more knowledge about contraceptives than their counterparts. This study finds that women transform their knowledge into behavior--that is, contraceptive knowledge reduces fertility, no matter which fertility metric is measured (life-time fertility or probability of giving birth). Since very few studies focus on the relationship between contraceptive knowledge and fertility, by exploring this relationship, this paper contributes to an improved understanding of how the individuals obtain the disseminated knowledge; how socioeconomic characteristics, mass media exposure, and social network influence the forming of knowledge; and whether the obtained knowledge is transformed into new behaviors.

Introduction

Many advertising campaigns sponsored by private or public agencies disseminate health, nutrition, and product information aimed at changing people's behaviors. Such information about issues reaches its goal only if individuals obtain

the disseminated information and transform the acquired information into new behaviors. This study focuses on the period when Taiwan's family planning programs were in effect and examines the relationship between contraceptive knowledge and fertility. It examines how the individuals build their contraceptive knowledge from the programs; how socioeconomic characteristics, mass media exposure, and social network influence the forming of that contraceptive knowledge; and whether the obtained contraceptive knowledge *reduces* fertility.

The implementation of family planning programs is an example of providing information intended to change behaviors: information about contraceptive techniques is provided to women of childbearing age so that they will increase the practice of contraception and thus control fertility. The ultimate aim is to couple low birth rates with a consistently low mortality rate to reduce population growth. For developing countries where the population transitions from a combination of high mortality rate and high birth rate to a combination of low mortality rate and high birth rate, the resulting rapid population growth may create pressures on housing, education, and social patterns. Such a situation often dramatically increases the financial burden of the nation as a whole. In order to control population growth by reducing fertility rates, governments may opt to implement family planning programs which provide married couples with information about modern contraceptive techniques, contraceptive access, and the benefits of having fewer children. In some societies, such programs may also aim to overcome entrenched gender preference toward sons.

Several studies have focused on investigating whether such family planning programs play any role in decreasing fertility, or whether the decrease is actually driven by economic and social changes; for example, improved educational and economic opportunities for women might cause them to desire fewer children.[1]

[1] A few studies address this issue. For example, Pritchett (1994) and Gertler and Molyneaux (1994).

However, the endogenous characteristics of the input-allocation of family planning programs – high fertility villages tend to be the target of family planning programs and hence receive more family planning inputs than other areas – make the evaluation of the causal effect of family planning programs challenging[2].

This study differs from previous studies examining the effectiveness of family planning programs on fertility by focusing on individuals' obtained contraceptive knowledge and fertility. This study examines the factors related to the acquisition of contraceptive knowledge, and the relationship between an individual's contraceptive knowledge and their fertility during the period when family planning programs were enacted. Since dissemination of information relating to modern contraceptive techniques is one of the main ways for family planning programs to control fertility, examining the ways married women obtain contraceptive knowledge from the programs; the differences in knowledge acquisition across different demographic, social, and economic clines; and the subsequent effects on fertility sheds new light on the effectiveness of family planning programs, as well as the relationship between contraceptive knowledge and fertility.

Taiwan's family planning programs, enacted nationwide in 1964, aimed to decrease the fertility rate in order to control population growth. To reach this goal, the programs educated citizens about population growth issues, extolled the benefits of smaller families, and valuing daughters as highly as sons. These aim at changing married couples' traditional values about family. In addition, the program provided information about accessing and using contraceptive techniques. In Taiwan in the 1960s, primary education was not universal and both public transportation and

[2] There are a few of randomly designed family planning programs, such as the Taichung city experiment conducted in 1963, the Matlab family planning program, and the family planning programs PROFAMILIA of Colombia (Sinha, 2005).

communication technologies were limited;[3] the family planning program therefore used a variety of information dispersal techniques, including visiting families, placing advertisements/announcements in mass media, and encouraging word-of-mouth communication via friends, relatives, or neighbors to disseminate the information on family planning programs. For example, the information about modern contraceptive techniques, modern contraceptive access, and the benefits of having fewer children. Previous literature (for example, Kan and Tsai, 2004; Aggarwal and Rous, 2006; Barber and Axinn, 2004; Montgomery and Casterline, 1993; Behrman et al., 2002) have found that mass media exposure and word-of-mouth communication play important roles in obtaining the disseminated information in developing countries such as Taiwan, Nepal, India, and Kenya.

The detailed information on women's contraceptive knowledge, fertility history, mass media exposure, women's organization participation, and household and demographic characteristics in the "Knowledge, Attitude and Practice of Contraception in Taiwan" data sets allow researchers to measure directly women's contraceptive knowledge; contraceptive knowledge across socioeconomic characteristics, mass media exposure, and social networks; and the outcomes on fertility.

However, the obtained contraceptive knowledge is jointly determined by factors related to the demand- and supply-side of contraceptive knowledge. Unobserved factors, such as a couple's modernization and their sex/ parity/ quantity preference toward children, determine the levels of demand for both fertility and contraceptive knowledge. The existence of unobserved factors makes identification of causality challenging. This study uses an instrumental variables approach to

[3] In 1964, around 22% of the population did not have primary education, 3.9 per thousand households had the motor transportations, and 11.6 per thousand households had a telephone set in Taiwan. (Source: Taiwan Statistical Data Book)

resolve the endogeneity issue. Mass media exposure and connection to social networks are treated as instrumental variables of contraceptive knowledge to examine the causal effect of contraceptive knowledge on fertility.

There have been several studies investigating the relationship between knowledge and behaviors applied to different fields of interest, such as product consumption, risky behaviors, and health outcomes. Very few studies, however, focus on the relationship between contraceptive knowledge and fertility[4]. By exploring this relationship, this paper contributes to an improved understanding of the relationship between knowledge and behavior.

Taiwan's Family Planning Programs

Taiwan's death rate fell from about 14 to 5 per thousand between 1948 and 1962, while the fertility rate remained unchanged. High fertility rates and low death rates led to an annual rate of population growth that reached 3.5% in the years between 1951 and 1956. The 3.5% growth rate caused the population to double in only 20 years (Freedman and Takeshita, 1969). Although it is possible for social and economic development to change the role of the traditional family and decrease the demand for children, it usually takes years to complete the transition from high mortality and fertility to low mortality and fertility. Therefore, Taiwan's family planning programs were implemented nationwide to slow down population growth and shorten the period of demographic transition to prevent a large population growth that might impede economic development.

Taiwan's family planning programs were enacted nationwide in 1964. Before 1964, there were some voluntary and quasi-governmental activities advocating family

[4] Goldin and Katz (2002), Bailey(2006), Ananat et al (2007) use access to, rather than knowledge of, contraceptive techniques to analyze its effect on age of first marriage, professional career, and life-time fertility.

planning. For example, in 1950 the Joint Commission for Rural Reconstruction (JCRR) issued one million copies of the pamphlet, “The Happy Family,” advocating family planning by the rhythm method. In 1954, the China Family Planning Association, a voluntary organization subsidized by the JCRR, organized a training program emphasizing birth control and child spacing for women living in the dependent villages (Freedman et al., 1994).

Around 1963 and 1964, there was an experimental study in the city of Taichung to test the effectiveness of a more intensive family planning program. This study established that many families were interested in family planning and that couples in all social strata would accept contraceptive techniques when they were offered. The success of the program provided support for a later nationwide family intervention. In 1964, the government started a nationwide five-year plan, with a grant of US $24 million, to reduce the fertility rate by persuading 600,000 women to use contraceptives for their family planning needs.

The program involved 300 female health workers who made motivational and educational visits to women of childbearing age in their homes to offer subsidized contraceptives (Freedman et al., 1994). Since the number of pre-pregnancy health workers was limited, they concentrated first on visiting families with more than three children, those with sons, those living in high-fertility counties, the poor, and those living in remote villages. The reason was that these women had a stronger motivation to accept contraception, and their higher acceptance rates would most effectively lower the overall fertility rate.

The family planning program also used public media, such as radio, TV, newspapers, and slides at Taiwan’s movie houses to explain contraceptive techniques and how to obtain contraceptives. Articles on family planning were clipped out every month from 15 of Taiwan’s 22 newspapers. In 1965 there were a total of 319

articles related to family planning (Chu, 1966). In addition, around 50,000 posters were printed and placed in villages around the island. Mass media and word-of-mouth communication are the main ways to disseminate the contraceptive information. Over 60% of married women indicate they obtained the information about family planning from mass media or friends/ relatives/neighbors[5].

The government also used financial incentives to encourage women to use contraception. When new kinds of contraceptive techniques were introduced, the government updated their method of subsidizing contraceptives. The government first encouraged using loop and subsidized half of the cost; then they started to encourage using contraceptive pills and condoms and subsidized part of the cost. In addition to the government's subsidization of sterilization surgery for the poor, each city government also used welfare funding to subsidize sterilization surgery for the general population (Freedman et al., 1994). The number of people undergoing surgical sterilization rose rapidly. The family planning programs were officially ended in 1985.

Literature Review

There have been several studies investigating the relationship between knowledge and behaviors that have focused on different fields of interest, such as consumption and health-related behaviors. Some studies measure an individual's information acquisition about issues and examine the individual's subsequent behavior according to different information acquisition (for example, Kenkel, 1991; Kan and Tsai, 2004; Nayga, 2000); others focus on an event shock, such as the removal of the ban on nutrition claims on product and advertising style campaigns, to identify the information effect to examine different reactions among different subgroups toward

[5] From KAP data sets.

the new information (for example, de Walque, 2004; Ippolito and Mathios, 1999).

Regarding the literature about factors related to fertility, there is a large body of literature, covering several different countries, investigating the relationship between contraception and fertility. Most of this literature focuses on contraceptive access rather than knowledge. Several studies focus on family planning programs in the developing countries. They use the time and location variation among family planning programs as inputs to investigate the effect of contraception access on fertility (for example, Miller, 2008). A few studies focus on fertility in the U.S.; they use abortion legalization and pharmaceutical regulations, which vary states and over time, to examine the effect of contraception accessibility on fertility related outcomes (Goldin and Katz, 2002; Bailey 2006, Ananat et al, 2007)). These studies demonstrate that women who have access to contraception at an early age have fewer births and better career achievement than those without such access.

In addition, a large body of literature has focused on the individual's decision to use (or not to use) contraception and their choice of contraception types focusing on institutional and social factors influencing the decisions. Institutional factors shape the accessibility and availability of contraceptives which directly influence the use and choice of contraception (Braunder-Otto et al. 2007). Social effects, on the other hand, influence contraceptive adoption through defining it as a social acceptable behavior, and by spreading the information and adoption of new behaviors (Montgomery and Casterline, 1993; Behrman et al., 2002; Edmeades, 2008). Institutional effects and social effects may jointly influence the adoption of new behaviors. Institutional effects may indirectly influence the new behavior by establishing a social and economic environment which relates to the diffusion and adoption of new behaviors (Edmeades, 2008).

This study argues that the process of establishing contraceptive knowledge is

similar to the process of decision making about contraceptives. The institutional effects and social effects influence the dissemination of contraceptive knowledge in the same way that they influence contraceptive practice and choice. The mass media campaigns/ advertisements sponsored by family planning programs could be seen as an institutional effect because they indirectly influence women's awareness of modern contraceptives, not only by spreading information about contraceptive methods, but also by identifying locations for obtaining contraceptives. These campaigns can also be seen as social effects, as they shape contraception as a social acceptable behavior. Social networks, through which the contraceptive knowledge spread, are another method by which a social effect influences the establishment of contraceptive knowledge and multiplies the effect of mass media on the build of contraceptive knowledge. Several studies focus on factors such as mass media and social networks, associating them with the establishment of health-related information (Kan and Tsai (2004); Aggarwal and Rous (2006); Barber and Axinn (2004); Montgomery and Casterline (1993); Behrman et al. (2002)).

This study adds to the existing literature by examining the effect of contraceptive knowledge obtained from several mechanisms, such as mass media and social networks, on fertility.

Data

This research is primarily based on data from five island-wide surveys, "Knowledge, Attitudes, and Practice of Contraception in Taiwan" (KAP). They are repeated cross-sectional data conducted respectively in 1965, 1967, 1976, 1980, and 1985.[6] These surveys interviewed married women of reproductive age (18-44). The

[6] I do not include KAP 3 data collected in 1970, because the nature of KAP 3 is different from the other sets of KAP. KAP 3 re-interviewed half of the respondents interviewed in 1967, while the other half of the data is from an independent sample in the 22-39 age group.

data set includes information about women's fertility history, desired number of children, and attitudes toward, knowledge of, and use of contraception. In addition, measures of socio-economic status and demographic information such as age, education, employment, and family history for both wives and husbands are covered.

Table 1-1 presents the summary statistics for each survey year. In 1965, the year after the nation wide implementation of family planning programs, the women in fertile ages have had 4.04 live births on average. In 1967, two years after, the average number of live births drops to 3.96 and it keeps dropping to 2.66 live births in 1985. On the other hand, contraceptive knowledge among married women of fertile age is expanding over time. In 1965, married women know about 3.5 modern contraceptive techniques on average; in 1967, married women know about 4 modern contraceptive techniques, and in 1980s, married women know about 8 modern contraceptive techniques. Figure 1 presents the prevalence of knowledge of the selected modern contraceptive techniques for married women in every survey year. It shows that the prevalence of each specific technique might reflect the target of contraception that family planning programs emphasize. For example, the family planning programs first encouraged practicing loop, ota ring, and tubal ligation; later on, the programs encouraged women to use condoms and oral pills. The data in Figure 1 is consistent with that pattern. Furthermore, the practices of contraception and abortion have been increasing (Table 1-1). In 1965, only 27% of married women ever practiced contraception; however, in 1985, 88% of them ever practiced contraception. In 1965, only 10% of married women had ever had an abortion; in 1985, 28% of them had had one or more abortion.

Table 1-1: Summary Statistics

	KAP 1 (1965)	KAP 2 (1967)	KAP 4 (1976)	KAP 5 (1980)	KAP 6 (1985)
Sample size	3,719	4,989	5,587	3,852	3,819

Table 1-1 (continued)

Dependent variable					
Number of living births	4.04	3.96	3.20	2.70	2.66
Ideal number of births	3.96	3.89	3.25	2.84	2.57
Abortion	0.10	0.12	0.20	0.23	0.28
Number of abortion	1.57	1.60	1.57	1.60	1.54
Number of contraceptive techniques known	3.5	4.00	6.15	8.05	7.97
Contraception practice	0.27	0.41	0.68	0.83	0.88
Independent variable					
Whether the respondent reads the newspaper often	0.14	0.21	0.29	0.51	0.62
Whether the respondent reads magazines often			0.11	0.16	0.22
Whether the respondent listens to the radio often		0.54	0.15	0.27	0.49
Whether the respondent watches the TV often		0.21	0.70	0.79	0.93
Does the respondent own a Radio	0.55				
Whether living with other married couples	0.27	0.28	0.16	0.10	0.11
Organization participation			0.15	0.06	0.06
No son	0.18	0.15	0.18	0.20	0.18
Women's Education level					
Illiterate	0.49	0.40	0.25	0.12	0.08
Elementary	0.41	0.49	0.59	0.58	0.48
Junior high	0.06	0.06	0.08	0.11	0.17
Senior high	0.03	0.04	0.05	0.13	0.21
College	0.01	0.01	0.02	0.06	0.06
Husband's years of schooling	5.78	6.19	7.32	8.60	9.26
Whether working outside of family	0.17	0.20	0.44	0.31	0.33
Whether living with parents or parent's in law	0.52	0.46	0.39	0.38	0.40
Women's age	31.95	32.15	33.49	30.70	32.20
Living in city dummy	0.30	0.31	0.43	0.47	0.50
Sample size	3,719	4,989	5,587	3,852	4,312
Husband's ethnicity (Fukiennese)	0.76	0.73	0.68	0.72	0.73
(Hakka)	0.14	0.13	0.12	0.12	0.14
(Mainlander)	0.09	0.14	0.17	0.12	0.09
Contraceptive Knowledge					
Know Condom	0.29	0.30	0.54	0.85	0.89
Know Foam Tablets	0.29	0.28	0.29	0.36	0.24
Know Jelly	0.17	0.15	0.23	0.35	0.26
Know Diaphragm	0.12	0.14	0.19	0.35	0.38
Know Rhythm	0.20	0.27	0.45	0.60	0.67
Know Basic Temperature	0.05	0.09	0.20	0.43	0.53
Know Coitus Interruption	0.04	0.08	0.24	0.45	0.50
Know Ota Ring	0.64	0.61	0.76	0.87	0.75
Know Loop	0.47	0.62	0.89	0.96	0.92
Know Oral Pill	0.31	0.47	0.85	0.93	0.93
Know Vasectomy	0.33	0.35	0.65	0.93	0.93
Know Tubal Ligation	0.61	0.63	0.83	0.96	0.96

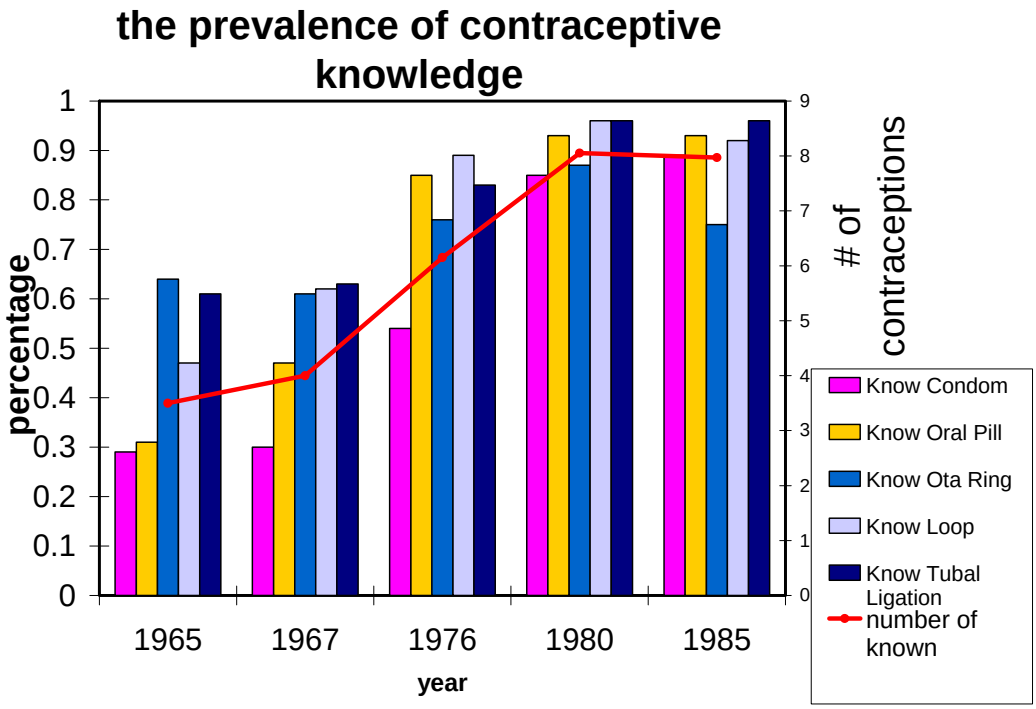

Figure 1: The Prevalence of Contraceptive Knowledge 1965, 1967, 1976, 1980, 1985

The increasing trends of mass media exposure, women's education levels, urban residence, and women's working status also reflect the rapid social changes and economic development of Taiwan during the 1960s-1980s. More and more women were regularly exposed to radio, TV, newspapers, and magazines over time. Women's education levels and working status also increased.

Identification Strategy

The direction of causation between contraceptive knowledge and fertility behaviors is a concern. One possibility is that contraception choices affect fertility; women who have larger contraceptive knowledge are more resourceful in choosing among different kinds of contraceptive techniques and practice the contraception to control their fertility. Another possibility is that fertility affects the acquisition of contraceptive knowledge. Women who have reached their desired number of

children, or have achieved their desired gender ratio among their children, have incentives to seek out more contraceptive knowledge than those who have not. Finally, external factors may determine levels of both fertility and contraceptive knowledge. For example, women who are more "modern" and "westernized" are more open to and resourceful with modern contraceptive techniques, and they at the same time demand fewer children.

Therefore, the Ordinary Least Squares (OLS) model without correcting the endogeneity in contraceptive knowledge, does not gauge the true effect of contraceptive knowledge on fertility. This study uses an instrumental variables approach to overcome the endogeneity issue, using mass media exposure and women's participation in organizations as the instruments of contraceptive knowledge. The hypotheses are: 1) married women who regularly listen to the radio, watch TV, read magazines, or read newspapers have more access to contraceptive advertisements and family planning campaigns, and hence, obtain more contraceptive information; 2) married women who actively participate in community-based organizations have a wider social network, and hence, obtain more contraceptive knowledge through word-of-mouth communications. The instruments are believed to influence fertility only through contraceptive knowledge; that is, they are uncorrelated with the error term in fertility equation. Section 7 explains in detail the strength and validity of these instruments.

Life-time Fertility

First, I used the OLS model, which does not take into account endogeneity issue, to estimate the life-time fertility equation (1) to investigate the relationship between contraceptive knowledge and fertility. N_i refers to the number of live births by the woman *i*; K_i is the number of contraceptive techniques the woman *i* has heard of;

X_i refers to other variables influencing fertility, such as the woman's age cohort, education, husband's education, husband's income, husband's ancestry, her current working status, urban/rural residence, cohabitation with parents-in-law, and other factors.

$$N_i = \beta_0 + \beta_1 K_i + \beta_2 X_i + \varepsilon_i \qquad (1)$$

Second, I take into account the endogeneity of contraceptive knowledge. In order to overcome the endogeneity issue, I use the two-stage least square (2SLS) approach: first, I use mass media exposure and organization participation as the instruments to identify the effect of contraceptive knowledge in equation (2), and then I use the predicted value of contraceptive knowledge from (2) to estimate the effect of contraceptive knowledge in the fertility equation (3). The variables indicating whether the respondents regularly watch TV, listen to the radio, read newspapers, or read magazines are proxies for exposure to the fertility-related campaigns and contraceptive advertisements in the mass media. The variables indicating whether they participate in community organizations are proxies for exposure to contraceptive knowledge through social networks (word-of-mouth communication).

$$K_i = \gamma_0 + \gamma_1 IV1_i + \gamma_2 IV2_i + \gamma_3 IV3_i + \gamma_4 IV4_i + \gamma_5 IV5_i + \gamma_6 X_i + \nu_i \qquad (2)$$

$$N_i = \beta_0 + \beta_1 \hat{K}_i + \beta_2 X_i + \varepsilon_i \qquad (3)$$

The Probability of Giving Birth

The number of live births is recorded from the year of marriage to the current year, while contraceptive knowledge, women's working status, urban/rural residence, and cohabitation with parents-in-law, and the measures of mass media exposure and social network are measured in the current year. To ensure the examination of the causal effect of knowledge on fertility, all variables are measured in the current state. I use linear probability model to examine the likelihood of giving birth in the previous

year in equation (4)[7].

$$\Pr(B_{t-1,i}) = G(\beta_0 + \beta_1 K_{t,i} + \beta_2 N_{t-1,i} + \beta_3 Boy_{t-1,i} + \beta_4 X_{t,i} + \varepsilon_i) \quad (4)$$

$B_{t-1,i}$ is a binary variable indicate whether the married women had a live birth last year; $K_{t,i}$ is the current contraceptive knowledge; $N_{t-1,i}$ is the number of live births until the last year; $Boy_{t-1,i}$ is the number of boy births until the last year; $X_{t,i}$ refers to other variables influencing fertility, such as the woman's age cohort, education, husband's education, husband's income, husband's ancestry, her current working status, urban/rural residence, cohabitation with parents-in-law, and other factors. OLS model without correcting the endogeneity issue is first estimated.

In addition, I take into account the endogeneity of contraceptive knowledge and use the 2SLS approach. I first use mass media exposure and organization participation as the instruments to identify the effect of contraceptive knowledge in equation (5), and then I use the predicted value of contraceptive knowledge from (5) to estimate the effect of contraceptive knowledge in the fertility equation (6). I used the same set of instrumental variables as the total number of live birth equation indicating whether the respondents regularly exposed to mass media and their connections to social networks.

$$K_i = \gamma_0 + \gamma_1 IV1_i + \gamma_2 IV2_i + \gamma_3 IV3_i + \gamma_4 IV4_i + \gamma_5 IV5_i + \gamma_6 X_i + \nu_i \quad (5)$$

$$\Pr(B_{t-1,i}) = G(\beta_0 + \beta_1 \hat{K}_{t,i} + \beta_2 N_{t-1,i} + \beta_3 Boy_{t-1,i} + \beta_4 X_{t,i} + \varepsilon_i) \quad (6)$$

Results

Life-time Fertility Equation

Table 1-2 presents the regression results of the number of live births estimated with OLS. The regressions are estimated separately by each survey year. Wife's

[7] This study examines the birth probability in the previous year instead of the current year, because it ensures the duration of each possible event occurs is one year and it can be consistent in each survey year.

education level and current working status, which could serve as proxies for prices of having children, are negatively associated with the number of live births. Husband's education is negatively correlated with number of live births. Husband's income is not statistically associated with the number of births.

Older women have more live births than younger ones. Husband's ancestry is associated with the number of live births. Compared with the Fukiennese, the Mainlanders have fewer live births. Women who live in the city have fewer births. The OLS model indicates that contraceptive knowledge is positively associated with the number of live births in the earlier survey years: 1965, 1967, and 1976. The magnitude of this association decreases with time. The sign of coefficient on contraceptive knowledge changes to negative in the later survey years: 1980 and 1985. The positive relationship between contraceptive knowledge and life time fertility contradicts the intuition that contraception prevents unintended births, since it does not take into account the endogeneity issue. Indeed, the positive relationship explains a possible source of endogeneity: there might be a target effect driving the positive relationship. For example, women with a very large number of children are the target of family planning programs and get more resources from the programs, such as family visits from health personnel, telephone contacts, etc about the contraceptive knowledge. The decreasing magnitude of positive target effects explains that the target effect has been vanishing over time. Another explanation for the positive relationship is the reverse causality between contraceptive knowledge and fertility: women who have had a large number of births might have more incentives to seek out effective contraceptive techniques on their own to prevent pregnancy.

Table 1-2: The number of live births, OLS model

OLS: dependant variable: number of live births					
	1965	1967	1976	1980	1985

Table 1-2 (continued)

Number of contraceptives known	0.07	0.05	0.02	-0.02	-0.02
	[0.01]**	[0.01]**	[0.01]**	[0.01]*	[0.01]+
No son	-1.49	-1.64	-1.15	-0.97	-0.90
	[0.10]**	[0.09]**	[0.06]**	[0.06]**	[0.05]**
age1822	-3.95	-3.75	0.00	-1.97	-1.78
	[0.14]**	[0.11]**	[0.00]	[0.11]**	[0.08]**
age2327	-3.27	-3.13	-2.20	-1.44	-1.31
	[0.14]**	[0.09]**	[0.07]**	[0.08]**	[0.07]**
age2832	-2.06	-2.09	-1.45	-0.80	-0.81
	[0.11]**	[0.08]**	[0.05]**	[0.08]**	[0.06]**
age3337	-0.83	-1.01	-0.64	-0.24	-0.37
	[0.10]**	[0.09]**	[0.04]**	[0.08]**	[0.05]**
Wife is working outside of family	-0.25	-0.17	-0.15	-0.12	-0.21
	[0.07]**	[0.07]**	[0.04]**	[0.04]**	[0.04]**
Wife years education 12 and over	-0.61	-0.74	-0.58	-0.47	-0.46
	[0.14]**	[0.12]**	[0.07]**	[0.04]**	[0.05]**
Wife years education 0-6	0.29	0.36	0.37	0.24	0.03
	[0.07]**	[0.06]**	[0.05]**	[0.06]**	[0.10]
Husband years education 0-6	0.30	0.12	0.20	0.26	0.21
	[0.07]**	[0.06]+	[0.06]**	[0.06]**	[0.12]+
Husband years education 12 and over	-0.42	-0.20	-0.30	-0.28	-0.25
	[0.07]**	[0.08]*	[0.05]**	[0.04]**	[0.05]**
Husband's ancestry: hakka	0.00	-0.13	-0.06	-0.09	-0.14
	[0.09]	[0.09]	[0.07]	[0.06]	[0.06]*
Husband's ancestry: mainlander	-0.56	-0.43	-0.14	-0.19	-0.33
	[0.09]**	[0.09]**	[0.06]*	[0.05]**	[0.07]**
Live in a city	-0.66	-0.22	-0.20	-0.20	-0.22
	[0.16]**	[0.10]*	[0.07]**	[0.07]**	[0.05]**
Live with parents-in-law	-0.08	-0.02	0.05	0.05	0.03
	[0.06]	[0.05]	[0.04]	[0.04]	[0.04]
Husband's income		-0.04	0.00	-0.04	-0.03
		[0.04]	[0.01]	[0.04]	[0.03]
Constant	6.11	6.38	4.60	3.76	4.03
	[0.13]**	[0.22]**	[0.06]**	[0.10]**	[0.11]**
Observations	3662	4871	4678	3852	3817
R-squared	0.56	0.53	0.49	0.47	0.46
Robust standard errors in brackets					
+ significant at 10%; * significant at 5%; ** significant at 1%					

In order to resolve the endogeneity issue, a 2SLS model which takes into account endogeneity is estimated. Table 1-3 and 1-4 present the results. The result of the first

stage is listed in Table 1-3, and the second stage in Table 1-4. The result in Table 1-3 indicates that women who are regularly exposed to mass media, including watching TV, listening to the radio, reading magazines, or reading newspapers have larger contraceptive knowledge than those who do not; women who participate in organizations have greater contraceptive knowledge than their non-participating counterparts. The instruments explain contraceptive knowledge very well. The F statistics are 26.92, 65.50, 46.06, 14.60, and 29.75 in 1965, 1967, 1976, 1980, and 1985 respectively. All F statistics are above 10, surpassing the threshold of powerfulness for instrumental variables[8]. The first stage indicates that mass media and social networks play crucial roles in obtaining contraceptive knowledge, consistent with the findings of previous literature.

Table 1-3: The number of live births, 2SLS (first stage)

2SLS: first stage: dv: number of contraceptive techniques known					
	1965	1967	1976	1980	1985
No son	-0.89	-0.84	-0.61	-0.00	-0.11
	[0.13]**	[0.12]**	[0.12]**	[0.12]	[0.10]
age1822	-0.66	-0.91	0.00	-0.65	0.11
	[0.22]**	[0.18]**	[0.00]	[0.31]*	[0.19]
age2327	-0.16	-0.34	-0.48	-0.12	0.62
	[0.14]	[0.13]**	[0.14]**	[0.20]	[0.15]**
age2832	0.43	0.24	-0.02	0.04	0.41
	[0.10]**	[0.12]*	[0.12]	[0.19]	[0.12]**
age3337	0.41	0.36	0.28	0.18	0.20
	[0.13]**	[0.12]**	[0.09]**	[0.16]	[0.11]+
Wife is working outside of family	0.00	0.25	0.16	0.07	0.25
	[0.14]	[0.11]*	[0.13]	[0.13]	[0.09]*
Wife's education is 12 or above	1.08	0.86	0.84	0.89	1.03
	[0.36]**	[0.28]**	[0.16]**	[0.12]**	[0.11]**
Wife's education is 0-6	-1.02	-0.80	-0.66	-0.77	-0.88
	[0.12]**	[0.11]**	[0.11]**	[0.18]**	[0.23]**
Husband's education is 0-6	-0.31	-0.46	-0.46	-0.45	-0.91
	[0.10]**	[0.09]**	[0.11]**	[0.13]**	[0.27]**

[8] Staiger and Stock (1997) suggest that the instrument set is considered weak if the first stage F statistic is less than 10.

Table 1-3 (continued)

Husband's education is 12 or above	1.28	0.98	0.78	0.61	0.66
	[0.21]**	[0.17]**	[0.13]**	[0.12]**	[0.10]**
Husband's ancestry: hakka	0.68	0.26	0.95	0.03	0.32
	[0.33]*	[0.15]+	[0.33]**	[0.26]	[0.17]+
Husband's ancestry: mainlander	0.17	0.24	0.33	-0.13	-0.44
	[0.19]	[0.16]	[0.17]+	[0.15]	[0.14]**
Living in a city	-0.14	0.62	0.54	0.04	0.80
	[0.47]	[0.18]**	[0.37]	[0.24]	[0.29]**
Living with parents in law	-0.18	-0.26	-0.27	-0.01	0.07
	[0.09]+	[0.09]**	[0.09]**	[0.08]	[0.08]
Listen to radio	0.36	0.82	0.51	0.21	0.30
	[0.10]**	[0.09]**	[0.13]**	[0.11]+	[0.09]**
Read newspapers	1.88	1.59	1.17	0.83	1.07
	[0.22]**	[0.16]**	[0.13]**	[0.15]**	[0.13]**
Live with married couples	0.06	-0.13	-0.39	-0.08	-0.09
	[0.11]	[0.09]	[0.16]*	[0.13]	[0.10]
Husband's income		0.49	0.09	0.38	0.24
		[0.07]**	[0.02]**	[0.10]**	[0.08]**
Watch tv		0.72	0.83	0.29	-0.03
		[0.13]**	[0.12]**	[0.13]*	[0.15]
Read magazines			0.89	0.84	0.54
			[0.14]**	[0.13]**	[0.08]**
Join organizations			0.49	0.42	0.52
			[0.19]*	[0.18]*	[0.16]**
Constant	4.47	2.19	1.86	6.27	6.33
	[0.18]**	[0.19]**	[0.14]**	[0.28]**	[0.22]**
F statistics	26.92	65.50	46.06	14.60	29.75
Observations	3662	4868	4678	3852	3819
R-squared	0.38	0.43	0.40	0.31	0.35
Robust standard errors in brackets					
+ significant at 10%; * significant at 5%; ** significant at 1%					

The results of the second stage are listed in Table 1-4. After taking into account endogeneity, the signs of the coefficients on contraceptive knowledge change from positive to negative. An additional contraceptive technique known by women *decreases* the total number of births by 0.16, 0.09, 0.14, 0.18, and 0.20 in 1965, 1967, 1976, 1980, and 1985 respectively. The price effect in fertility equation is negative--the women with high education and currently working outside of the family have fewer births. The income effect in the fertility equation is positive but only reaches

statistical significance in 1967. The influences of other demographic factors on fertility are similar with the findings in OLS. Older cohorts have more live births. Mainlanders have fewer live births than Fukiennese on average.

Table 1-4: The number of live births, 2SLS (second stage)

2SLS: dependent variable: number of live births					
	1965	1967	1976	1980	1985
Number of contraceptive techniques known	-0.16	-0.09	-0.14	-0.18	-0.20
	[0.05]**	[0.03]**	[0.03]**	[0.03]**	[0.03]**
No son	-1.68	-1.76	-1.24	-0.96	-0.92
	[0.09]**	[0.07]**	[0.06]**	[0.05]**	[0.05]**
age1822	-4.10	-3.86	0.00	-2.06	-1.76
	[0.14]**	[0.12]**	[0.00]	[0.10]**	[0.09]**
age2327	-3.31	-3.16	-2.25	-1.46	-1.20
	[0.09]**	[0.07]**	[0.06]**	[0.06]**	[0.06]**
age2832	-1.98	-2.04	-1.45	-0.79	-0.72
	[0.08]**	[0.07]**	[0.05]**	[0.06]**	[0.06]**
age3337	-0.76	-0.96	-0.58	-0.22	-0.33
	[0.08]**	[0.07]**	[0.05]**	[0.06]**	[0.05]**
Wife is working outside of family	-0.24	-0.14	-0.13	-0.11	-0.18
	[0.07]**	[0.06]*	[0.05]**	[0.04]**	[0.04]**
Wife's education 12 or above	-0.18	-0.55	-0.32	-0.25	-0.20
	[0.19]	[0.13]**	[0.09]**	[0.08]**	[0.07]**
Wife's education 0-6	-0.03	0.15	0.20	0.06	-0.22
	[0.10]	[0.07]*	[0.05]**	[0.06]	[0.08]**
Husband's education 0-6	0.22	0.04	0.11	0.18	0.02
	[0.07]**	[0.06]	[0.06]+	[0.07]**	[0.11]
Husband's education 12 or above	-0.00	0.01	-0.08	-0.13	-0.08
	[0.14]	[0.09]	[0.06]	[0.06]*	[0.05]
Husband's ancestry: hakka	0.15	-0.10	0.09	-0.08	-0.07
	[0.10]	[0.08]	[0.07]	[0.06]	[0.06]
Husband's ancestry: mainlander	-0.52	-0.36	-0.06	-0.21	-0.41
	[0.11]**	[0.08]**	[0.05]	[0.06]**	[0.07]**
Living in a city	-0.67	-0.12	-0.06	-0.17	-0.06
	[0.11]**	[0.10]	[0.07]	[0.06]**	[0.07]
Live with parents in law	-0.12	-0.06	0.01	0.05	0.04
	[0.06]+	[0.05]	[0.04]	[0.04]	[0.04]
Husband's income		0.06	0.03	0.04	0.04
		[0.04]	[0.01]*	[0.04]	[0.03]
Constant	7.25	6.79	5.01	4.81	5.32

Table 1-4 (continued)

	[0.37]**	[0.21]**	[0.20]**	[0.29]**	[0.28]**
Observations	3662	4868	4678	3852	3817
R-squared	0.50	0.50	0.43	0.40	0.36
Over-identification test (p-value)	0.4707	0.0826	0.1415	0.0307	0.0099
Standard errors in brackets					
+ significant at 10%; * significant at 5%; ** significant at 1%					

The Probability of Giving Birth

This study estimates the probability of giving birth using OLS and 2SLS approach. The result of OLS is listed in Table 1-5. The result indicates that contraceptive knowledge has almost no effect on the likelihood of giving birth in the last year, conditional upon the accumulative live birth has been given before the previous year, except in 1967. Those who had not had any sons before the previous year yet are more likely to give birth last year than the counterparts. This is true in each survey year. The result implies that married couples' preference toward sons is still existent. The younger cohorts have a higher probability of giving birth in the previous year than older cohorts. Women who are currently working outside of family have a lower probability of giving birth within the past year. Women's education is not associated with the likelihood of giving birth. Mainlanders are less likely to have births last year compared to Fukiennese.

Table 1-5: The probability of giving births, OLS model

OLS: dv: whether having births last year					
	1965	1967	1976	1980	1985
Cumulative not having sons	0.09	0.18	0.12	0.08	0.11
	[0.02]**	[0.02]**	[0.02]**	[0.02]**	[0.02]**
Total live births until last year	-0.00	-0.00	-0.04	-0.09	-0.09
	[0.00]	[0.00]	[0.01]**	[0.01]**	[0.01]**
Number of contraceptive techniques known	-0.00	-0.01	0.00	0.00	0.00
	[0.00]	[0.00]*	[0.00]	[0.00]	[0.00]+

Table 1-5 (continued)

age1822	0.41	0.43	0.00	0.20	0.26
	[0.04]**	[0.04]**	[0.00]	[0.04]**	[0.05]**
age2327	0.52	0.49	0.31	0.20	0.26
	[0.03]**	[0.03]**	[0.03]**	[0.03]**	[0.03]**
age2832	0.39	0.33	0.28	0.09	0.13
	[0.02]**	[0.02]**	[0.02]**	[0.02]**	[0.02]**
age3337	0.15	0.13	0.15	-0.00	0.00
	[0.02]**	[0.02]**	[0.01]**	[0.02]	[0.01]
Wife is working outside of family	-0.10	-0.05	-0.13	-0.09	-0.07
	[0.02]**	[0.02]**	[0.02]**	[0.01]**	[0.02]**
Wife years education 12 or above	0.00	-0.02	0.03	-0.01	0.00
	[0.04]	[0.04]	[0.04]	[0.02]	[0.02]
Wife years education 0-6	-0.00	0.02	0.02	-0.01	0.01
	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]
Husband years education 0-6	0.05	0.04	0.00	0.03	-0.01
	[0.02]*	[0.02]*	[0.02]	[0.02]	[0.03]
Husband years education 12 and above	-0.03	-0.01	-0.04	-0.04	-0.01
	[0.03]	[0.02]	[0.02]*	[0.02]*	[0.02]
Husband ancestry: hakka	0.03	-0.00	-0.01	-0.00	-0.02
	[0.03]	[0.03]	[0.02]	[0.02]	[0.02]
Husband ancestry: mainlander	-0.07	-0.02	-0.08	-0.08	-0.06
	[0.03]*	[0.02]	[0.02]**	[0.02]**	[0.02]**
Living in a city	-0.06	-0.01	-0.03	-0.03	-0.03
	[0.02]*	[0.03]	[0.02]	[0.02]	[0.02]+
Live with parents-in-law	0.01	0.01	0.02	0.04	0.04
	[0.02]	[0.02]	[0.01]	[0.01]**	[0.01]**
Husband’s income		-0.02	-0.00	0.02	0.02
		[0.01]	[0.00]	[0.01]	[0.01]+
Constant	0.08	0.31	0.27	0.34	0.23
	[0.04]+	[0.08]**	[0.03]**	[0.04]**	[0.04]**
Observations	3564	4776	4460	3788	3614
R-squared	0.21	0.24	0.21	0.26	0.33
Robust standard errors in brackets					
+ significant at 10%; * significant at 5%; ** significant at 1%					

The result of 2SLS analysis is listed in Table 1-6 and 1-7. Table 1-6 presents the first stage. The results support the result in Table 1-3 that mass media exposure and social networks play important roles in the acquisition of contraceptive knowledge. The instruments are powerful in predicting contraceptive knowledge.

Table 1-6: The probability of giving births, 2SLS (first stage)

2SLS, first stage, dv: number of contraceptive techniques known					
	1965	1967	1976	1980	1985
Cumulative having no sons	-0.63	-0.70	-0.60	0.02	-0.15
	[0.12]**	[0.12]**	[0.11]**	[0.10]	[0.10]
Number of live births until last year	0.19	0.17	0.09	-0.09	-0.08
	[0.03]**	[0.03]**	[0.03]**	[0.04]*	[0.05]
Age1822	0.43	0.08	0.00	-0.90	-0.06
	[0.25]+	[0.22]	[0.00]	[0.31]**	[0.26]
age2327	0.73	0.43	-0.09	-0.31	0.50
	[0.19]**	[0.16]**	[0.16]	[0.20]	[0.17]**
age2832	0.96	0.69	0.22	-0.06	0.33
	[0.13]**	[0.13]**	[0.13]	[0.19]	[0.14]*
age3337	0.64	0.56	0.38	0.16	0.17
	[0.13]**	[0.12]**	[0.10]**	[0.16]	[0.12]
Wife is working outside of family	-0.00	0.26	0.15	0.06	0.23
	[0.14]	[0.11]*	[0.13]	[0.13]	[0.09]*
Wife's education is 12 or above	1.17	1.00	0.95	0.83	1.00
	[0.37]**	[0.27]**	[0.15]**	[0.13]**	[0.11]**
Wife's education is 0-6	-1.16	-0.84	-0.69	-0.75	-0.88
	[0.13]**	[0.11]**	[0.11]**	[0.18]**	[0.23]**
Husband's education is 0-6	1.36	1.00	0.80	0.59	0.64
	[0.21]**	[0.17]**	[0.13]**	[0.12]**	[0.10]**
Husband's education is 12 or above	0.73	0.26	0.94	0.02	0.31
	[0.32]*	[0.15]+	[0.33]**	[0.26]	[0.16]+
Husband's ancestry: hakka	0.27	0.31	0.32	-0.14	-0.47
	[0.19]	[0.15]*	[0.17]+	[0.16]	[0.13]**
Husband's ancestry: mainlander	0.03	0.66	0.57	0.02	0.78
	[0.45]	[0.18]**	[0.37]	[0.24]	[0.28]**
Live in a city	-0.16	-0.24	-0.26	-0.01	0.07
	[0.09]+	[0.09]**	[0.09]**	[0.08]	[0.08]
Live with parents in law	0.41	0.84	0.50	0.21	0.29
	[0.10]**	[0.09]**	[0.13]**	[0.11]+	[0.09]**
Listen to the radio	1.91	1.63	1.18	0.82	1.07
	[0.21]**	[0.16]**	[0.13]**	[0.15]**	[0.13]**
Read newspapers	0.10	-0.11	-0.40	-0.09	-0.09
	[0.11]	[0.09]	[0.16]*	[0.13]	[0.10]
Live with married couples		-0.47	-0.47	-0.43	-0.90

Table 1-6 (continued)

		[0.09]**	[0.11]**	[0.13]**	[0.27]**
Husband's income		0.48	0.09	0.38	0.24
		[0.07]**	[0.02]**	[0.10]**	[0.08]**
Watch TV		0.70	0.85	0.29	-0.03
		[0.13]**	[0.12]**	[0.12]*	[0.15]
Read magazines			0.90	0.84	0.53
			[0.14]**	[0.13]**	[0.08]**
Join Organization			0.49	0.43	0.52
			[0.18]*	[0.18]*	[0.16]**
Constant	3.16	1.15	1.46	6.57	6.62
	[0.23]**	[0.25]**	[0.18]**	[0.29]**	[0.24]**
F statistics					
Observations	3662	4868	4678	3852	3817
R-squared	0.39	0.44	0.41	0.32	0.35
Robust standard errors in bracket					
+ significant at 10%; * significant at 5%; ** significant at 1%					

Table 1-7 presents the second stage. The results show that, conditional on the number of births until last year, one more contraceptive technique known *prevents* the likelihood of having births by 0.06, 0.03., 0.04, 0.05 and 0.05 last year in survey years of 1965, 1967, 1976, 1980, and 1985 respectively[9]. The more births each woman has had, the less likely she is to give birth, and the magnitude of this effect increases over time. This explains the number of births to each woman has been decreasing over time which reflects the decreasing birth rate. Women who have not had any sons remain more likely to have another birth. This shows that sex preference toward sons still exists. Younger cohorts are more likely to have births than older ones. Women who are currently working outside of the family are less likely to give birth. Women with higher education are more likely to have given birth recently, which might reflect the positive relationship between high education and young ages. Mainlanders are less likely to give births than Fukiennese. Women who currently live with parents-in-law are more likely to have given birth recently, but the coefficients are only significant in

[9] The proportion of women who gave birth in the previous year is 0.440, 0.386, 0.363, 0.281, 0.262 in each survey year.

1980 and 1985. Husband's income is positively associated with the probability of giving birth.

Table 1-7: The probability of giving births, 2SLS (second stage)

2SLS, second stage, dv: whether having births last year					
	1965	1967	1976	1980	1985
Number of contraceptive techniques known	-0.06	-0.03	-0.04	-0.05	-0.05
	[0.02]**	[0.01]**	[0.01]**	[0.01]**	[0.01]**
Cumulative having no sons	0.05	0.16	0.10	0.08	0.10
	[0.03]*	[0.02]**	[0.02]**	[0.02]**	[0.02]**
Number of live births until last year	0.01	-0.00	-0.04	-0.10	-0.09
	[0.01]	[0.00]	[0.01]**	[0.01]**	[0.01]**
age1822	0.44	0.44	0.00	0.14	0.25
	[0.05]**	[0.04]**	[0.00]	[0.04]**	[0.04]**
age2327	0.55	0.50	0.31	0.18	0.28
	[0.03]**	[0.03]**	[0.03]**	[0.03]**	[0.03]**
age2832	0.44	0.34	0.29	0.09	0.15
	[0.03]**	[0.02]**	[0.02]**	[0.02]**	[0.02]**
age3337	0.19	0.15	0.16	0.01	0.01
	[0.03]**	[0.02]**	[0.02]**	[0.02]	[0.02]
Wife is working outside of family	-0.10	-0.04	-0.12	-0.08	-0.06
	[0.02]**	[0.02]*	[0.02]**	[0.02]**	[0.01]**
Wife's education is 12 or above	0.13	0.02	0.10	0.06	0.08
	[0.06]*	[0.04]	[0.03]**	[0.03]*	[0.02]**
Wife's education is 0-6	-0.09	-0.01	-0.03	-0.07	-0.08
	[0.03]**	[0.02]	[0.02]	[0.02]**	[0.03]**
Husband's education is 0-6	0.02	0.02	-0.02	-0.00	-0.06
	[0.02]	[0.02]	[0.02]	[0.03]	[0.04]
Husband's education is 12 or above	0.08	0.02	0.02	0.01	0.04
	[0.04]*	[0.03]	[0.02]	[0.02]	[0.02]*
Husband's ancestry: hakka	0.07	0.01	0.03	0.00	0.00
	[0.03]*	[0.02]	[0.02]	[0.02]	[0.02]
Husband's ancestry: mainlander	-0.06	-0.01	-0.06	-0.09	-0.09
	[0.03]+	[0.02]	[0.02]**	[0.02]**	[0.02]**
Live in a city	-0.06	0.00	0.01	-0.02	0.02
	[0.03]+	[0.03]	[0.02]	[0.02]	[0.02]
Live with parents in law	0.00	0.00	0.01	0.04	0.05
	[0.02]	[0.01]	[0.01]	[0.01]**	[0.01]**
Husband's income		0.00	0.00	0.04	0.04
		[0.01]	[0.00]	[0.02]**	[0.01]**

Table 1-7 (continued)

Constant	0.32	0.35	0.36	0.75	0.68
	[0.10]**	[0.06]**	[0.07]**	[0.12]**	[0.11]**
Observations	3564	4773	4460	3788	3614
R-squared	0.12	0.23	0.16	0.16	0.23
Over-identification test(p-value)	0.9775	0.6887	0.1788	0.2236	0.7259
Standard errors in brackets					
+ significant at 10%; * significant at 5%; ** significant at 1%					

In general, the results indicate that contraceptive knowledge *reduces* fertility no matter whether that fertility is measured by life-time fertility or the probability of recently having given birth.

Evaluating the IV strategy

The instruments of contraceptive knowledge -- mass media exposure and social networks – have a strong joint influence on the obtainment of contraceptive knowledge. This study would be able to identify the causal effect of contraceptive knowledge on fertility as long as the exclusion restriction is valid, that is, as long as mass media exposure and social networks affect fertility only through contraceptive knowledge.

Indeed, the over-identification test suggests that the instruments this study uses are valid especially in the likelihood of having births equation. The p-values to over identification tests are listed in Table 1-4 and 1-7. The null hypothesis that no association between contraceptive knowledge and error term in fertility equation fail to be rejected in the year 1965 and 1976 for total number of live births equation, and every survey year for the likelihood of having birth equation.

However, a number of arguments still can be made to question exclusion restriction. First, mass media exposure and/or organization participation might not only expand contraceptive knowledge but also shape fertility attitudes in a way that

influences fertility demand. If fertility attitudes changed through mass media exposure influence the acquisition of contraceptive knowledge, then the coefficient on contraceptive knowledge in the second stage of the 2SLS approach does not solely reflect the effect of contraceptive knowledge on fertility; it also reflects the couple's attitudes about a desired number of children and/or the sex composition of their family. Women who are regularly exposed to mass media or who have a wider social network are more likely to have access to family planning messages on the benefits of having fewer children and access to knowledge of modern contraceptive techniques than women without that exposure. If contraceptive attitudes and knowledge are correlated, the coefficient on contraceptive knowledge in the fertility equation might not only reflect the contraceptive knowledge but also attitudes which lead to over-estimate the effect of contraceptive knowledge.

Another argument concerning the validity of the instrumental variables used in this paper is based upon a hypothetical unobserved characteristic which may collectively drive contraceptive knowledge, mass media exposure and organization participation. Women selected to the group with regular exposure to mass media and/or with wider social networks are different from the group of women who are not. They might be different in observable ways. For example, women who are regularly exposed to mass media and/or have larger social networks might have a higher level of education, be younger, and be wealthier. On the other hand, it is possible they might be different in unobservable ways. For example, women with regular mass media exposure and wider social networks might be more open to new information than those with less exposure. These observable and unobservable characteristics might influence the fertility decision. While this study controls for differences in observable characteristics, it does not control for differences in unobservable characteristics. If there is an unobservable difference between the two groups in the case described

above, the coefficient on contraceptive knowledge might be biased upward and not reflect the true effect of contraceptive knowledge on fertility.

Robustness Check

In order to take into account the potential factors leading to the biased contraceptive knowledge effects listed in the section 7 -- the unobserved married couple's modernity and attitudes toward family planning might lead to the over-estimated contraceptive knowledge effect on fertility. This study takes the advantages of the affluent data sets this study uses which have the information on attitudes toward family planning and general traditional viewpoints. It controls for the attitudes toward family planning and general traditional viewpoints in the fertility equation in 2SLS aims to resolve the potential issues and get the consistent contraceptive knowledge effect on fertility.

The results indicate that the equations of total live births and probability of having births are very robust after taking into account women's modernity and attitudes toward family planning. The evidence provides the credence to the causal effect of contraceptive knowledge this study finds. The results are listed in Table 1-8-1 and Table 1-8-2.

Table 1-8-1[10]: The number of live births control for family attitudes

The number of live births equation (2SLS)					
	1965	1967	1976	1980	1985
Contraceptive knowledge	-0.17	-0.10	-0.13	-0.18	-0.21
	[0.06]**	[0.03]**	[0.03]**	[0.04]**	[0.03]**
Tradition	0.02	0.17	0.09	0.12	
	[0.09]	[0.07]*	[0.04]*	[0.04]**	
Attitudes	0.42	0.44	0.27	0.06	0.11
	[0.11]**	[0.08]**	[0.09]**	[0.08]	[0.04]**

[10] The variable, tradition, measures the married women's viewpoints toward tradition. Tradition is coded with "1" if the respondents answer "definitely yes" or "probability yes" to the question "do you expect to live with your children or grandchildren in old age?"; and "0" otherwise. The variable, attitude, measures the married women's viewpoints toward family planning programs. Attitude is coded with "1" if the respondents answer "approve very much" or "approve" to the question "are you in favor of family planning/ contraception?"; and "0" otherwise.

Table 1-8-1 (continued)

No son	-1.66	-1.71	-1.23	-0.96	-0.92
	[0.09]**	[0.07]**	[0.06]**	[0.05]**	[0.05]**
Age1822	-4.14	-3.88	0.00	-2.06	-1.78
	[0.14]**	[0.12]**	[0.00]	[0.10]**	[0.09]**
Age2327	-3.36	-3.21	-2.25	-1.45	-1.21
	[0.09]**	[0.07]**	[0.06]**	[0.06]**	[0.06]**
Age2832	-2.02	-2.08	-1.46	-0.78	-0.73
	[0.08]**	[0.06]**	[0.05]**	[0.06]**	[0.06]**
Age3337	-0.78	-0.99	-0.59	-0.21	-0.33
	[0.08]**	[0.07]**	[0.05]**	[0.06]**	[0.05]**
Wife is working outside of family	-0.25	-0.13	-0.13	-0.11	-0.18
	[0.07]**	[0.06]*	[0.05]**	[0.04]**	[0.04]**
Wife education is 12 or above	-0.17	-0.52	-0.31	-0.23	-0.20
	[0.19]	[0.13]**	[0.09]**	[0.08]**	[0.07]**
Wife education is 0-6	-0.02	0.14	0.19	0.04	-0.23
	[0.10]	[0.07]*	[0.05]**	[0.07]	[0.08]**
Husband education is 0-6	0.22	0.05	0.10	0.17	0.01
	[0.07]**	[0.06]	[0.06]+	[0.07]*	[0.11]
Husband education is 12 or above	-0.01	0.03	-0.08	-0.12	-0.08
	[0.14]	[0.09]	[0.06]	[0.06]*	[0.05]
Husband's ancestry: hakka	0.13	-0.09	0.09	-0.08	-0.07
	[0.10]	[0.08]	[0.07]	[0.06]	[0.06]
Husband's ancestry: mainlander	-0.51	-0.35	-0.06	-0.21	-0.42
	[0.11]**	[0.08]**	[0.05]	[0.06]**	[0.07]**
Living in a city	-0.68	-0.13	-0.05	-0.18	-0.07
	[0.11]**	[0.10]	[0.07]	[0.06]**	[0.07]
Live with parents in law	-0.11	-0.06	0.00	0.04	0.05
	[0.06]+	[0.05]	[0.04]	[0.04]	[0.04]
Husband's income		0.06	0.03	0.05	0.04
		[0.04]	[0.01]*	[0.04]	[0.03]
Constant	6.91	6.25	4.80	4.77	5.35
	[0.37]**	[0.22]**	[0.20]**	[0.28]**	[0.28]**
Observations	3662	4868	4678	3852	3817
R-squared	0.50	0.51	0.44	0.39	0.35
Standard errors in brackets					
+ significant at 10%; * significant at 5%; ** significant at 1%					

Table 1-8-2: The probability of giving births control for family attitudes

The probability of having birth (2SLS)					
	1965	1967	1976	1980	1985
Number of contraceptive knowledge known	-0.10	-0.04	-0.04	-0.06	-0.05
	[0.02]**	[0.01]**	[0.01]**	[0.02]**	[0.01]**
Tradition	-0.02	0.03	0.01	0.04	n/a
	[0.03]	[0.02]	[0.02]	[0.02]+	n/a
Attitudes	0.20	0.12	0.14	0.06	0.06
	[0.04]**	[0.03]**	[0.04]**	[0.04]	[0.02]**
Cumulative having no sons	-0.18	-0.08	-0.18	-0.08	-0.08
	[0.04]**	[0.03]**	[0.03]**	[0.02]**	[0.02]**
Number of live births until last year	0.00	-0.00	-0.06	-0.12	-0.11
	[0.01]	[0.01]	[0.01]**	[0.01]**	[0.01]**
age1822	0.34	0.41	0.00	0.21	0.28
	[0.06]**	[0.05]**	[0.00]	[0.06]**	[0.05]**

Table 1-8-2 (continued)

age2327	0.55	0.58	0.35	0.30	0.37
	[0.05]**	[0.03]**	[0.04]**	[0.03]**	[0.03]**
age2832	0.53	0.45	0.39	0.19	0.23
	[0.04]**	[0.03]**	[0.03]**	[0.03]**	[0.02]**
age3337	0.26	0.18	0.23	0.09	0.07
	[0.03]**	[0.02]**	[0.02]**	[0.03]**	[0.02]**
Wife is working outside of family	-0.09	-0.05	-0.10	-0.09	-0.06
	[0.03]**	[0.02]*	[0.02]**	[0.02]**	[0.02]**
Wife education is 12 or above	0.16	0.05	0.11	0.07	0.14
	[0.07]*	[0.04]	[0.04]**	[0.03]*	[0.03]**
Wife education is 0-6	-0.10	-0.02	-0.06	-0.09	-0.08
	[0.04]**	[0.03]	[0.02]**	[0.03]**	[0.03]*
Husband education is 0-6	0.02	0.02	0.02	-0.02	-0.03
	[0.03]	[0.02]	[0.02]	[0.03]	[0.04]
Husband education is 12 or above	0.12	-0.01	0.02	0.05	0.03
	[0.05]*	[0.03]	[0.03]	[0.03]+	[0.02]
Husband's ancestry: hakka	0.07	0.04	-0.00	-0.02	-0.02
	[0.04]+	[0.03]	[0.03]	[0.03]	[0.02]
Husband's ancestry: mainlander	-0.01	-0.00	-0.04	-0.10	-0.08
	[0.04]	[0.03]	[0.02]	[0.02]**	[0.03]**
Living in a city	-0.13	-0.01	0.02	-0.01	0.02
	[0.04]**	[0.03]	[0.03]	[0.03]	[0.03]
Live with parents in law	-0.01	0.03	-0.02	0.05	0.03
	[0.02]	[0.02]+	[0.02]	[0.02]**	[0.02]+
Husband's income		-0.01	0.01	0.02	0.04
		[0.01]	[0.00]+	[0.02]	[0.01]**
Constant	0.64	0.29	0.58	0.98	0.80
	[0.13]**	[0.08]**	[0.09]**	[0.13]**	[0.12]**
Observations	2497	3567	3291	3032	3054
R-squared		0.22	0.17	0.21	0.25
Standard errors in brackets					
+ significant at 10%; * significant at 5%; ** significant at 1%					

Conclusion/Discussion

Taiwan's family planning programs, enacted nationwide in 1964, aimed to decrease women's fertility and control population growth. The programs changed married couples' fertility demand by educating them about population growth issues, and by disseminating knowledge of modern contraceptive methods. This paper examines the effect of contraceptive knowledge on fertility, and focuses on the period right after the family planning programs were enacted. In order to take into consideration the endogeneity of contraceptive knowledge in the fertility equation, this study uses the 2SLS approach. Mass media exposure and social networks are the

proxies for acquired contraceptive knowledge. The empirical results indicate that contraceptive knowledge significantly *reduces* fertility, whether fertility is measured as life-time fertility or the probability of giving birth.

Besides, this paper found that mass media exposure and social networks play important roles in obtaining knowledge of modern contraceptive techniques. Women who regularly watch TV, listen to the radio, or read newspapers and magazines are more likely to be exposed to contraceptive-related information and hence have more knowledge of contraceptives. Similarly, women who participate in women's organizations are more likely to obtain contraceptive information through word-of-mouth communication.

Price and income are the fundamental factors in the demand functions. In the fertility equation, women's working status and years of schooling, which can serve as proxies for the price (opportunity cost) of having children are negatively associated with fertility; income (husband's income) is positively associated but not statistically significant with the number of births. Demographic characteristics, such as ethnicity, age cohorts, and residency with parents-in-law are associated with fertility decisions. The preference toward sons is still existent in Taiwanese society. Women who haven't had any sons are more likely to give birth, conditional upon the number of babies they have already had.

There is a large body of literature investigating the relationship between knowledge and behaviors, covering different fields of interests, such as product consumption, risky behaviors, and health outcomes. Very few such studies focus on the relationship between contraceptive knowledge and fertility decision. This paper investigates the effect of contraceptive knowledge on fertility, and helps to shed new light on the relationship between knowledge and behaviors.

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CHAPTER 2: U.S. CIGARETTE DEMAND: 1944-2004

Abstract

In this paper, we use data from 23 national cross-sectional surveys conducted by the Gallup Poll from 1944 through 2004 to estimate standard two-part models of cigarette demand as a function of demographics, income, and cigarette prices. Because the data cover a long time span, we are able to study cigarette demand before and during the early years of tobacco control efforts, as well as during the most recent period. Our results show that from 1944 to 2004: the gender difference in smoking rates almost disappears; the black-white difference reverses; a strong gradient with schooling emerges; and the negative income elasticities strengthened in magnitude. The various and varying demographic influences on cigarette demand are potentially fruitful areas for future health economics research. We further examine the issue of the unobserved state-level factors and their relationship to cigarette prices over the period from 1944 to 2004.

Introduction

Cigarette smoking has continued to be one of the major causes of premature death in the U.S.[11] The release of the Surgeon General's report in 1964 gave the endorsement of the government and first spread the information of smoking-related health hazards to the public. After 1964, the Surgeon General's reports kept releasing information on smoking-related health risks and claiming that cigarette smoking was the most important preventable cause of premature death not only for smokers themselves but also for secondhand smokers. A number of policies, interventions, and tobacco control efforts – raising cigarette taxes, restricting smoking

[11] http://www.cdc.gov/MMWR/preview/mmwrhtml/mm5114a2.htm.

in public places, putting health warnings on cigarette products, and disseminating the information of scientific and clinical evidence on smoking-related health hazards – have been implemented as attempts to reduce cigarette smoking.

There have been several studies examining the response of cigarette consumption to cigarette prices and smoking regulations, which vary across states and times, and other studies examining smoking behaviors among different socioeconomic strata either using aggregate data at the nationwide or state level (for example, Keeler et al., 2001; Sloan et al., 2002) or using micro data at the individual level (for example, Sloan and Trogdon, 2004; Wasserman et al., 1991). Indeed, individual-level data which contain detailed information on demographic characteristics allow examination of the effects of gender, income, schooling and other socioeconomic indicators on smoking behaviors. Important socioeconomic characteristics, such as income and schooling, have been shown to be inversely associated with smoking behaviors. Past literature analyzing the effect of cigarette prices, regulations, and related socioeconomic indicators have focused on short periods of time.

There have, however, been enormous changes in individual and governmental attitudes toward cigarette smoking, in the available knowledge on health risks from smoking, and in the tobacco industry's marketing strategies over the past half century. Smoking cigarettes was not publicly perceived as dangerous until the late 1950s. Information concerning smoking-related health hazards was gradually disseminated to the public between 1950 and 1970 (DeWalque, 2004). After the 1964 Surgeon General’s report, the government started to aggressively implement several interventions, such as raising the tax on cigarettes, placing warning labels on cigarette products, generating anti-smoking campaigns for public media, and banning cigarette advertisements from television, to reduce cigarette smoking. Tobacco companies, adapted by introducing alternative products such as light and filtered cigarettes, and by

disseminating contradictory messages about the safety of cigarettes to the government's negative messages about tobacco use (Sloan et al., 2002).

Therefore, price, income, and socioeconomic indicators, such as gender, schooling, and race, might relate differently to cigarette smoking behavior over time. Wasserman et al. (1991) found that price elasticity has become increasingly negative over time from the 1970s to the 1980s. Men were initially far more likely to smoke than women, but the gender gap in smoking rates has decreased over time (U.S. Bureau of the Census, 1999). DeWalque (2004) found that smoking prevalence was similar for individuals in all education categories around 1940, but by 2000 there was an inverse association between educational achievement and the smoking decision. Smoking has also undergone a substantial shift in its association with personal; cigarettes were a normal good around the 1970s, but changed to an inferior good in the late 1980s (Wasserman, 1991). Tracking back cigarette consumption and expanding the time span of analysis allows us see the patterns of cigarette consumption and its associations with economic determinants, such as price and income, and non-economic determinants, such as gender, race, and schooling over time.

To our knowledge, Sloan et al. (2002) and DeWalque (2004) are the only smoking-related studies which cover over half the twentieth century where the dramatic changes in attitudes toward tobacco products occur. Sloan et al. (2002) use aggregate data at the nationwide level from 1900 to 1998 to see the impacts of cigarette price, health information, and per capita income on cigarette consumption. DeWalque (2004) uses retrospective information the respondents provided on smoking history from National Health Interview Survey (NHIS). He investigates smoking prevalence across different educational levels and analyzes the impacts of schooling on smoking prevalence, initiation, and cessation in the United States from 1940 to 2000. Using aggregate data or retrospective data analyzing the economic and

non-economic determinants on cigarette consumption might be valid in its own right. However, aggregate data fails to capture adequately the associations of individual characteristics, such as gender, income, and schooling on cigarette consumption, and the retrospective information on smoking behaviors will cause errors in classification of smoking status for some person-years which lead to inaccurately measured influences of cigarette prices. In addition, the retrospective data might not be able to accurately capture the influences of the time-variant determinants, such as income, on cigarette demand.

We use 23 repeated cross-sections from 1944 to 2004 conducted by Gallup Polls which provide information on current smoking behaviors and socioeconomic characteristics. Having individual data which covers over half of the century allows examination of the associates of price and income on cigarette consumption and the patterns of smoking behaviors across gender, race, and educational levels over time.

Our results show that it is important to recognize that the influences of economic and non-economic factors on cigarette demand change over time. From 1944 to 2004 the economic factors (especially income) change from having no statistically significant effects to being negatively associated with cigarette smoking; the negative associations strengthen in magnitude over time. The influences of non-economic factors (gender, race, and schooling) on cigarette demand also change over time. From 1944 to 2004, the gender difference in smoking rates almost disappears, the black-white difference reverses, and a strong gradient with schooling emerges.

Literature Review

A few studies cover a segment of time-span and analyze the time-patterns of the associations between the determinants of cigarettes smoking and smoking

behaviors. Some studies focus on economic determinants, such as cigarette price and income; others focus on non-economic determinants, such as gender, education, and race.

Sloan et al. (2002) analyze a century of national aggregate data on cigarette consumption, from 1900 to 1999. The large time span allows this study to take into account the changing attitudes of the federal government toward cigarette smoking. In the first half of the century, the government actually promoted smoking. During World War I and II, cigarettes were issued to soldiers and the government subsidized the sale to soldiers. However, since 1964, when the U.S. Surgeon General's report first stated a link between cigarette smoking and lung cancer, information on the health-related risks of cigarette smoking has been consistently available to the public.

Sloan et al. (2002) uses a rational addiction framework analyzing per capita cigarette consumption as a function of cigarette prices, lagged and future consumption, per capita disposable income, and health-risk information concerning cigarette smoking. This study introduces a series of qualitative variables (0, 1) to reflect the timing of various public announcements, policies, and new health information. It examines cigarette consumption in the whole century, 1900-1997, and the sub-century, 1950-1997, respectively. Sloan et al. (2002) found an average price elasticity of -0.15 and income elasticity of 0.15. Besides, they concluded that the influence of smoking-related health risk on cigarette consumption is less important than is generally believed. Finally, their test for structural changes in demand indicates the rejection of the null hypothesis of single structural demand for the full century.

Indeed, this study contributes in several ways. First, it expands the analysis to the entire 20^{th} century, which covers all important cigarette-related events and interventions. This extensive date range helps examine how information affected demand over time; results usually occur years after policy changes. This approach also

enables the investigators to see the patterns of overall cigarette consumption associated with interventions at different historical moments. However, it sheds little light on the understanding of cigarette smoking. The study only provides century-long averages (-0.15 price elasticity and 0.15 income elasticity) for the relationship between economic factors, such as cigarette prices and income, and smoking behavior. Several previous studies (for example, Keeler et al. 2001 and Wasserman et al. 1991), however, have found that price elasticity and income elasticity have been changing over years or decades.

Keeler et al. (2001) uses annual data for the panel of U.S. states over the period 1960-1990 in examination of the effect of cigarette prices on cigarette consumption. In order to allow variations on the determinants of cigarette smoking over decades, this study stratifies the data by decades, 1960s, 1970s, and 1980s, and estimates separate regressions for each decade. In this study, cigarette consumption is measured as a function of cigarette prices, per capita income, education, and other demographic characteristics of the population, such as religion, marital status, race, gender, and age. All variables are measured at the state aggregate level. The results indicate that the correction for omitted-variable bias makes cigarettes less price elastic than previous literature had found. Price elasticity changed from about -0.8 in the 1960s to a range of -0.2 - -0.3 in the 1980s.[12] This study provides a possible explanation for the decreasing price elasticity. As more and more people have quit smoking, the remaining smokers are more likely to be "hard-core" smokers, who are less responsive to cigarette prices. Income elasticities were positive, ranging from 0.2 to 0.3. The results also indicated a strong education effect on cigarette smoking; a change from no high school diploma to a college degree entails a significant reduction in smoking. The study included

[12] Wasserman et al. (1992), however, found that price elasticities of cigarette demand have been more and more negative over time from 1974 to 1985.

demographic characteristics, such as gender and race, in its analysis. The results indicate that, in the 1960s, African American cigarette consumption statistically increases, but the results are sensitive across different specifications. In 1970s, and 1980s, there are no significant differences in cigarette consumption across races. Gender-linked results are inconclusive. Coefficients on gender in each decade do not explain much, because the gender compositions are very similar from state to state. It is hard to determine gender effects with state-level data.

This study contributes in several ways. First of all, it covers a relatively long period of time (1960s-1980s) and separates the data with decade-by-decade analysis. This approach allows the investigators to examine the time-patterns of the associations between factors and cigarette smoking. Secondly, having the panel state-level data helps correct omitted variables, such as anti-smoking sentiment varying by state, which might bias the effect of cigarette prices. However, there are some drawbacks to using state-level aggregate data. First, due to the data limitation, this study fails to investigate the smoking decision measured by smoking prevalence. Second, using state-level aggregate data might shed some lights on the effects of economic factors, such as cigarette prices and per capita income, on cigarette consumption, but it fails to gauge the effects of individual demographic characteristics, such as gender, race, education, on the smoking decision.

There have been several studies using individual level data, from the National Health Interview Survey, to examine smoking behavior and the time-patterns of the effects of its determinants. Fiore et al. (1989) and Pierce et al. (1989) use seven National Health Interview Surveys, from 1974 to 1985, to analyze smoking prevalence, cessation, and initiation across gender, race, and education.

The results indicated that smoking prevalence is higher for men than for women in each survey year from 1974 to 1985. The overall estimated prevalence of smoking

among adults in the United States has decreased steadily. Furthermore, the rate of decline in smoking prevalence for men was statistically larger than the rate for women. This study predicts that if these trends continue into 1990s, smoking rates for men and women will converge. In terms of smoking cessation across gender, the study shows that a higher proportion of men than women have quit smoking in the study period. In terms of smoking initiation across gender, the study shows that smoking initiation, which is measured by smoking prevalence among 20- to 24-year-olds, has fallen rapidly in young men. On the contrary, smoking initiation has stayed the same in young women. This study therefore indicates that differences in initiation rates rather than in cessation rates are mostly responsible for the converging rates of smoking prevalence among men and women.

Regarding smoking disparity across race, this study shows that blacks smoked at higher rates than whites in every survey year between 1974 and 1985. This study pointed out that this disparity may diminish because among black men smoking prevalence and initiation decreased at a faster rate and the quit ratio increased at a faster rate than among white men.

Regarding education, the results indicate that smoking prevalence declined across all educational levels from 1974 to 1985 and that smoking prevalence is lower for more educated individuals. Furthermore, among college graduates smoking prevalence dropped more precipitously than among other educational counterparts. In terms of smoking cessation, the quit ratio increased across all education categories during the study period, with highly educated people in a consistent higher quit ratio than other educational counterparts. In terms of smoking initiation, people who attend college are less likely to initiate smoking than those who do not. This is true across gender categories. In summary, this study indicates that educational level has become the major demographic factor of the smoking decision.

Fiore et al. (1989) and Pierce et al. (1989) contribute important information to the literature. First, they examine smoking prevalence in sufficient detail to separate overall smoking behaviors into cessation and initiation. This contribution helps researchers understand the formulation of the smoking decision and the factors which have different impacts on prevalence, cessation, and initiation respectively. Second, they investigate smoking behaviors as a function of gender, race, and education every survey year. Finally, they examine the time- patterns of the associations of gender-smoking, race- smoking, and education- smoking.

There are some drawbacks to these studies. In examination of smoking behaviors, this study does not take into account of economic factors, such as cigarette price and income which are correlated with the outcome and predictors of the outcomes of this study: smoking prevalence, and gender and race, respectively. For example, income is associated with smoking decision, and confounding with education. Without taking these factors into consideration, the estimated coefficients might be biased from the true effects on cigarette smoking.

Wasserman et al. (1991) uses individual level data, the National Health Interview Survey (NHIS), spanning the 1970s and 1980s, to investigate cigarette smoking. This study put emphases on the effects of cigarette prices, income, and smoking regulations, as well as demographic characteristics. With the significant coefficients on the price-year, income-year, and education-year interaction terms, the results indicate that the effects of cigarette prices, income, and education on cigarette smoking are changing over time.

The results indicate that price elasticities become more and more negative over time. The price elasticity is 0.059 in 1970, -0.017 in 1974 and reaches -0.226 in 1985. The income elasticities changed from positive to negative, ranging from 0.051 in 1970 to -0.023 in 1985, but the negative income elasticities in the late 1970s and 1980s are

not statistically different from zero. Cigarette consumption decreases as education increases. Furthermore, individuals with higher levels of education decrease their cigarette consumption much more over time than the less educated.

Smoking regulations imposed at the state level decreases cigarette consumption. After controlling for smoking regulations, price coefficients drop dramatically. The price elasticities estimated in this study are smaller than what other studies have found. This study argues that the regulation index, which serves as the proxy for anti-smoking sentiment, reduces the omitted variable bias in the estimated price coefficients.

This study contributes in some ways. It is the first study to take into account the smoking regulation index. It found that smoking regulation is negatively associated with individual cigarette smoking. Also, adding smoking regulation in the smoking equation reduces the omitted variable bias in the estimated price coefficient. Additionally, this study indicates that the influences of price, income, and education on cigarette smoking are changing over time. The price elasticities become more and more negative over time. The income elasticities change from positive to negative over time. Educated individuals decrease cigarette smoking by a much larger margin over time than do those with less education. Finally, this study tries a two-part model, which separately estimates the smoking decision and smoking level conditional upon smokers. This method helps clarify the decision of cigarette smoking and the factors that influence the decision.

While previous literature indicates that the effects of gender and race on cigarette smoking are changing over time (Pierce et al. 1989 and Fiore et al. 1989), this study assumes that the influences of gender and race stay the same over time. In addition, even though this study shows the time-patterns of the influences of some factors on cigarette smoking, it only covers the years from 1970 to 1989. Without covering the earlier years in the 1950s and 1960s, in which cigarette smoking started to be

perceived as the cause of lung cancer, and the later years in the 1990s and 2000s, in which several national and state-level smoking interventions have been imposed, it only indicates one segment in the overall span of smoking evolution.

The Gallup data, which provides the individual- level information on cigarette smoking and spans from 1944 to 2004, hence, allows us to avoid the limitations of the previous studies and advance our understanding of the evolution of cigarette smoking.

Data

The data used in this analysis come from Gallup Polls conducted by the Gallup organization. Gallup Polls are national public opinion polls of non-institutionalized civilians aged 18 and over, asking their opinions about politics, social circumstances, policies, and a variety of other questions. This analysis uses all years from the Gallup surveys, which provide information related to tobacco use such as current smoking status, number of cigarettes smoked per day, knowledge of health-related risk of smoking, and attitudes toward smoking. In addition, Gallup Polls also include demographic information, such as gender, race, education attainment, age, and annual household income. This study uses the Gallup Poll surveys which provide smoking-related information: 1944, 1949, 1954, 1957, 1969, 1971, 1972, 1977, 1981, 1986, 1987, 1988, 1990, 1991, 1994, 1996, 1997, 1999, 2000, 2001, 2002, 2003, and 2004.[13]

Gallup Polls also provide information on the state in which the respondents currently live. Knowing the geographic locations allows us to link each state's average cigarette price, tax, and state anti-smoking sentiment measure to each individual observation. The state's average cigarette price and tax data come from *The Tax*

[13] 1944, 1949, 1954, 1957, 1969, 1971, 1972, 1977, and 1981 Gallup Polls are face-to-face interview surveys. Gallup Polls in 1987, 1988, 1990, 1991, 1994, 1996, 1997, 1999, 2000, 2001, 2002, 2003, 2004, and 2005 are telephone surveys.

Burden on Tobacco in 2005. The anti-smoking sentiment measures come from TUS-CPS[14]. The state regulations to clean indoor air restrictions are from several sources: Impacteen website, CDC (STATE system website), and the U.S. Department of Health and Human Services, 1986b. The sample size for the twenty-three years of Gallup Polls is 30,208 with around 1,000 observations for each survey year.

Reliability of Gallup Poll Data

Gallup Poll data have not been widely used in economic literature. Studies tend to access this data to analyze public opinion on politics, inflation, unemployment, and poverty. Gallup Poll data also provide information on smoking behaviors, knowledge, and attitudes. However, there are only a few studies using Gallup Poll data to deal with smoking-related topics. These studies used the Gallup data to provide trends of tobacco use and smoking risk knowledge as supplement to their primary object of study (for example, Viscusi, 1992; Viscusi and Hakes, 2006), but none of them further examine specific effects, such as prices, regulations, or demographic identifiers on tobacco use.

Since only a few studies source Gallup Poll data, and none of them used Gallup Polls in examining the effects of cigarette price and demographic identifiers on tobacco use, there might be some concerns about the reliability of Gallup Poll data. We therefore compare the data on smoking prevalence from Gallup Polls with the data from the National Health Interview Survey (NHIS) to see if there is any consistency in the measurement of smoking prevalence across different data sets.

This study divides the sample by gender and compares smoking prevalence between men and women across different data sets (See Table 2-1 for details[15]). Even

[14] The anti-smoking sentiment measure is provided by Decicca et al. (2007). See Decicca et al. (2007) for the detail.
[15] We borrow the information on smoking prevalence across years and gender in NHIS from Wasserman et al. (1991).

though Gallup Polls do not cover the exact same survey years as the NHIS[16], this study compares close survey years. Smoking prevalence as measured by the Gallup Poll is similar with prevalence measured by the NHIS, but the smoking prevalence from the Gallup Poll is always slightly higher – about 3 to 4 percentage points on average. The measurement differences across the two data sets are very consistent over time.[17]

Table 2-1: Comparing the Smoking Status Reported in NHIS and Gallup Poll

Smoking decision (current smoker, %)					
	Gallup			NHIS[18]	
Year	male	female	year	Male	female
1969	45.6	36.3	1970	42.5	31.2
1971	47.5	37.9	1974	42.7	32.3
1972	46.4	38.4	1976	41.6	32.5
1977	42.0	34.7	1979	36.8	30.4
1981	38.2	31.1	1980	36.6	30.1
1987	31.1	28.1	1983	33.7	29.5
1988	32.1	28.3	1985	31.5	29.9

Descriptive Summary

The descriptive statistics for each survey year are listed in Table 2-2. The smoking prevalence among national adults has been decreasing over years. Almost half of the national adults in our sample were current smokers in 1940s: 49% of adults smoked in 1944 and 46% in 1949. In the following three decades, the 1950s, 1960s,

[16] See Wasserman (1991).
[17] The reason why smoking prevalence measured in Gallup Polls is always higher than prevalence measured in the NHIS might be attributable to a difference in the way questions are asked. In the NHIS, respondents are first asked, “Have you ever smoked 100 cigarettes?” If the respondent answers, “Yes,” s/he is asked, “Do you smoke now?” People who have never smoked 100 cigarettes or above are never asked, “Do you smoke now?” Gallup, however, asks the respondents, “Do you smoke now?” without first asking them, “Have you ever smoked 100 cigarettes?” The measurement of smoking decision is much stricter in the NHIS than in the Gallup Poll.
[18] The information of smoking decision from NHIS is from Wasserman (1988).

and early 1970s, the smoking prevalence among adults decreased very slightly, and overall smoking prevalence hovered around 41% to 42%. Beginning in the late 1970s, the smoking prevalence began declining fairly steadily. 35% of national adults were current smokers in the late 1970s and early 1980s, 30% in the late 1980s, 25% in the 1990s, and 23% in the 2000s.

Table 2-2: Descriptive Statistics

Year	current smokers	number of cigarettes per day	Male	age	White	lesshigh	highdrop	high	somecol	college	sample size
1944	0.49	17.49	0.58	46.71	0.80	0.44	0.16	0.17	0.08	0.13	3261
1949	0.46	17.81	0.50	43.30	0.92	0.31	0.22	0.27	0.10	0.11	1354
1954	0.44	19.72	0.50	42.54	0.94	0.32	0.25	0.24	0.09	0.10	1370
1957	0.40	N/A	0.48	44.87	0.89	0.34	0.22	0.24	0.11	0.09	1499
1969	0.41	17.74	0.50	45.41	0.89	0.20	0.18	0.33	0.18	0.12	1469
1971	0.43	N/A	0.48	44.22	0.90	0.18	0.17	0.33	0.19	0.12	1451
1972	0.42	N/A	0.48	44.76	0.89	0.16	0.20	0.32	0.19	0.13	1531
1977	0.38	21.27	0.49	44.22	0.87	0.12	0.15	0.33	0.25	0.15	1484
1981	0.35	20.20	0.50	45.12	0.87	0.10	0.15	0.33	0.23	0.19	1513
1986	0.30	19.09	0.50	41.40	0.87	0.04	0.09	0.36	0.26	0.25	1004
1987	0.30	17.07	0.50	43.21	0.86	0.05	0.09	0.35	0.24	0.26	1003
1988	0.30	18.83	0.50	43.53	0.91	0.04	0.07	0.34	0.26	0.29	996
1990	0.25	16.49	0.50	44.58	0.87	0.04	0.09	0.31	0.28	0.28	1213
1991	0.27	16.90	0.51	45.06	0.88	0.05	0.09	0.33	0.27	0.26	996
1994	0.26	16.99	0.51	44.41	0.82	0.02	0.07	0.35	0.28	0.27	997
1996	0.26	17.18	0.51	44.56	0.82	0.02	0.08	0.27	0.30	0.32	994
1997	0.26	17.40	0.49	44.98	0.78	0.02	0.07	0.31	0.28	0.32	1015
1999	0.22	14.51	0.48	45.88	0.82	0.02	0.07	0.27	0.28	0.37	997
2000	0.23	14.02	0.48	46.62	0.83	0.02	0.07	0.26	0.28	0.38	1024
2001	0.26	14.57	0.47	47.27	0.83	0.02	0.06	0.30	0.27	0.35	1033
2002	0.21	16.08	0.49	47.01	0.83	0.01	0.05	0.27	0.30	0.37	1003
2003	0.22	15.17	0.46	47.99	0.87	0.01	0.06	0.25	0.27	0.40	1002
2004	0.22	15.88	0.48	50.24	0.86	0.01	0.05	0.26	0.30	0.38	997

In addition to smoking status, Gallup Polls provide information on cigarette consumption (the number of cigarettes smoked per day) if respondents were current smokers[19]. Compared to the declining pattern of smoking prevalence over time, cigarette consumption for smokers differed very little. The average number of cigarettes consumed per day stayed around 18 in the 1940s, 1950s, 1960s, 1970s, and 1980s. The number of cigarettes consumed decreased to around 16 in the 1990s and decreased further to 15 in the 2000s.

The composition of the sample is very consistent across different survey years. The average age is around 45 in each survey year. White are in the majority – over 80% of the sample. Gender is evenly distributed in the sample. The number of years of schooling has increased over time. In 1944, only 20% of people in the sample had a college diploma or some level of college education, and more than half population, around 60% of the sample, did not have a high school degree. In the 1990s and 2000s, around 60% of the sample had a college diploma or some level of college education, and around 90% of the people in our sample at least had a high school diploma.

Empirical Models and Variables

We first estimate two-part models of adult smoking: using a linear probability model for the estimation of smoking participation and an OLS model for the smoking level conditional upon participation. In order to investigate the time-patterns of the influences of the determinants on smoking behaviors, we first divide the sample by decades, and estimate the regressions in 1940s, 1950s, 1970s, 1980s, 1990s, and 2000s. We have three reasons for this specification. First, this method helps to investigate the time-patterns of the associations between economic and non- economic determinants and smoking participation. The non-economic determinants are gender, race, education,

[19] 1957, 1971, 1972 Gallup Polls did not ask smokers how much they smoked per day.

and age; the economic determinants are price and income. Secondly, instead of using cross-sectional analysis, pooling surveys by decades allows us to control for unobserved factors varying at the state level and affecting smoking participation. Finally, compared with cross-sectional analysis, pooling surveys by decades increases the sample size and the accuracy of estimation, given the small sample size in each survey year.

In addition, we pool all years of data from 1944 to 2004 and put in a cohort dummy and its interaction with gender to capture the cohort effect across gender on cigarette demand. We also pool all years of data from 1970 to 2004 and put in interaction terms of year and cigarette prices, as well as year and household income to investigate the changes of cigarette price influence and income influence over time.

The dependent variables for the empirical models of adults smoking are measures of smoking participation and smoking level conditional upon being current smokers. Smoking participation is measured in this way: if the respondent answered "yes" to the question "Do you smoke now?" or to "Have you, yourself, smoked any cigarettes in the past week?" participation is coded as "1"; otherwise it is coded as "0." [20] In the Gallup survey, the smoking level question is "about how many cigarettes do you smoke per day?" Before 1997, the Gallup survey provides several response categories for respondents to fit in. We take the midpoint of each category and assign it to the individuals who belong to the category. After 1997, the Gallup survey started to ask respondents to provide the exact number of cigarettes smoked per day. We keep the numbers of cigarettes the respondents provided in the regressions.

The explanatory variables are age, age squared, gender, race, education, annual household income, and cigarette price. The average price is calculated yearly for every state and weighted by type of sale. Data on annual household income that the Gallup

Polls provide for each survey year are categorical. In order to get a continuous variable on annual household income, we take the midpoint of each household income category, and assign it to each individual who belongs to that category. All data on cigarette prices and annual household incomes are deflated to 1982 dollars using the Consumer Price Index for All Urban Consumers (CPI-U).

This paper uses the same measures of state-level anti-smoking sentiment as the measures in Decicca et al. (2008). The measures are extracted from TUS-CPS in 1992-1993. They measure the general opinions on topics such as policies restricting smoking, the promotion and advertising of tobacco products, and whether respondents allow smoking in their homes. From the responses to the attitudes questions, the indicators are measured which reflect the attitudes toward smoking in general and called the anti-smoking sentiments measures.

Since the newly enacted laws on restricting smoking in public places in the first half twentieth century starts in 1960 in Delaware (U.S. Department of Health and Human Services, 1986). We reported the smoking regulations in public places at the state level since 1960. Data on regulations restricting smoking in public places came from several sources. The regulations from 1960 to 1986 are primarily from reports published by the U.S. Department of Health and Human Services (1986a, b), which includes the abstracts of the applicable laws. The regulations from 1991 to 1994 are from the Impacteen website, and the regulations from 1995 to 2008 are from STATE system website from CDC.

These sources provide information on whether and when a particular state implemented smoking restriction regulations in public places such ass child care centers, cultural facilities, government worksites, health care facilities, private schools, private worksites, public schools, public transit, recreational facilities, restaurants, and shopping malls. We follow the criteria Wasserman et al (1991) used and collapse

these regulations into a regulation index measuring different types of regulations on smoking in public places. A state that regulates smoking in places where people spend a large portion of time received a higher score than a state that only regulates smoking in unimportant places. If a state restricts smoking at private worksites, it receives a score of one. If a state restricts smoking in restaurants and not at private worksites, it receives a score of 0.75. If a state restricts smoking in private schools, public schools, public transit, recreational facilities, and shopping malls, but not at private worksites or restaurants, it receives a score of 0.5. If a state only restricts smoking in some places, such as child care centers, government worksites, and health care facilities, it receives a score of 0.25. If a state doesn't restrict smoking in any places, it receives a score of 0.

Results

Regressions by Decades

Table 2-3 and 2-4 present results for a two-part model of cigarette demand dividing the pooled sample by decades. We use four different model specifications:

1. Does not include state fixed effects or clean indoor air regulations;
2. Only includes state clean indoor air regulations;
3. Only includes state fixed effects;
4. Includes both state fixed effects and clean indoor air regulations.

The results of smoking participation with different model specifications are presented in Tables 2-3-1, 2-3-2, 2-3-3, and 2-3-4. The results of smoking level with different model specifications are presented in Tables 2-4-1, 2-4-2, 2-4-3, and 2-4-4. The sample is broken down by decades, and cigarette demand is estimated separately

in the 1940s, 1950s, 1970s, 1980s, 1990s, and 2000s[21]. This approach provides larger sample sizes than are available for single survey years, but still allows the influences of the demographic and economic variables to vary over time.

Table 2-3-1: Smoking Participation (Linear Probability Model with State Fixed Effects)

Smoking participation, linear probability model, with SFE						
	1940s	1950s	1970s	1980s	1990s	2000s
Age	-0.02	0.01	0.01	0.02	0.01	0.01
	[0.00]**	[0.00]*	[0.00]**	[0.00]**	[0.00]**	[0.00]**
Age square	0.01	-0.02	-0.01	-0.02	-0.02	-0.01
	[0.00]**	[0.00]**	[0.00]**	[0.00]**	[0.00]**	[0.00]**
Lesshigh	-0.05	-0.01	0.01	-0.02	0.02	0.14
	[0.03]+	[0.02]	[0.02]	[0.03]	[0.04]	[0.06]*
Highdrop	-0.02	0.03	0.04	0.06	0.07	0.13
	[0.03]	[0.02]+	[0.02]*	[0.02]**	[0.02]**	[0.03]**
some college	-0.01	-0.05	-0.02	-0.06	-0.07	-0.04
	[0.03]	[0.04]	[0.02]	[0.02]**	[0.01]**	[0.02]*
College	-0.01	-0.07	-0.13	-0.14	-0.14	-0.15
	[0.03]	[0.04]+	[0.02]**	[0.02]**	[0.01]**	[0.02]**
Male	0.17	0.21	0.1	0.06	0.03	0.03
	[0.03]**	[0.03]**	[0.01]**	[0.01]**	[0.01]*	[0.01]*
White	-0.23	-0.06	-0.02	0	0.04	0.06
	[0.03]**	[0.03]*	[0.02]	[0.02]	[0.02]*	[0.02]**
Realtax	0.12					
	[0.81]					
Realprice		0.45	-0.04	0.04	-0.03	0.03
		[0.50]	[0.18]	[0.24]	[0.11]	[0.05]
Income			0	-0.07	-0.05	-0.04
			[0.02]	[0.02]**	[0.01]**	[0.01]**
Constant	1.11	-0.12	0.36	-0.04	0.24	0.07
	[0.13]**	[0.48]	[0.19]+	[0.25]	[0.14]	[0.12]
Price elasticity	0.04	0.91	-0.09	0.10	-0.13	0.24
Income elasticity			0	-0.20**	-0.21**	-0.17**
Observations	3160	2869	5843	4287	5796	4703
R-squared	0.11	0.11	0.08	0.07	0.06	0.08
Robust standard errors in bracket						
+ significant at 10%; * significant at 5%; ** significant at 1%						

[21] In 1960s, the Gallup organization only conducted the smoking related survey in 1969. Since there is only one year of data in the 1960s, we include 1969 to 1970s regressions in Table 2 and 3.

Table 2-3-2: Smoking Participation (Linear Probability Model with Clean Indoor Air Index)

Smoking participation: linear probability model, with year dummies and index						
	1940s	1950s	1970s	1980s	1990s	2000s
Age	-0.016	0.007	0.008	0.019	0.011	0.009
	[0.003]**	[0.004]+	[0.002]**	[0.002]**	[0.002]**	[0.002]**
Age square	0.010	-0.015	-0.015	-0.023	-0.015	-0.013
	[0.003]**	[0.004]**	[0.002]**	[0.002]**	[0.002]**	[0.002]**
Lesshigh	-0.057	-0.018	0.003	-0.018	0.031	0.134
	[0.028]*	[0.023]	[0.020]	[0.026]	[0.036]	[0.054]*
Highdrop	-0.029	0.026	0.042	0.069	0.077	0.132
	[0.026]	[0.019]	[0.021]*	[0.021]**	[0.021]**	[0.032]**
Somecol	-0.005	-0.045	-0.021	-0.061	-0.066	-0.041
	[0.035]	[0.042]	[0.018]	[0.019]**	[0.012]**	[0.018]*
College	-0.016	-0.071	-0.136	-0.142	-0.135	-0.152
	[0.031]	[0.037]+	[0.021]**	[0.017]**	[0.014]**	[0.015]**
Male	0.167	0.208	0.102	0.063	0.028	0.027
	[0.030]**	[0.026]**	[0.014]**	[0.013]**	[0.011]*	[0.011]*
White	-0.238	-0.047	-0.032	0.007	0.031	0.069
	[0.026]**	[0.030]	[0.022]	[0.023]	[0.015]*	[0.017]**
Realtax	0.250					
	[0.165]					
Realprice		-0.104	0.149	0.064	0.013	-0.029
		[0.159]	[0.055]**	[0.113]	[0.045]	[0.017]+
Income			0.008	-0.079	-0.052	-0.039
			[0.015]	[0.017]**	[0.010]**	[0.009]**
Index			-0.050	-0.018	-0.005	0.033
			[0.056]	[0.024]	[0.019]	[0.021]
Constant	1.093	0.462	0.214	0.022	0.173	0.188
	[0.091]**	[0.133]**	[0.067]**	[0.128]	[0.062]**	[0.071]*
Price elasticity	0.09	-0.21	0.34**	0.18	0.07	-0.25+
Income elasticity			0.02	-0.23**	-0.23**	-0.17**
Observations	3160	2869	5843	4287	5796	4703
R-squared	0.09	0.09	0.07	0.06	0.06	0.07
Robust standard errors in brackets						
+ significant at 10%; * significant at 5%; ** significant at 1%						

Table 2-3-3: Smoking Participation (Linear Probability Model)

Smoking participation: w/o wasserman index and w/o state fixed effects						
	1940s	1950s	1970s	1980s	1990s	2000s
Age	-0.016	0.007	0.008	0.019	0.011	0.009
	[0.003]**	[0.004]+	[0.002]**	[0.002]**	[0.002]**	[0.002]**
Age square	0.010	-0.015	-0.015	-0.023	-0.015	-0.013
	[0.003]**	[0.004]**	[0.002]**	[0.002]**	[0.002]**	[0.002]**
Lesshigh	-0.057	-0.018	0.003	-0.018	0.031	0.132
	[0.028]*	[0.023]	[0.020]	[0.026]	[0.036]	[0.054]*
Highdrop	-0.029	0.026	0.043	0.069	0.077	0.131
	[0.026]	[0.019]	[0.021]*	[0.021]**	[0.021]**	[0.032]**
Somecol	-0.005	-0.045	-0.021	-0.061	-0.066	-0.041
	[0.035]	[0.042]	[0.018]	[0.019]**	[0.012]**	[0.018]*
College	-0.016	-0.071	-0.137	-0.143	-0.135	-0.152

Table 2-3-3 (continued)

	[0.031]	[0.037]+	[0.021]**	[0.017]**	[0.014]**	[0.015]**
Male	0.167	0.208	0.102	0.063	0.028	0.027
	[0.030]**	[0.026]**	[0.014]**	[0.013]**	[0.011]*	[0.011]*
White	-0.238	-0.047	-0.030	0.008	0.031	0.069
	[0.026]**	[0.030]	[0.022]	[0.024]	[0.015]*	[0.017]**
Realtax	0.250					
	[0.165]					
Realprice		-0.104	0.131	0.039	0.007	-0.015
		[0.159]	[0.056]*	[0.106]	[0.042]	[0.016]
Income			0.009	-0.079	-0.052	-0.039
			[0.015]	[0.017]**	[0.010]**	[0.009]**
Constant	1.093	0.462	0.230	0.036	0.177	0.182
	[0.091]**	[0.133]**	[0.070]**	[0.128]	[0.063]**	[0.071]*
Price elasticity	0.09	-0.21	0.30*	0.11	0.04	-0.13
Income elasticity			0.02	-0.23**	-0.23**	-0.17**
Observations	3160	2869	5843	4287	5796	4703
R-squared	0.09	0.09	0.07	0.06	0.06	0.07
Robust standard errors in brackets						
+ significant at 10%; * significant at 5%; ** significant at 1%						

Table 2-3-4: Smoking Participation (Linear Probability Model with State Fixed Effects and Clean Indoor Air index)

Smoking participation: w/state fixed effects and w/ wasserman index						
	1940s	1950s	1970s	1980s	1990s	2000s
Age	-0.016	0.008	0.008	0.019	0.011	0.009
	[0.004]**	[0.004]*	[0.002]**	[0.002]**	[0.002]**	[0.002]**
Age square	0.010	-0.016	-0.015	-0.023	-0.015	-0.013
	[0.004]**	[0.004]**	[0.002]**	[0.002]**	[0.002]**	[0.002]**
Lesshigh	-0.051	-0.005	0.011	-0.017	0.025	0.140
	[0.029]+	[0.024]	[0.020]	[0.028]	[0.037]	[0.055]*
Highdrop	-0.024	0.033	0.043	0.061	0.075	0.130
	[0.026]	[0.019]+	[0.022]+	[0.021]**	[0.021]**	[0.033]**
Somecol	-0.006	-0.047	-0.022	-0.064	-0.065	-0.041
	[0.035]	[0.042]	[0.018]	[0.020]**	[0.012]**	[0.019]*
College	-0.012	-0.067	-0.135	-0.144	-0.136	-0.150
	[0.031]	[0.039]+	[0.020]**	[0.017]**	[0.014]**	[0.016]**
Male	0.171	0.209	0.102	0.063	0.029	0.026
	[0.031]**	[0.026]**	[0.014]**	[0.013]**	[0.012]*	[0.012]*
White	-0.225	-0.060	-0.025	0.003	0.036	0.064
	[0.026]**	[0.028]*	[0.022]	[0.025]	[0.015]*	[0.017]**
Realtax	0.121					
	[0.810]					
Realprice		0.448	-0.119	0.036	-0.014	0.027
		[0.501]	[0.194]	[0.238]	[0.107]	[0.049]
Income			-0.000	-0.074	-0.054	-0.040
			[0.015]	[0.017]**	[0.010]**	[0.009]**
Index			-0.160	-0.001	0.069	-0.026
			[0.035]**	[0.050]	[0.042]	[0.038]
Constant	1.105	-0.115	0.430	-0.036	0.229	0.083
	[0.105]**	[0.477]	[0.186]*	[0.251]	[0.142]	[0.119]

Table 2-3-4 (continued)

Price elasticity	0.04	0.92	-0.28	0.10	-0.07	0.23
Income elasticity			-0	-0.22**	-0.23**	-0.35**
Observations	3160	2869	5843	4287	5796	4703
R-squared	0.11	0.11	0.08	0.07	0.06	0.08
Robust standard errors in brackets						
+ significant at 10%; * significant at 5%; ** significant at 1%						

Table 2-4-1: Smoking Level (OLS Model with State Fixed Effects)

Smoking level regressions with state fixed effects					
	1940s-1950s	1970s	1980s	1990s	2000s
Age	-0.1	0.93	0.73	0.45	0.71
	[0.12]	[0.13]**	[0.14]**	[0.10]**	[0.10]**
Age square	0.12	-1.02	-0.75	-0.41	-0.62
	[0.11]	[0.14]**	[0.16]**	[0.11]**	[0.12]**
Less high	1.67	0.72	1.35	0.34	3.49
	[0.71]*	[0.99]	[1.52]	[2.02]	[2.36]
Highdrop	0.05	0.98	0.15	1.5	2.64
	[0.75]	[0.98]	[0.95]	[0.72]*	[1.32]+
Some college	-0.1	-1.17	-1.09	-0.18	-0.93
	[0.80]	[0.96]	[0.95]	[0.66]	[0.62]
College	0.41	-1.03	-2.97	-2.12	-3.32
	[0.66]	[1.47]	[0.90]**	[0.75]**	[0.83]**
Male	3.94	2.87	2.77	1.6	3.27
	[0.54]**	[0.61]**	[0.71]**	[0.57]**	[0.54]**
White	-3.37	5.15	7.06	4.24	4.4
	[0.75]**	[1.07]**	[0.82]**	[0.78]**	[0.86]**
Realtax	-3.96				
	[53.35]				
Realprice		12.52	-1.86	-1.53	-3.21
		[9.16]	[13.04]	[4.61]	[2.72]
Income		0.01	0.18	-0.11	-1.35
		[0.91]	[0.75]	[0.45]	[0.48]**
Constant	15.35	-14.7	-6.09	3.83	2.22
	[14.39]	[7.92]+	[13.67]	[5.33]	[6.27]
price elasticity	-0.04	0.61	-0.09	-0.12	-0.42
income elasticity		0	0.01	-0.01	-0.09**
Observations	1397	1131	1349	1476	1101
R-squared	0.1	0.17	0.13	0.1	0.21
Robust standard errors in brackets					
+ significant at 10%; * significant at 5%; ** significant at 1%					

Table 2-4-2: Smoking Level (OLS Model with Clean Indoor Air Index)

Smoking level: OLS model with year dummies and clean indoor air index					
	1940s-1950s	1970s	1980s	1990s	2000s
Age	-0.11	0.91	0.75	0.44	0.72
	[0.11]	[0.11]**	[0.14]**	[0.10]**	[0.09]**
age22	0.14	-1.00	-0.77	-0.40	-0.63
	[0.11]	[0.13]**	[0.15]**	[0.11]**	[0.11]**
Lesshigh	1.52	0.59	1.36	-0.14	3.43
	[0.65]*	[0.98]	[1.44]	[1.95]	[2.11]
highdrop	0.12	0.93	0.20	1.51	2.29
	[0.76]	[0.94]	[0.91]	[0.71]*	[1.27]+
Somecol	-0.50	-1.15	-0.69	-0.27	-1.12
	[0.75]	[0.93]	[0.90]	[0.62]	[0.57]+
College	0.38	-1.34	-2.81	-2.37	-3.33
	[0.61]	[1.41]	[0.87]**	[0.76]**	[0.77]**
Male	3.94	3.05	2.66	1.60	3.19
	[0.49]**	[0.59]**	[0.68]**	[0.57]**	[0.55]**
White	-3.59	5.02	7.18	4.17	4.41
	[0.81]**	[0.97]**	[0.74]**	[0.79]**	[0.82]**
Rrealtax	5.24				
	[4.94]				
Rrcprice		4.44	-12.42	-3.60	-2.56
		[2.81]	[4.12]**	[1.75]*	[0.97]*
income_hh		0.17	0.01	-0.04	-1.45
		[0.82]	[0.71]	[0.42]	[0.47]**
Index		-3.11	0.31	-1.57	-1.16
		[1.22]*	[1.06]	[0.66]*	[1.06]
Constant	19.63	-5.77	6.80	7.75	0.99
	[2.65]**	[3.13]+	[5.00]	[3.60]*	[2.70]
Price elasticity		0.22	-0.6**	-0.28*	-0.34*
Income elasticity		0.01	0.00	-0.00	-0.10**
Observations	1397	1131	1349	1476	1101
R-squared	0.07	0.12	0.11	0.07	0.16
Robust standard errors in brackets					
+ significant at 10%; * significant at 5%; ** significant at 1%					

Table 2-4-3: Smoking Level (OLS Model)

Smoking level: w/o wasserman index and w/o state fixed effects					
	1940s-1950s	1970s	1980s	1990s	2000s
Age	-0.11	0.91	0.75	0.44	0.72
	[0.11]	[0.11]**	[0.14]**	[0.10]**	[0.09]**
Age square	0.14	-1.00	-0.77	-0.40	-0.63
	[0.11]	[0.13]**	[0.15]**	[0.11]**	[0.11]**
Lesshigh	1.52	0.68	1.37	-0.07	3.40
	[0.65]*	[0.97]	[1.44]	[1.94]	[2.13]
Highdrop	0.12	0.97	0.20	1.51	2.28
	[0.76]	[0.94]	[0.90]	[0.72]*	[1.28]+
Somecol	-0.50	-1.18	-0.68	-0.23	-1.16
	[0.75]	[0.91]	[0.90]	[0.63]	[0.56]*
College	0.38	-1.27	-2.80	-2.39	-3.32

Table 2-4-3 (continued)

	[0.61]	[1.41]	[0.88]**	[0.76]**	[0.77]**
Male	3.94	2.99	2.66	1.56	3.17
	[0.49]**	[0.60]**	[0.68]**	[0.57]**	[0.56]**
White	-3.59	5.15	7.19	4.17	4.40
	[0.81]**	[0.94]**	[0.75]**	[0.79]**	[0.80]**
Realtax	5.24				
	[4.94]				
Realprice		2.81	-11.96	-5.40	-3.08
		[2.94]	[3.68]**	[1.66]**	[0.84]**
Income		0.26	0.01	-0.06	-1.46
		[0.81]	[0.71]	[0.42]	[0.48]**
Constant	19.63	-5.30	6.51	9.73	1.25
	[2.65]**	[3.16]	[4.86]	[3.60]**	[2.50]
Price elasticity	0.23	0.14	-0.66**	-0.46**	-0.34**
Income elasticity		0.01	0	-0.004	-0.08**
Observations	1397	1131	1349	1476	1101
R-squared	0.07	0.12	0.11	0.07	0.16
Robust standard errors in brackets					
+ significant at 10%; * significant at 5%; ** significant at 1%					

Table 2-4-4: Smoking Level (OLS Model with State Fixed Effects and Clean Indoor Air Index)

Smoking level: w/ state fixed effects and w/ wasserman index					
	1940s-1950s	1970s	1980s	1990s	2000s
Age	-0.10	0.93	0.73	0.45	0.70
	[0.12]	[0.13]**	[0.14]**	[0.10]**	[0.10]**
Age square	0.12	-1.02	-0.75	-0.41	-0.61
	[0.11]	[0.14]**	[0.16]**	[0.11]**	[0.12]**
Lesshigh	1.67	0.72	1.35	0.35	3.48
	[0.71]*	[1.00]	[1.52]	[2.02]	[2.36]
Highdrop	0.05	0.96	0.15	1.50	2.62
	[0.75]	[0.99]	[0.95]	[0.72]*	[1.32]+
Somecol	-0.10	-1.12	-1.09	-0.18	-0.92
	[0.80]	[0.98]	[0.95]	[0.66]	[0.62]
College	0.41	-1.13	-2.97	-2.12	-3.31
	[0.66]	[1.50]	[0.91]**	[0.75]**	[0.82]**
Male	3.94	2.89	2.77	1.60	3.26
	[0.54]**	[0.62]**	[0.71]**	[0.57]**	[0.54]**
White	-3.37	5.10	7.06	4.24	4.43
	[0.75]**	[1.07]**	[0.82]**	[0.79]**	[0.86]**
Realtax	-3.96				
	[53.35]				
Realprice		12.19	-1.86	-1.43	-3.36
		[8.18]	[13.04]	[4.69]	[2.78]
Income		-0.03	0.18	-0.12	-1.35
		[0.91]	[0.75]	[0.45]	[0.48]**
Index		-3.35	-0.00	0.52	-2.15
		[1.66]+	[2.82]	[1.23]	[2.29]
Constant	16.88	-13.75	-6.09	2.29	3.55
	[6.20]*	[7.75]+	[13.66]	[8.02]	[6.31]

Table 2-4-4 (continued)					
Price elasticity	-0.17	0.61	-0.1	-0.12	-0.37
Income elasticity		-0.001	0.01	-0.01	-0.07**
Observations	1397	1131	1349	1476	1101
R-squared	0.10	0.18	0.13	0.10	0.21
Robust standard errors in brackets					
+ significant at 10%; * significant at 5%; ** significant at 1%					

The results show that there have been dramatic changes in the relationships between smoking determinants and cigarette demand from the 1940s to the 2000s. The relationships are very consistent across different specifications except the influence of cigarette prices.

Males were more likely to smoke than women in each decade from the 1940s to the 2000s. The gender difference in smoking participation is statistically significant in each decade. However, the magnitude of gender difference in smoking participation has been decreasing over time: the gender difference in smoking participation was 17 percentage points in 1940s, 21 percentage points in 1950s, 0.1 percentage points in 1970s, 0.06 percentage points in 1980s, and 0.03 percentage points in 1990s and 2000s. In terms of conditional demand, male smokers smoke two to four more cigarettes per day than female smokers in each decade from the 1940s to the 2000s.

Whites were less likely to smoke in the 1940s and the 1950s; however, the black-white difference has been reversed – whites were more likely to smoke in recent decades, the 1990s and 2000s. White smokers smoked about three fewer (about 20 percent fewer) cigarettes per day in the 1940s and 1950s, but smoked from four to seven more cigarettes per day than non-white smokers in the later decades. The results for gender and race generally confirm and extend the findings of Fiore et al. (1989) for the years 1974-1985.

In addition, the results show that the relationship between schooling and the

demand for cigarettes also changes from the 1940s to the 2000s. In the 1940s, the associations between schooling and cigarette demand are small and usually statistically insignificant. The only marginally statistically significant differences are that people with less than a high school education were less likely to smoke, but conditional on smoking, smoked more cigarettes per day. However, in the 1950s, people with four-year college degrees were less likely to smoke than those who with high school degrees, but the difference is only marginally significant. A gradient between smoking participation and schooling begins to emerge in the 1950s and strengthens in the following decades. In the 1970s, people with four- year college degrees were statistically less likely to smoke. In each decade after 1980, compared to people with high school degrees, those who with college degrees whether a four-year or two-year college were less likely to smoke. By the 2000s, college graduates are 15 percentage points less likely to smoke than high school graduates, while high school drop outs are 13 percentage points more likely to smoke than high school graduates. These trends are consistent with Kenkel and Liu (2008). Consistent with a causal role for schooling through health information, Kenkel and Liu find that the schooling-smoking gradient emerged in the 1950s and 1960s in tandem with a schooling-health knowledge gradient. However, the persistence and growth of the schooling-smoking gradient over the latter part of the 20th century points to other, possibly non-causal, roles for schooling.

Because of data limitations we are only able to examine the influence of income on cigarette demand from 1970s onward. The results present changes in the associations between annual household income and smoking demand over time. In the 1970s, there was no statistically significant association between income and cigarette demand. However, later on, in the 1980s, 1990s, and 2000s, household income was negatively and statistically significantly associated with smoking

participation. The estimated coefficients imply that the income elasticity of smoking participation have been changed from the 1970s to the 2000s. We found that a 1-percent increase in household income is associated with a *decrease* in the probability of smoking, by 0.20 percent in the 1980s, 0.21 percent in the 1990s, and 0.17 percent in the 2000s. In the 2000s, the income elasticity of conditional demand for cigarettes is also negative and statistically significant. Our results are fairly similar to Wasserman et al. (1991), who estimates that the income elasticity of cigarette demand changed from +0.051 in 1970 to -0.023 in 1985.

Overall, the results indicate that there have been dramatic changes in smokers' characteristics over time – in early decades, smokers tended to be male and non-white, with no significant difference in socioeconomic status between smokers and non-smokers. In later decades, however, the gender gap has been shrinking, from 17 percentage points in 1940s to the 3 percentage points in the 2000s; the black-white difference reverses; and smokers tend to be those with fewer financial resources and less education than non-smokers.

Regarding the influence of cigarette prices on cigarette demand, the results are sensitive to different model specifications. In Table 2-3-3, the model without state fixed effects and clean indoor air regulations, the signs of the coefficient on cigarette prices change from negative in the 1950s to positive in the 1970s, 1980s, 1990s, and then to negative in the 2000s. In Table 2-3-2, the model includes the state level clean indoor air regulations, and the pattern of coefficients on cigarette prices is similar to that in Table 2-3-3, except that the relationship of cigarette prices reaches statistical significance in the 2000s. Table 2-3-1 and Table 2-3-4 include state fixed effects and both fixed effects and clean indoor air regulations, respectively. The coefficients on cigarette prices are very sensitive to state fixed effects. Once we include the state fixed effects, the pattern of the relationships between cigarette prices and smoking

participation changed. The signs of the estimated coefficients and, hence, the implied price elasticities, vary from positive to negative across different decades. The results do not present any statistically significant associations between cigarette price and smoking demand in each decade. In their meta-analysis, Gallet and List (2003) find that the mean of price elasticity estimates from 86 studies is -0.48, with a range from -3.12 to +1.41. While our estimates are not outside this very wide range, they fall outside the narrower range of -0.3 to -0.5 described by Chaloupka and Warner (2000). Several more recent estimates suggest that the Chaloupka-Warner range may have over-stated the price-elasticity of cigarette demand (Tauras 2005, Levy and Meara 2006, Colman and Remler 2008). In the only previous study that uses individual-level data to estimate the demand for cigarettes over a long time period in the U.S., Wasserman *et al.* (1991) also find that "the price elasticity of demand is unstable over time, ranging from 0.06 in 1970 to -0.23 in 1985." In contrast, using state-level data from 1960-1990, Keeler *et al.*'s (2001) results imply that the price elasticity of demand is fairly stable over time at around -0.2 to -0.4.

Regressions of Pooling Years

The Cohort Effects: Pooling Years from 1944-2004

Table 2-5 presents results for a two-part model of cigarette demand using the pooled data from 1944 through 2004. The pooled data allow us to explore trends over time and across birth cohorts.[22] In addition to a general time trend, the results show strong birth cohort differences in smoking participation that vary by gender. The coefficients on the birth cohort indicators capture the cohort differences for women; the coefficients on the cohort*male interactions capture the cohort differences

[22] Our approach in these models follows Wasserman *et al.* (1991). As they point out, the results for age in these models must be interpreted carefully. Because the models include year and birth cohort dummies, the models identify the effect of within-cohort age variation.

for men. Compared to men in the most recent birth cohort (born in the 1980s or later), men in the earlier birth cohorts are more likely to smoke. For example, men born in the 1890s or 1900s are almost 20 percentage points more likely to smoke. With the exception of the oldest birth cohort (born in the 1880s or before), smoking participation among men falls fairly steadily with birth cohort.[23] Male smokers in the earlier birth cohorts also report smoking more cigarettes per day. In contrast, women in the earliest birth cohorts from the 1880s and 1890s are about 15 percentage points less likely to smoke, and report smoking fewer cigarettes per day conditional on smoking.

Table 2-5: The Cohort Effects: Pooling Years from 1944-2004

Pooling years 1944-2004		
	smoking participation	Smoking level
Age	0.004	0.353
	[0.001]**	[0.055]**
Age square	-0.009	-0.384
	[0.001]**	[0.056]**
Lesshigh	-0.007	1.322
	[0.013]	[0.435]**
Highdrop	0.045	0.654
	[0.010]**	[0.347]+
Somecol	-0.051	-0.547
	[0.007]**	[0.324]+
College	-0.146	-2.303
	[0.007]**	[0.359]**
White	-0.004	3.561
	[0.013]	[0.524]**
Realtax	0.018	-2.111
	[0.009]+	[0.613]**
Year	-0.003	0.046
	[0.001]**	[0.046]

[23] The result for the 1880s birth cohort might reflect differential mortality among smokers. By the earliest Gallup Poll on smoking in 1944, members of this birth cohort were already at least 55 years old. More of the 1880s male birth cohort might have smoked but might not have survived to be interviewed in 1944 or later. Differential mortality should play less of a role for the other birth cohorts, because most of the mortality differential between smokers and nonsmokers occurs after the age of 50 (Gilpin and Pierce 2002).

Table 2-5 (continued)

Index	-0.026	-1.647
	[0.011]*	[0.466]**
Cohort1880	-0.162	2.619
	[0.096]+	[4.304]
Cohort1890	-0.144	4.790
	[0.094]	[3.914]
Cohort900	-0.074	3.711
	[0.090]	[3.344]
Cohort1910	0.002	5.348
	[0.081]	[3.150]+
Cohort1920	0.008	5.418
	[0.077]	[2.728]+
Cohort1930	0.029	6.551
	[0.063]	[2.273]**
Cohort1940	0.035	6.045
	[0.058]	[1.950]**
Cohort1950	-0.003	4.961
	[0.054]	[1.660]**
Cohort1960	0.002	3.799
	[0.053]	[1.438]*
Cohort1970	0.005	1.507
	[0.047]	[1.333]
male==1	0.007	2.476
	[0.054]	[1.329]+
Cohort1880*male	0.104	2.486
	[0.058]+	[2.424]
cohort1890*male	0.196	-0.468
	[0.058]**	[1.838]
cohort1900*male	0.177	2.630
	[0.061]**	[1.603]
Cohort1910*male	0.123	0.893
	[0.062]+	[1.423]
cohort1920*male	0.098	1.858
	[0.057]+	[1.479]
cohort1930*male	0.043	1.167
	[0.056]	[1.730]
cohort1940*male	0.072	-0.044
	[0.052]	[1.403]
cohort1950*male	0.054	0.212
	[0.053]	[1.570]
cohort1960*male	-0.015	-1.043
	[0.057]	[1.522]
cohort1970*male	0.004	0.146
	[0.058]	[1.445]

Table 2-5 (continued)

Constant	6.502	-88.257
	[2.225]**	[90.929]
Observations	26684	7026
R-squared	0.09	0.09
Robust standard errors in brackets		
+ significant at 10%; * significant at 5%; ** significant at 1%		

The Influences of Economic Factors: Pooling Years from 1970 to 2004

Table 2-6 presents the results for a two-part model of cigarette demand using the pooled data from 1970 to 2004. We included the interactions of income and year, and cigarette prices and year in the regressions, which allows us capture the coefficients on income and price change over time. Three specifications are estimated: model with fixed effects and time trends, model with fixed effects and year dummies, and model with index for smoking restriction in public places and year dummies. Table 2-6-1 presents the results for the smoking participation model, and Table 2-6-2 presents the results for the smoking level model.

Table 2-6-1: Smoking Participation: Pooling Years from 1970 to 2004

Smoking participation: pooling years from 1970 to 2004			
	Fixed effects & time trends	Fixed effects and year dummies	Index and year dummies
Year	-0.003239		
	[0.001551]*		
Age	0.010465	0.010440	0.010410
	[0.000889]**	[0.000914]**	[0.000898]**
Age square	-0.015252	-0.015257	-0.015187
	[0.000860]**	[0.000886]**	[0.000866]**
Lesshigh	0.003547	0.002875	0.001289
	[0.015336]	[0.015334]	[0.014781]
Highdrop	0.067688	0.066742	0.067378
	[0.011072]**	[0.011103]**	[0.011088]**
Somecol	-0.050679	-0.050278	-0.050414
	[0.007132]**	[0.007134]**	[0.007136]**
College	-0.145732	-0.144917	-0.145247
	[0.007932]**	[0.008063]**	[0.008069]**
Male	0.053786	0.054228	0.054271

Table 2-6-1 (continued)

	[0.008079]**	[0.008153]**	[0.008098]**
White	0.023576	0.024068	0.021434
	[0.013151]+	[0.013257]+	[0.013431]
Realprice	-3.154633	5.392097	8.793370
	[2.580572]	[4.513241]	[3.401336]*
Year*price	0.001585	-0.002707	-0.004398
	[0.001290]	[0.002254]	[0.001702]*
Income	3.767346	3.881072	4.014538
	[0.886419]**	[0.890916]**	[0.876437]**
Yeal*income	-0.001911	-0.001968	-0.002034
	[0.000444]**	[0.000447]**	[0.000439]**
Index	-0.037628	-0.021656	-0.009384
	[0.014426]*	[0.014517]	[0.013254]
Constant	6.639274	0.212698	0.202717
	[3.087917]*	[0.048932]**	[0.044032]**
Observations	20629	20629	20629
R-squared	0.08	0.08	0.08
Robust standard errors in brackets			
+ significant at 10%; * significant at 5%; ** significant at 1%			

Table 2-6-2: Smoking Level: Pooling Years from 1970 to 2004

Smoking level: pooling years from 1970 to 2004			
	Fixed effects and time trends	Fixed effects and year dummies	Index and year dummies
Year	0.007797		
	[0.002370]**		
Age	0.042073	0.043187	0.043115
	[0.003756]**	[0.003769]**	[0.003745]**
Age square	-0.040633	-0.041997	-0.041954
	[0.004197]**	[0.004268]**	[0.004223]**
Lesshigh	0.006521	0.017608	0.020993
	[0.040598]	[0.039613]	[0.039998]
Highdrop	0.036115	0.040735	0.042707
	[0.026151]	[0.026494]	[0.026410]
Somecol	-0.069786	-0.069838	-0.065161
	[0.022363]**	[0.023097]**	[0.023038]**
College	-0.231985	-0.222981	-0.215958
	[0.029495]**	[0.029136]**	[0.028581]**
Male	0.155171	0.154518	0.152342
	[0.019307]**	[0.019740]**	[0.019616]**
White	0.360132	0.355259	0.353685
	[0.028761]**	[0.027719]**	[0.026029]**
Log(price)	6.639385	45.524784	40.512681
	[7.610496]	[15.077707]**	[12.187859]**

Table 2-6-2 (continued)

Year*log(price)	-0.003535	-0.022952	-0.020450
	[0.003810]	[0.007561]**	[0.006132]**
Income	12.298494	11.916097	11.821545
	[3.175275]**	[2.905348]**	[2.940047]**
Year*income	-0.006191	-0.006000	-0.005954
	[0.001598]**	[0.001463]**	[0.001480]**
Index	-0.064866	-0.047361	-0.083291
	[0.038683]+	[0.037491]	[0.028164]**
Constant	-14.063863	1.429414	1.500721
	[4.717127]**	[0.112255]**	[0.111231]**
Observations	5032	5032	5032
R-squared	0.15	0.17	0.16
Robust standard errors in brackets			
+ significant at 10%; * significant at 5%; ** significant at 1%			

In Table 2-6-1, the coefficients on cigarette prices and the interaction of cigarette prices and year differ in different model specifications – the average cigarette price influence is negative but not statistically significant in the model with fixed effects and time trends; the influence is positive but not statistically significant in the model with fixed effects and year dummies; the influence is positive and reaches statistical significance in the model with clean indoor air regulation index and year dummies. In addition, the interaction between cigarette prices and year differs in different model specifications – the interaction is positive but not statistically significant in the model with state fixed effects and time trends; the interaction is negative but not statistically significant in the model with fixed effects and year dummies; the interaction is negative and statistically significant in the model with clean indoor air index and year dummies.

In Table 2-6-2, the average cigarette price influence is positive and decreases over time. The results are statistically significant in the model with state fixed effects and year dummies and the model with clean indoor air regulations and year dummies.

Regarding the influence of income on cigarette demand, the results are much

consistent across model specifications. The average income influence is positive and decreases over time. The results reach statistical significance in 1% significance level.

We impute the year-basis price elasticity and income elasticity for smoking participation and smoking level using the results from Table 2-6-1 and 2-6-2 for the model with clean indoor air index and year dummies. The results are presented in Table 2-7. The signs of price elasticities for smoking participation and smoking level flip from positive to negative over time. This is consistent with Wasserman (1988). There are some differences between our results and Wasserman (1988) – we found that price elasticity for smoking participation flips from positive to negative in 2000 and price elasticity for smoking level flips from positive to negative in 1981; Wasserman (1988) found that price elasticity flips from positive to negative much earlier – for smoking participation, price elasticity flips from positive to negative in 1976, and for smoking level, price elasticity flips from positive to negative in 1979.

Table 2-7: Imputed Price Elasticity and Income Elasticity from Two Part Model 1970 - 2004

	Smoking participation		Smoking level	
year	Price elasticity	Income elasticity	Price elasticity	Income elasticity
1970	0.563	0.024	0.224	0.005
1971	0.544	0.017	0.203	0.005
1972	0.525	0.011	0.183	0.005
1973	0.506	0.004	0.162	0.004
1974	0.487	-0.003	0.142	0.004
1975	0.467	-0.010	0.121	0.004
1976	0.448	-0.017	0.101	0.003
1977	0.429	-0.023	0.080	0.003
1978	0.410	-0.030	0.060	0.003
1979	0.391	-0.037	0.039	0.002
1980	0.372	-0.044	0.019	0.002
1981	0.352	-0.051	-0.001	0.002
1982	0.333	-0.058	-0.022	0.001
1983	0.314	-0.064	-0.042	0.001

Table 2-7 (continued)

1984	0.295	-0.071	-0.063	0.001
1985	0.276	-0.078	-0.083	0.000
1986	0.257	-0.085	-0.104	0.000
1987	0.237	-0.092	-0.124	-0.001
1988	0.218	-0.098	-0.145	-0.001
1989	0.199	-0.105	-0.165	-0.001
1990	0.180	-0.112	-0.185	-0.002
1991	0.161	-0.119	-0.206	-0.002
1992	0.142	-0.126	-0.226	-0.002
1993	0.122	-0.132	-0.247	-0.003
1994	0.103	-0.139	-0.267	-0.003
1995	0.084	-0.146	-0.288	-0.003
1996	0.065	-0.153	-0.308	-0.004
1997	0.046	-0.160	-0.329	-0.004
1998	0.027	-0.166	-0.349	-0.004
1999	0.007	-0.173	-0.370	-0.005
2000	-0.012	-0.180	-0.390	-0.005
2001	-0.031	-0.187	-0.410	-0.005
2002	-0.050	-0.194	-0.431	-0.006
2003	-0.069	-0.200	-0.451	-0.006
2004	-0.088	-0.207	-0.472	-0.006

Income elasticity also flips from positive to negative from 1970 to 2004. We found that income elasticity for smoking participation flips from positive to negative in 1974. The signs and magnitudes of income elasticity are consistent with Wasserman (1988). We also found that income elasticity for smoking level flips from positive to negative in 1987 and since then the elasticity becomes more and more negative over time. Since Wasserman (1988) only covers data through 1985, the income elasticity for smoking level in his model does not capture that the sign flips from positive to negative.

Omitted Variable Bias in Price Elasticity

The patterns in Table 2-8 suggest that the potential for omitted variable bias in estimates of the price-elasticity of cigarette demand might be increasing over the time period we study. The models in Table 2-3 and Table 2-4 allow the state fixed effects

to vary by decade, so in principle they should control for the type of changing state-level influences suggested by the results of Table 2-8. In practice, there is only limited within-state variation in taxes/prices per decade, especially in the earlier decades we study. This means that with these data we may be unable to precisely estimate the effects of the cigarette prices separately from the state fixed effects. Because of this inherent data limitation, we do not view our results as being very informative about the price-elasticity of cigarette demand.

Table 2-8: State Level Models of Cigarette Prices
Dependent variables: state-level cigarette tax/price

	1944	1949	1954	1957	1969	1971	1972	1977
Tobacco states	-0.02	0.05	-0.11	-0.11	-0.20	-0.28	-0.31	-0.25
	[0.11]	[0.07]	[0.08]	[0.07]	[0.09]*	[0.10]**	[0.11]**	[0.06]**
Anti smoking sentiment	0.06	0.23	-0.15	-0.00	0.42	0.08	0.16	0.21
	[0.27]	[0.14]	[0.19]	[0.17]	[0.22]+	[0.24]	[0.25]	[0.15]
Constant	0.41	0.31	1.59	1.69	1.93	1.89	1.90	1.71
	[0.05]**	[0.03]**	[0.04]**	[0.04]**	[0.04]**	[0.05]**	[0.05]**	[0.03]**
Observations	31	43	49	49	51	51	51	51
R-squared	0.01	0.06	0.04	0.06	0.26	0.19	0.22	0.37
Standard errors in brackets								
+ significant at 10%; * significant at 5%; ** significant at 1%								

	1981	1986	1987	1988	1990	1991	1994	1996
Tobacco states	-0.19	-0.24	-0.27	-0.29	-0.21	-0.21	-0.24	-0.27
	[0.05]**	[0.06]**	[0.06]**	[0.07]**	[0.10]*	[0.10]*	[0.13]+	[0.15]+
Anti smoking sentiment	0.17	0.31	0.31	0.37	0.76	0.71	0.74	0.86
	[0.12]	[0.14]*	[0.15]*	[0.17]*	[0.23]**	[0.24]**	[0.32]*	[0.35]*
Constant	1.47	1.98	2.03	2.15	2.37	2.55	2.38	2.45
	[0.02]**	[0.03]**	[0.03]**	[0.03]**	[0.05]**	[0.05]**	[0.06]**	[0.07]**
Observations	51	51	51	51	51	51	51	51
R-squared	0.35	0.45	0.46	0.44	0.37	0.34	0.25	0.27
Standard errors in brackets								
+ significant at 10%; * significant at 5%; ** significant at 1%								

	1997	1999	2000	2001	2002	2003	2004
Tobacco states	-0.26	-0.26	-0.23	-0.24	-0.33	-0.43	-0.50
	[0.15]+	[0.18]	[0.19]	[0.19]	[0.25]	[0.29]	[0.32]
Anti smoking sentiment	1.07	1.41	1.49	1.39	1.62	1.62	1.58
	[0.37]**	[0.43]**	[0.46]**	[0.47]**	[0.61]*	[0.70]*	[0.78]*
Constant	2.56	3.53	3.73	3.87	4.17	4.29	4.24

Table 2-8 (continued)

	[0.07]**	[0.09]**	[0.09]**	[0.09]**	[0.12]**	[0.14]**	[0.16]**
Observations	51	51	51	51	51	51	51
R-squared	0.30	0.32	0.29	0.27	0.24	0.22	0.20
Standard errors in brackets							
+ significant at 10%; * significant at 5%; ** significant at 1%							

Discussion

Over the sixty-year time span covered in our data, smoking participation falls from almost 50 percent to 22 percent. Although prices are the focus of many studies of cigarette demand, differences in cigarette prices over time do not explain all of the longer-run downward trend in smoking participation (see Figure 2).[24]

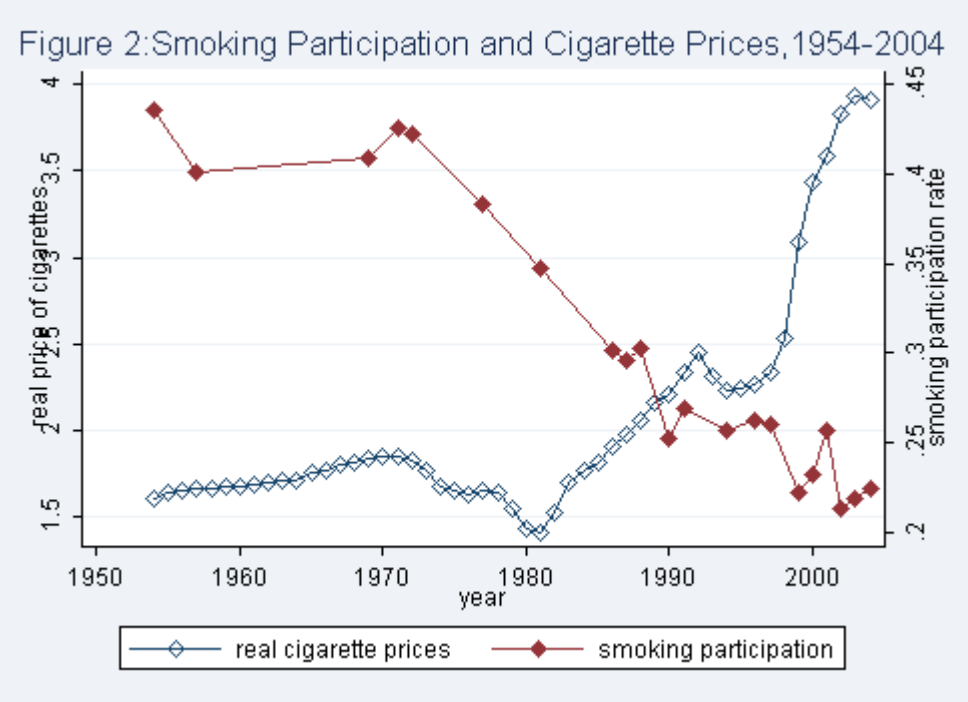

Figure 2: Smoking Participation and Cigarette Prices, 1954-2004

Our results show that it is important to recognize that the influences of economic and non-economic factors on cigarette demand change over time. From

[24] In a multiple regression estimated with the 21 data points in Figure 1, after controlling for a linear and quadratic time trend, the coefficient on price is +0.03 (t=1.94).

1944 to 2004 the economic factors (price and income) change from having no statistically significant effects to being negatively associated with cigarette smoking; the negative associations strengthen in magnitude over time. The influences of non-economic factors (gender, race, and schooling) on cigarette demand also change over time. From 1944 to 2004: the gender difference in smoking rates almost disappears; the black-white difference reverses; a strong gradient with schooling emerges; and the negative income elasticities strengthened in magnitude. While the longer time period we study is not very informative about the role of cigarette prices, our results show that it is important to recognize that the influences of key demographic factors on cigarette demand change over time.

As discussed in special Surgeon General's Reports, other social and behavioral sciences explore gender and racial differences in smoking (USDHHS 1998, 2001). The various and varying demographic influences on cigarette demand are potentially fruitful areas for future health economic research as well. In particular, better understanding the schooling-smoking gradient, and the perhaps related negative income elasticity of cigarette demand, remain key challenges.

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CHAPTER 3: WTO ENTRY, A NEW CIGARETTE TAX SCHEME, AND THE TOBACCO MARKET IN TAIWAN

Abstract

This study analyzes the impacts of Taiwan's entry into the WTO, which was accompanied by a series of policy changes on both the supply and demand sides of the tobacco market. It investigates the link between cigarette tax and price by imputing the tax pass-through rates, and confirms the hypothesis that free trade induces an increase in advertisements and the introduction of new brands and products. Regarding smokers' reactions to price changes, this study finds some evidence that smokers not only react to price changes, but also react to relative price changes by switching brands. It also takes into account other scenarios accompanying the WTO entry that influence the brand choices. One limitation of this study is that the small sample size and limited number of switchers in the data set hinders econometric analysis. However, the descriptive statistics suggest an effect of relative price change that usually has been overlooked.

Introduction

Taiwan became a member of the World Trade Organization (WTO) on January 1st, 2002. The goal of the WTO is to promote the benefits from free trade by encouraging the member nations to reduce tariff and non-tariff trade barriers. In the tobacco market, trade liberalization means more competition in product prices, quality, and marketing, and consequently results in an increase in cigarette consumption. This study analyzes the impacts of Taiwan's entry into the WTO in 2002 and the accompanying policy changes, on both the supply (cigarettes producers) and demand sides (cigarettes consumers) of the market.

Taiwan's entry into the WTO brought a dramatic change to its tobacco market. The changes were: (1) replacement of the tobacco monopoly profit tax by a new cigarettes tax scheme, (2) the transformation of the Taiwan Tobacco and Wine Monopoly Bureau (TTWMB), the exclusively government-run domestic cigarette supplier, into a corporation, and (3) the imposition of a NT$5 health and welfare surcharge on every cigarette pack. After these changes cigarette prices increased by about NT$10 for both domestic and imported cigarettes[25]. Since imported cigarettes had higher prices to begin with, this led to a change in the price of imported cigarettes relative to domestic cigarettes – the domestic cigarette prices typically increased by 35% while the imported cigarette prices typically increased by 25%.

This study analyzes the changes in cigarette prices after the policy changes. This first part of the study explores how much of the tax is passed through onto the price for each individual brand and product. The next part of the study examines whether there is a difference in tax pass-through rates between domestic and imported cigarettes. Lastly, the increased competition in product quality and marketing, and increases in cigarette advertisements are examined.

The changes in prices and marketing promotions are expected to influence cigarettes consumption. This study analyzes the ways smokers react to these changes in terms of cigarette smoking and brand switching. In addition, because the tax-induced cigarette prices change in both absolute and relative values, it is possible to disentanglement of the overall price effect into substitution and income effects. This study estimates whether or not smokers react to price increases by switching to lower price brands, and whether or not smokers react to relative price changes by switching to higher-priced brands with lower price increase rates.

This study extends the previous research by focusing on the reactions of the

[25] The yearly average NT dollar exchange rate was 33.8 against the US dollar in 2001.

supply and demand sides of the tobacco market to a series of policy changes in 2002 in the following areas: (1) it establishes a relationship between the new cigarettes tax scheme and price-hike by analyzing the tax pass-through rates; (2) it analyzes the non-price competitions; and (3) it investigates the influence of cigarette price-hikes on brand switching behaviors. Tsai *et al.* (2005) found that after the price-hike, smokers switched to lower-priced cigarettes. This study, however, argues that smokers not only reacted to the absolute price increase, but also to the relative price increase. Moreover, this study also takes into account other scenarios that accompanied Taiwan's entrance into the WTO and that are associated with brand choices

Background of the Tobacco Market and New Cigarette Tax Scheme

Prior to 1987, the tobacco market in Taiwan was a monopoly, with only one government-run legal supplier of cigarettes, called the Taiwan Tobacco and Wine Monopoly Bureau (TTWMB). At that time, foreign cigarette makers were prohibited from exporting and marketing their products in Taiwan; the TTWMB had the exclusive right to import foreign cigarette brand and impose high tariffs and quota regulations. In 1987, under the impact of trade sanctions under section 301 of the US Trade Act, the U.S. successfully negotiated a trade agreement with Taiwan and started to export cigarettes to Taiwan. Thereafter, Taiwan allowed other foreign tobacco companies to export and market their own brands. The market share for imported cigarettes steadily increased after 1987, where there was a less than 1% market share of imported cigarettes, to 20% in the late 1980s and 30% in the 1990s. By 2000, the share had risen to 55%[26].

Prior to 2002, the Taiwanese government did not impose any taxes on cigarettes, but the monopoly profit was collected by the government. The monopoly profit for

[26] Data come from Taiwan Tobacco and Wine Statistical yearbook.

domestic cigarettes was around NT$11 per pack in 2001[27]. The Taiwanese government imposed a NT$16.6 per pack monopoly profit tax on imported cigarettes. The monopoly profit tax was approximately 47% of the retail price (Hu, 1997).

In 2002, Taiwan gained official membership into the WTO, which changed the fundamental characteristics of its tobacco market: TTWMB transformed from a government agency to a cooperation called Taiwan Tobacco and Liquor Cooperation (TTLC), though the Taiwanese government still owned 100% of the company stocks (the ultimate goal is to privatize TTLC and release its stocks to the public in 2009), and the monopoly profit imposed in both domestic and imported cigarettes had been replaced with a new cigarette tax scheme. On January 1st, 2002, a new tax scheme was implemented which mandated that all cigarettes be subject to a cigarette tax of NT$11.8 per 20-piece pack, an additional NT$5 as a Health and Welfare Surcharge to help fund tobacco control and national health insurance, and a 5% sales revenue tax. On top of that, an additional 27% tariff was imposed on imported cigarettes. The new cigarette tax scheme led to a cigarette tax hike. From 2001 to 2002, the tax increase for domestic cigarettes ranged from NT$6.33 to NT$8.34 per pack, varying by brand and product, while the tax increase for the imported cigarettes ranged from NT$3.59 to NT$45.28 per pack, also varying between brands and products. Table 3-1 presents the ways cigarette taxes were calculated for both domestic and imported cigarettes before and after 2002. The section of relationship between taxes and prices presents a detailed description of prices and taxes before and after implementation of the tax scheme, and addresses the relationship between taxes and prices as well.

[27] From Tsai et al (2005b). The monopoly profit for domestic cigarettes is calculated by the monopoly profit collected from cigarettes/ packs of cigarettes sold. The monopoly profit is the total revenue minus the total cost.

Table 3-1 Cigarette Tax Policy Before and After the New Tax Scheme in 2002

		Before 2002		After 2002	
		Domestic	Imported	Domestic	Imported
		D1	I1	D2	I2
A	Production Cost/ Imported Cost	A (D1)	A(I1)	A(D2)	A(I2)
B	Tariffs	NA		NA	27%
					B(I2)=A(I2)*27%
C	Excise Tax			NA	NA
D	Cigarette Tax	NA	NA	NT$11.8	NT$11.8
E	Health and Welfare Surcharge	NA	NA	NT$5	NT$5
F	Sales Tax			5%	5%
				F(D2)=	F(I2)=
				(A(D2)+D)*5%	(A(I2)+B(I2)+D)*5%
G	Monopoly Profit	NT$11	NT$16.6	NA	NA
		G(D1)= C+F	G(I1)= B+C+F		
H	Total Tax	NT$11	NT$16.6	NT$16.8+F(D2)	NT$16.8+B(I2)+F(I2)

Sources: Tsai (2005b) “The evaluation of the impact of the new tax scheme on tobacco market” report from National Health Research Institute, Taiwan.
Note: the amount of monopoly profit per pack for domestic cigarettes is calculated by Shu and Hsieh (1999).

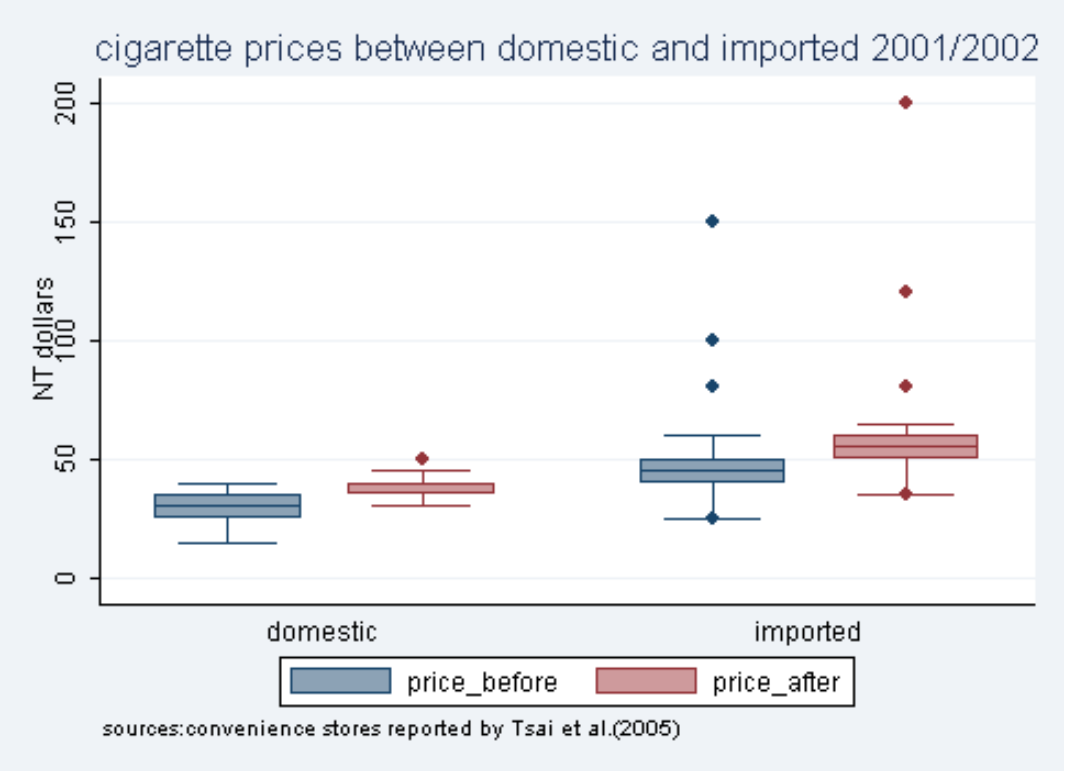

Figure 3: Cigarette Prices between Domestic and Imported Cigarettes 2001 and 2002

The Economics of 2002 Policy Changes

In 2002, the government-run bureau (TTWMB) was transformed into a government-run corporation (TTLC), with plans that it will become a privately owned company in 2009. Although the objective functions for bureaucrats and corporations are different – the bureaucrats maximize the total budget of their bureau (Niskanen1968), while the corporations maximize their total profits, their common characteristics of the government-ownership may lead to similar ways of operations. It is important, though is difficult, to distinguish their objective functions in order to predict the ways they set up their prices and operate their businesses. The following present several possibilities of the objective functions for TTWMB and TTLC.

For example, if the budget size of the TTWMB was tied with the monopoly profits it brought, TTWMB would have performed like a profit maximizing firm.

However, if the budget size of TTWMB was also related to its success in public reputations, it would have set a higher price than the profit maximizing rate in order to reduce the smoking prevalence and improve the public health. For example, the Taiwanese government has been aggressively control the tobacco use since the late 1990s.

If the TTLC, a government-owned corporation, operated like a profit maximizing industry, and targeted at having a successful stock offering in 2009, it would have had incentives to offer a lower price than the price offered by TTWMB. However, because the TTLC was still owned by the government, the political pressure might lead it still takes into account the public health issues. For example, Taiwanese government imposed a NT$5 per pack health and welfare surcharge on cigarettes in 2002 aimed at reducing smoking rates by increasing cigarette prices. This explains the pressure faced by the government that it should keep the cigarette prices high in order to increase the public health of the nation. Therefore, it is uncertain about the differences in objective functions of the TTWMB and TTLC. The following provides the economic framework for a link between tax and price in a less competitive market. In addition, the non-price competition in a less competitive market is also addressed in this section. Finally, the economic logic supporting the reactions of consumers to the policy changes are discussed.

Economic theory predicts that the tax pass-through rates are determined by the demand and supply conditions, and market competitiveness. In the competitive industries with a constant marginal cost of production, taxes will be fully passed through to consumers. In less competitive markets, theory predicts a number of possible outcomes. Stern (1987) concluded a much broader range for tax pass-through rates by examining a set of possible market structures. For example, Stern (1987) found that in oligopoly when demand curve is isoelastic, the tax pass

through rate will be above 100 percent. In addition, the tax pass through rates will be greater (lower) in monopolistic competition based on if the elasticity of demand is less (greater) than one. Several empirical studies confirmed that in the less competitive market, the tax pass-through rates are above 1 and range from about one to two (Cook, 1981; Young and Bielinska-Kwapisz, 2002; Barnett et al. 1995). Kenkel (2005) focused on alcohol beverage prices in Alaska and observed higher pass-through rates in some brand categories (the pass-through rate for on premise wine and spirits ranges from about 3 to 4). Delipalla and O'Donnell (1999) found that the tax pass-through varies from under-shifting to over-shifting in an imperfectly competitive market based on the incidence of *ad valorem* or specific taxes.

Since the Taiwanese tobacco market is less competitive and the tax incidence is different between the domestic and imported cigarettes -- the domestic cigarette taxes are combinations of excise taxes and value-added taxes, while the imported cigarette taxes are comprised of an excise tax, value-added tax, and an *ad valorem* tax--this study expects an over-shift tax pass-through with higher tax pass-through rates in domestic as compared to imported cigarettes.

In addition, the non-price competitions, reflected in the increasing expenditures on advertisements and the newly introduced products meant to stand out from rival products, are important in a less competitive market. Therefore, this study expects that after entry into the WTO, there would be increases in cigarette advertisements and promotions in the tobacco market; moreover, the new brands and products would be introduced in ways to target different subgroups and expand its business scope.

After the series of policy changes in 2002, the prices for domestic and imported cigarettes increased by about NT$10. Although imported cigarettes had higher prices than domestic ones, the uneven price-increase rates allowed imported cigarettes to seem less expensive. This study focuses on brand switching behaviors in response to

the price changes.

Economic model predicts that when the price of a product changes, there are two effects on consumers. First is the change in price of a product relative to other products, referred to as a "substitution effect". Second is the income change due to the price change, referred to as an "income effect". Tsai *et al.* (2005) concluded that after the price-hike, smokers who used to purchase expensive cigarette brands were more likely to switch, and they switched to lower-priced cigarettes. However, Tsai *et al.* only capture the income effect, and overlook the "substitution effect". This study argues that some smokers might switch from lower-priced domestic cigarettes to higher-priced imported cigarettes, because imported cigarettes became less expensive than domestic ones after the price-hike.

Data

This study uses two data sources. One is an individual level survey data, the Taiwan Cigarette Consumption Behaviors Survey (TCCBS), and the other is the cigarette prices data which provide the prices for each brand/product on the market in 2001 and 2002, collected by Tsai (2005b).

The TCCBS data is a longitudinal survey annually conducted from 2000 to 2003 by the National Health Research Institutes (NHRI) in Taiwan. The data set provides abundant information on cigarette smoking and consumption. The cigarette smoking behaviors presented in the data set include current smoking status, smoking risk information, second-hand exposure, and attitudes toward smoking restrictions. The cigarette consumption behaviors included in the data set are their top three cigarette brands consumed, the self-reported prices for each brand consumed, the reason behind choosing this brand, and the consumption behaviors related to smuggled cigarettes. Demographic characteristics and socioeconomic status are also included in the data

set.

In the initial year of survey, 3,824 non-institutionalized civilians aged 12-64 years old were interviewed. The number of respondents dropped considerably from the initial survey to the second-year survey – around 20% of respondents dropped out between the first and second round. After the second round panel was conducted in 2001, the dropout rates in subsequent years were substantially lower. This study mainly uses two year waves, 2001 and 2002, which cover before and after the policy change.

This study restricts the respondents to those who consistently participated in each wave of survey. This criterion provides 2,610 respondents with 518 respondents who smoked both in 2001 and 2002.

The information on cigarette prices comes from Tsai (2005b), a research report of the NHRI in Taiwan. It collected cigarette prices for each cigarette brand and product from 7-eleven convenience stores. In the report, it listed out cigarette prices for each brand and product on the market in 2001 and 2002.

The Relationship between Taxes and Prices

The cigarette tax hike in 2002 induced by the new tax scheme was substantial when compared to the recent history of cigarette taxes. For example, from 1987, the year when the market opened to foreign brand cigarettes, until 2002, the monopoly profit tax imposed on the foreign cigarette brands had been NT$16.8 and was not increased to adjust for inflation. After 2002, the new tax scheme was imposed which led to a cigarette tax hike, and cigarette prices increased accordingly by about NT$10.

In this section, I provide a detailed description of the cigarette tax increase and price increase after the new tax scheme was implemented. Additionally, I estimate the relationship between cigarette taxes and prices across different brands and

products by imputing the tax pass-through rates.

Table 3-2 presents for each brand/product its price and tax in 2001 and 2002, price and tax differences from 2001 to 2002, and tax pass-through rates. The first three columns present the names of tobacco companies, brands, and products, respectively, followed by prices in 2001 and 2002, price differences between 2001 and 2002, taxes in 2001 and 2002, tax differences between 2001 and 2002, and tax pass-through rates. Prices in 2001 and 2002 are collected by Tsai (2005b); tax for domestic cigarettes in 2001 refers to the tobacco monopoly profit NT$11(Tsai, 2005b), calculated by the total amount of tobacco monopoly profit divided by number of cigarette packs sold; tax for imported cigarettes in 2001 refers to the monopoly profit tax NT$16.6 per pack; tax in 2002 for domestic and imported cigarettes are imputed based on the tax policy presented in Table 3-1.

Table 3-2 Cigarette Prices and Taxes across Brands before and after 2002

Price increase across brands before and after 2002								
Brand	Product	price 01	price 02	price diff	Tax 01	tax 02	tax diff	tax pass-through
Domestic Cigarette								
Taiwan Tobacco and Liquor Cooperation								
Long Life	Yellow soft	25	35	10	11	17.33	6.33	1.58
	Yellow hard	25	35	10	11	17.33	6.33	1.58
	Yellow hard light	30	40	10	11	17.58	6.58	1.52
	White Soft light	25	35	10	11	17.33	6.33	1.58
	White hard light	30	40	10	11	18.34	7.34	1.36
	White thin long light	30	40	10	11	18.34	7.34	1.36
	English light	25	35	10	11	18.09	7.09	1.41
	Gentel round light	35	45	10	11	18.59	7.59	1.32
	Gentel hard light	30	40	10	11	18.34	7.34	1.36
	Gentel hard very light	30	40	10	11	18.34	7.34	1.36
Sinox 100	light	50			11	19.34	8.34	
YES	light	40	45	5	11	18.84	7.84	0.64
Fame Lights	light	28	35	7	11	18.24	7.24	0.97
Net @live	hard pack light	35	40	5	11	18.59	7.59	0.66
Passion		40	50	10	11	18.84	7.84	1.28

Table 3-2 (continued)

Precious		30	40	10	11	18.34	7.34	1.36
Precious	Light	35	40	5	11	18.59	7.59	0.66
New Paradise		15	30	15	11	17.59	6.59	2.28
New Paradise	light	25	35	10	11	18.09	7.09	1.41
White Cloud		30	35	5	11	18.34	7.34	0.68
Gold Dragon	hard pack	30			11	18.34	7.34	
President		26			11	18.14	7.14	
Victory		22			11	17.94	6.94	
Pease	light	30			11	18.34	7.34	
Handsome	light	30			11	18.34	7.34	
Imported Cigarette								
Japan Tobacco International								
Mild Seven	Lights	40	50	10	16.6	25.19	8.59	1.16
Mild Seven	Charcoal Filter	40	50	10	16.6	25.19	8.59	1.16
Mild Seven	Slim Lights Menthol	45	55	10	16.6	26.86	10.26	0.97
Mild Seven	International	60	65	5	16.6	31.86	15.26	0.33
Mi-Ne	Prestige	80	80	0	16.6	38.53	21.93	0.00
Mi-Ne	Classic	60	65	5	16.6	31.86	15.26	0.33
YSL	Menthol	50	60	10	16.6	28.53	11.93	0.84
YSL	Filter		60					
YSL	Menthol lights		60					
YSL	Filter lights		60					
Peace	Filter	50	60	10	16.6	28.53	11.93	0.84
Peace	Lights		60					
Salem	SlimLights	40	50	10	16.6	25.19	8.59	1.16
Salem	Slim Lights Menthol							
Salem	classic	45	55	10	16.6	26.86	10.26	0.97
Camel			50					
Imperial Tobacco Limited								
Davidoff	Lights	50	60	10	16.6	28.53	11.93	0.84
Davidoff	Classic	50	60	10	16.6	28.53	11.93	0.84
Davidoff	Lights(Slims)	50	60	10	16.6	28.53	11.93	0.84
Davidoff	Ultra	50	60	10	16.6	28.53	11.93	0.84
Davidoff	Mild	50	60	10	16.6	28.53	11.93	0.84
Davidoff	Supreme	30	40	10	16.6	21.86	5.26	1.90
Davidoff	Magnum	150	200	50	16.6	61.88	45.28	1.10
Davidoff	Magnum	150	200	50	16.6	61.88	45.28	1.10
Boss	International	40	50	10	16.6	25.19	8.59	1.16
Boss	Lights	40	50	10	16.6	25.19	8.59	1.16
West	Lights	40	40	0	16.6	25.19	8.59	0.00
West	classic	40	40	0	16.6	25.19	8.59	0.00
Regal			100					
Philips Morris International								
Marlboro	Lights	40	50	10	16.6	25.19	8.59	1.16
Marlboro	Menthol Lights	40	50	10	16.6	25.19	8.59	1.16

Table 3-2 (continued)

Marlboro	Classic	40	50	10	16.6	25.19	8.59	1.16
Parliament	Lights	45	55	10	16.6	26.86	10.26	0.97
Parliament	Classic	45	55	10	16.6	26.86	10.26	0.97
Parliament	Lights	40	50	10	16.6	25.19	8.59	1.16
Virginia	Lights Slims	45	55	10	16.6	26.86	10.26	0.97
L&M	Milds	25	35	10	16.6	20.19	3.59	2.78
Saratoga			65					
British American Tobacco								
555	Ultra	50	60	10	16.6	28.53	11.93	0.84
555	Blue	50	60	10	16.6	28.53	11.93	0.84
555	Lights	40	50	10	16.6	25.19	8.59	1.16
555	State Express	40	50	10	16.6	25.19	8.59	1.16
Dunhill	Lights	40	50	10	16.6	25.19	8.59	1.16
Dunhill	Ultra Lights	40	50	10	16.6	25.19	8.59	1.16
Dunhill	Ultimate Lights	40	50	10	16.6	25.19	8.59	1.16
Craven "A"	Lights	30	40	10	16.6	21.86	5.26	1.90
Kent		45	55	10	16.6	26.86	10.26	0.97
Cartier	Infinite Lights	55	65	10	16.6	30.20	13.60	0.74
Cartier	Lights	55	65	10	16.6	30.20	13.60	0.74
Cartier	Ultra Lights	55	65	10	16.6	30.20	13.60	0.74
Gallaher Limited								
Sobranie	Classic	40	50	10	16.6	25.19	8.59	1.16
Sobranie	Classic Lights	40	50	10	16.6	25.19	8.59	1.16
Sobranie	Mints	50	60	10	16.6	28.53	11.93	0.84
Sobranie	Pinks	50	60	10	16.6	28.53	11.93	0.84
Sobranie	Cocktail		170					
Nat Sherman, Inc.								
Nat Sherman		100	120	20	16.6	45.20	28.60	0.70
Sampoern								
Duport	Classic	40	50	10	16.6	25.19	8.59	1.16
Duport	Lights	40	50	10	16.6	25.19	8.59	1.16
VonEicken Group								
Springwater			90					

Table 3-2 indicates that after the new tax scheme was implemented, the tax increase for domestic brands ranged between [NT$6.33, NT$8.34], while for the imported brands, tax increases fell in the range of [NT$3.59, NT$45.28], varying by brands and products. The cigarette prices increased accordingly. The price increases for domestic and imported cigarettes fell in the range of [NT$5, NT$15] and [NT$0,

NT$50], respectively, with a NT$10 increase for most of the brands[28]. Hence, in comparing the tax and price increase for each brand, the results indicate that taxes are over-shifted for some brands and under-shifted to prices for others.

This study further calculates the tax pass-through rates listed in the last column of Table 3-2. The tax pass-through rates are calculated by dividing the price changes by the amount of tax increases for each brand and product. Overall, the tax pass-through rate ranges from 0 to 2.78, with a median 1.16. This implies the tax pass-through rates fall in a broad possibility from 0 to 2.78 - it ranges from an extreme case that the tax does not pass through to price at all, to another extreme case in which the tax is over-shifted to price by 278%. On average, the tax pass-through rate is 1.16, implying that taxes are over-shifted to prices – 100% increase in tax is associated with a 116% increase in price.

The tax incidences are different between domestic and imported cigarettes. The domestic cigarette taxes are combinations of excise taxes and value-added taxes, while the imported cigarette taxes are comprised of an excise tax, value-added tax, and *ad valorem* tax. Therefore, I divide the sample into two groups, and compare the tax pass-through rates between domestic and imported cigarettes. For domestic cigarettes, the tax pass-through rate ranges from 0.64 to 2.28, with a median 1.36. For imported cigarettes, the tax pass-through rate ranges from 0 to 2.78 with a median 0.97. Although for both domestic and imported cigarettes, tax pass-through rates are bouncing above and below 1, the median tax pass-through rate is over 1 for domestic and under 1 for imported cigarettes. The finding is consistent with previous empirical studies about the tax pass-through rates varying by different tax incidences. They found the over-shifting of the specific tax and under-shifting of the *ad valorem*

[28] Three products' prices increase by NT$0, six products' prices increase by NT$5, one product price increases by NT$7, one product price increases by NT$15, one product price increases by NT$20, and two products' prices increase by NT$50.

tax in a less competitive market (for example, Johnson (1978); Delipalla and O'Donnell (1999); Barzel (1976)).

New Brands, Nicotine, and Advertisements before and after 2002

The structural change of the domestic cigarette supplier that accompanied Taiwan's entry into the WTO brought competition into the tobacco market. The increasing competition is reflected in several new introduced brands and products, and the increasing advertisement expenditures.

From 2002 to 2004, domestic cigarette company added one new brand and eight new products, while foreign cigarette companies added seventeen new brands and thirty-nine new products (Tsai 2005b). The new brands and products contain lower nicotine than the existing products in the market (Tsai 2005b).

Table 3-3 presents the magazine advertisement expenditures for each cigarette brand in 2001 and 2002. Overall, the foreign tobacco companies spent much more on advertisements than did domestic tobacco company: in 2002 the advertisement expenditures on imported and domestic cigarettes are 90% and 10% of the total cigarette advertisements expenditures, respectively. However, domestic cigarette company increased its expenditures in 2002: the expenditure was NT$8,972 in 2001 and increased to NT$25,609 in 2002[29]. This was an increase of 285%. For imported cigarettes, the expenditure on cigarette advertisements in magazines was NT$175,200 in 2001 and NT$228,256 in 2002[30], or an increase of 130%.

[29] The tobacco advertisements were only allowed in magazines after 1997 in Taiwan.
[30] The expenditures presented in the paper are not adjusted for the consumer price index (CPI). Because the CPI index had decreased from 2001 to 2002, the adjusted 2002 advertisement expenditures would be higher than the value without being adjusted. The 2001 is the base year with consumer price index (CPI) 100, and the CPI for 2002 is 99.80.

Table 3-3 Cigarettes Magazine Advertisements 2001-2002
unit: NT$1000

	2001	2002
domestic cigarettes		
Long Life	6,128	12,918
Sinox 100	360	-
YES	-	-
Fame Lights	-	-
Net @live	2,484	-
Passion	-	7,926
Precious	-	-
New Paradise	-	4,765
White Cloud	-	-
Gold Dragon	-	-
President	-	-
Victory	-	-
Pease	-	-
Handsome	-	-
domestic total	8,972	25,609
domestic(%)	0.05	0.10
Imported cigarettes		
Mild Seven	22,500	37,714
Mi-Ne	12,682	17,767
YSL	4,120	-
Peace	3,810	3,565
Salem	14,906	15,763
Camel	-	-
Davidoff	14,696	29,330
Boss	-	-
West	11,756	15,545
Regal	-	-
Marlboro	19,930	22,074
Parliament	-	-
Virginia	-	-
L&M	8,100	4,410
Saratoga	-	-
555	10,175	4,818
Dunhill	20,835	14,698
Craven "A"	-	3,460
Kent	-	-
Cartier	5,940	-
Sobranie	13,700	21,140
Nat Sherman	750	810
Duport	11,150	37,062
Springwater	150	100
imported total	175,200	228,256
imported(%)	0.95	0.90

Table 3-3 (continued)

Total	184,172	253,865

Sources: Tsai (2005b). The original data is from the Rainmaker XKM international corporation. It collects all cigarettes advertisements from 152 magazines and calculates the expenditures for each brand based on the suggested cost for each magazine. "–" indicates there is no expenditure for the specific brand is collected.

Impacts on Cigarettes Consumption

This section analyzes the influences of the cigarette tax-induced -price-hike and relative price change on cigarette smoking and brand switching. It compares the brand switching behaviors where there is no policy change with where there is a policy change. In addition, it takes into account other scenarios such as the effect of increasing amount of advertisements and new brands and products after Taiwan's entry into the WTO on cigarettes brand choices.

Smoking Prevalence

Table 3-4 presents the general smoking status between 2001 and 2002. The sample has 2,610 respondents who appeared in both waves in 2001 and 2002. In 2001, 551 respondents were current smokers. In 2002, the number reduced slightly to 547 current smokers. Twenty-nine people initiate or relapse into smoking in 2002, and thirty-three quit smoking in 2002. The results suggest that on balance, smoking prevalence stays about the same (21%) before and after the tax hike, though a few people cease smoking and others begin or relapse.

Table 3-4: The Transition of Smoking Status in 2001 and 2002

2002 2001	Smoke	Not Smoke	Total
Smoke	518	33	551
Not smoke	29	2030	2059
Total	547	2063	2610

Brand-Switching Behaviors between 2001 and 2002

Table 3-5 presents smokers' brand choices in 2001 and 2002. The table presents a relationship between the rows, the brand choice in 2001, against the columns, the brand choice in 2002. This table includes 512 smokers who smoked both in 2001 and 2002. In the table, the first column and row indicate the cigarette prices for each associated brand in 2001 and 2002, respectively. The second column and row indicate the assigned mark for each associated brand. The third column is the brand name. The numbers in the cell in the table indicate the number of smokers who fit into each specific category. Brand names are sorted by listing domestic brands first, followed by imported cigarette brands. The domestic cigarette brands (Long Life, Precious, Precious (light), and New Paradise), are listed first, and followed by the imported cigarette brands (Boss, Mild Seven, 555, Davidoff, Marlbolo, Parliament, Mi-Ne, Virginia Slim Lights, L&M, Dunhill, Kent, and Salem).

The top three brands in 2001 and 2002 were Long Life, Mild Seven, and Davidoff. In 2001, 233 out of 512 (46%) smoked Long Life, 117 out of 512 (23%) smoked Mild Seven, 78 out of 512 (15%) smoked Davidoff, and the rest of the smokers (16%) smoked other brands. The market shares for cigarette brands are highly clustered in the three brands of Long Life, Mild Seven, and Davidoff.

Table 3-5 brand switching between 2001 and 2002

		$	35	40	40	30	50	50	50	60	50	55	65	55	35	50	55	50		stay	switch	switch low	switch high
$	2001 (row)	2002 (column)	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	total				
25	A	Long Life	202	1	0	7	0	12	1	4	2	0	1	0	1	1	0	1	233	202	31	7	23
30	B	Precious	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
35	C	Previous(light)	0	5	0	1	0	0	0	1	0	0	0	0	0	0	0	0	7	0	7	1	1
15	D	New Paradise	0	0	0	7	0	1	0	1	1	0	0	0	0	0	0	0	10	7	3	0	3
		domestic total in 2001																	251	210	41	8	27
40	E	Boss	1	0	0	0	5	4	0	0	0	0	0	0	0	0	0	0	10	5	5	1	0
40	F	Mild Seven	9	0	0	1	0	91	3	5	2	0	4	0	1	1	0	0	117	91	26	11	9
40	G	555	1	0	0	0	1	3	7	0	0	0	0	0	0	0	0	0	12	7	5	1	0
50	H	Davidoff	16	0	0	1	2	15	1	39	1	0	1	0	1	1	0	0	78	39	39	38	1
40	I	Marlboro	0	0	0	0	0	1	0	0	7	0	0	0	1	0	0	0	9	7	2	1	0
45	J	Parliament	1	0	0	0	0	1	0	0	0	3	0	0	0	0	0	0	5	3	2	2	0
60	K	Mi-Ne	0	0	0	0	0	2	0	2	0	0	8	0	0	0	0	0	12	8	4	4	0
45	L	Virginia Slim Lights	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0
25	M	L&M	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	1	2	0	0
40	N	Dunhill	2	0	0	0	0	1	0	0	0	0	0	0	0	9	0	0	12	9	3	2	0
45	O	Kent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0
40	P	Salem	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0
		imported total in 2001																	261	173	88	60	10
		total	234	7	0	17	8	131	12	52	13	3	14	1	5	12	1	2	512				

In the table, the diagonal cells indicate the number of smokers who continued smoking the same brands in 2001 and 2002, for each specific brand. Overall, 383 out of 512 smokers (75%) stuck with the same brands, while 129 out of 512 smokers (25%) switched brands after the price-hike. Among brand switchers (N=129), 68 switched to lower-priced brands (53%), and 34 switched to higher-priced brands (26%) than they would have paid if they had stuck with their original brands. Sixty-one (47%) brand switchers switched across domestic and imported cigarettes. Overall, the results indicate that after the tax hike, about 25% smokers switched brands; among the brand switchers, over half of them switched to lower-priced cigarettes. This provides convincing evidence to support the hypothesis that smokers switch to lower-priced cigarettes to avoid the cigarette price-hike.

Because the price-increase rate is higher in domestic cigarettes than imported ones after the tax hike, domestic cigarettes become less cheap relative to imported cigarettes after the tax scheme. I further investigate whether or not smokers react to relative price changes. I divide the sample into domestic and imported brand users in 2001, and investigate whether or not domestic brand users switch to imported brands after the price-hike.

Among the domestic cigarette smokers in 2001(N=251), 210(84%) stuck with the same brands while 41(16%) switched brands. In addition, among those who switched brands (N=41), eight (20%) switched to lower-priced brands, and 27 (66%) switched to higher-priced brands, relative to what they would have paid if they had stuck with their original brands. Twenty-six, almost all of the switchers who switched to the higher-priced cigarettes, chose imported cigarettes. In contrast, among the imported cigarette smokers who switched brands (N=89), 60 (67%) switched to lower-priced cigarettes and 10 (11%) switched to higher-priced cigarettes. Among the 60 imported-brand users who switched to lower- priced brands, 32 (53%)

chose domestic brands. Thus, the fact that a large portion of domestic-brand users switched to higher- priced imported cigarettes, and a relatively small portion of imported-brand users switched to lower- priced domestic cigarette brands after the price-hike means that smokers react to relative price change.

Brand-Switching Behaviors between 2000 and 2001

In order to ensure that the brand switching behaviors seen between 2001 and 2002 are influenced by price hikes alone rather than any other factor, this section provides the brand switching behaviors from 2000 to 2001, where there is no change in cigarette prices. If the brand switching behaviors from 2000 to 2001 capture every possible influence but price-hike, it can serve as the basis of comparison for the brand switching behaviors after the price-hike. If the switching behaviors show similar patterns between time frames 2000-2001 and 2001-2002, it is unlikely that the price-hike explains the switching behaviors seen in 2001-2002. If, on the contrary, the switching behaviors exhibit different patterns between the two time frames, it gives some confidence to the claim that the pattern of brand switching 2001-2002 is probably not random, and is influenced by the price-hike. The brand choices in 2000 and 2001 are presented in Table 3-6.

Table 3-6: Brand Switching between 2000 and 2001

		25	30	35	15	40	40	40	50	40	45	60	45	25	50	40	45	40					
		A	B	C	D	E	F	G	H	I	J	K	L	M	M'	N	O	P	Total	stay	switch	switch low	switch high
A	Long Life	193	0	1	7	2	18	2	12	0	1	1	0	0	0	2	0	0	239	193	46	7	39
B	Precious	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	1	5	0	5
C	Previous(light)	2	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	1	3	2	1
D	New Paradise	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
domestic total in 2000																			250	196	54	9	45
E	Boss	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	7	5	2	1	0
F	Mild Seven	11	0	0	1	2	74	4	9	2	0	3	0	1	1	3	0	1	112	74	38	13	13
G	555	0	0	0	1	1	0	5	2	0	0	0	0	0	0	0	0	0	9	5	4	1	2
H	Davidoff	7	0	0	0	0	5	0	47	0	0	3	0	0	0	1	0	0	63	47	16	13	3
I	Marlboro	0	0	0	0	0	1	0	0	4	0	0	0	0	0	0	1	0	6	4	2	0	1
J	Parliament	0	0	0	1	0	0	0	0	0	4	0	0	0	0	0	0	0	5	4	1	1	0
K	Mi-Ne	2	0	0	0	0	3	1	2	0	0	5	0	0	0	0	0	0	13	5	8	8	0
L	Virginia Slim Lights	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	2	1	1	1	0
M	L&M	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	2	1	1	1	0
N	Dunhill	0	0	0	0	0	2	0	1	0	0	0	0	0	0	3	0	0	6	3	3	2	1
O	Kent	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	2	1	1	1	0
imported total in 2000																			227	150	77	42	20
Total		216	1	7	12	10	106	12	73	7	5	12	1	2	1	9	2	1	477	346	131	51	65

The brand choices in 2000 and 2001 during which cigarette prices did not change are presented in Table 3-6. The data refer to has 477 smokers who smoked both in 2000 and 2001, after deleting the observations with missing values in brand choices. Overall, 131 out of 477 (27%) smokers switched brands. The percentage of brand switchers is slightly higher than that after the price-hike. Among the brand switchers (N=131), 51 (39%) switched to lower- priced cigarettes, and 65 (50%) switched to higher- priced cigarettes. On the contrary, the results from the previous section indicate that over half of smokers switched to lower- priced cigarettes after the tax hike. Therefore, the evidence suggests that consumers only switched to lower-priced cigarettes after a price-hike.

In addition, I compare whether or not domestic-brand users switched to higher-priced imported cigarettes in 2000-2001 and 2001-2002. In 2000-2001, among the domestic-brand users who switched brands (N=54), 45 (83%) switched to higher-priced cigarettes, and nine (17%) switched to lower-priced cigarettes. In contrast to the result that almost all of the switchers switching to higher -priced cigarettes chose imported cigarettes (26 out of 27) after the price-hike, only 39 out of 45 switched to imported cigarettes in 2000-2001. Moreover, I compare the whether or not imported-brand users switched to lower- priced domestic cigarettes in 2000-2001 and 2001-2002. Contrary to the results that 32 out of 60 (53%) switchers switching to low price cigarettes chose domestic cigarettes after the price-hike, in 2000-2001, before the tax hike, 25 out of 42 (60%) chose domestic cigarettes. After the price-hike, domestic cigarettes became relatively less cheap, and imported cigarettes become relatively less expensive. These provide some evidence that after a relative price change, the behaviors of switching to higher-priced imported cigarettes and lower- priced domestic cigarettes occur more often and less often, respectively.

Other Scenarios Influence the Brand Choices

Since the new brands/products and advertisements also influence smokers' brand choices, in this section I take into account their influences on brand switching. In 2002, when Taiwan became a member of WTO, there were no new cigarette brands and products entering the market. Therefore, smokers had the same set of brand options to choose from in 2001 and 2002. It rules out the possibility that the new competition in 2002 that brought in new introduced brands/products influenced smokers' brand choices. In addition, although domestic cigarette companies aggressively advertised their products, this study finds that in 2001-2002, there were more domestic-brand users switching to higher priced brands chose the imported brands than in 2000-2001.

Conclusion

This study analyzes the impacts of Taiwan's entry into the WTO and the accompanying series of policy changes on both the supply and demand sides of the tobacco market. It investigates the link between cigarette tax and price by imputing the tax pass-through rates. This study also provides evidence that suggests that the tax pass-through rates depend on the incidence taxation. The general pattern is consistent with previous findings. In addition, this study investigates the non–price competitions, such as competitions in quality and marketing. It confirms that free trade induces an increase in advertisements, and results in the introduction of more new brands and products into the market.

This study also investigates the impacts of tax-induced cigarette prices on cigarette smoking and brand switching. It seeks to distinguish the income from substitution effects due to price increases by providing evidence that smokers not only react to price-hikes, but to relative price changes as well. In addition to the previous

findings that, in general, smokers tend to switch to lower- priced cigarette brands after the price-hike, this study finds that quite a few lower- priced cigarette smokers switched to higher- priced cigarette brands with lower price-increase rates. Moreover, this study takes into account the other scenarios accompanying Taiwan's entrance into the WTO which may influence smokers' brand choices. For example, the increasing competition in the tobacco market reflected in several new introduced brands/products and the increasing expenditures on cigarettes advertisements have been ruled out.

The limitation is that the small sample size and the limited number of switchers in the data set hinder further econometric analysis on brand switching. In addition, because the data does not provide smokers' level of smoking among their top three cigarette brands, this study does not know their relative strength of favor among the three different cigarette brands they consumed. This study focuses on the first cigarette brands smokers provided. However, the descriptive summaries provide some evidence to support the claim that smokers not only react to price-hikes, but to relative price changes as well. It calls to attention the effect of relative price change that usually has been overlooked in other studies.

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Conclusion

Healthy behaviors directly improve the overall public health of a nation while reducing the cost of health care systems. Public and private agencies have, accordingly, conducted interventions such as increasing taxes, providing health-risk knowledge, implementing restrictions, etc. as attempts to alter citizens' unwanted behaviors and encourage their healthy behaviors.

The first chapter investigates whether people respond to the new health-related knowledge. It examines whether married couples respond to information about modern contraceptive practices in a way that is reflected in fertility decline during the period when Taiwan's family planning programs were implemented. The results indicate that contraceptive knowledge significantly *reduces* fertility, whether fertility is measured as life-time fertility or the probability of giving birth.

The results of the second chapter indicate that people in different socioeconomic subgroups respond differently to health-related knowledge and regulations. It focused on health behaviors of smoking and found a dramatic change in smokers' characteristics during decades of tobacco control efforts – in early decades, smokers tend to be male and non-white, with no significant difference in socioeconomic status between smokers and non-smokers. However, in later decades, the gender gap in cigarette smoking has shrunk to 3 percentage points in 2000s; the black-white difference reverses; smokers tend to be less well-off and less educated than non-smokers.

The third chapter investigates impacts of Taiwan's entry into the WTO and the accompanying series of policy changes on both the supply and demand sides of the tobacco market. This study provides evidence that suggests that the tax pass-through rates depend on the incidence taxation. It confirms that free trade induces an increase in advertisements, and results in the introduction of more new brands and products

into the market. Regarding smokers' reactions to price changes, this study finds some evidence that smokers not only react to price changes, but also react to relative price changes by switching brands.