Correlates of Seasonal Flu Vaccination in Canada: Demographics, Epidemics, and Vaccination Program Design

by

Maryia Zhdanava

Submitted in partial fulfillment of the requirements for the degree of Master of Arts

at

Dalhousie University
Halifax, Nova Scotia
August 2013

Table of Contents

List of Tables

List of Figures

Abstract

This paper examines the correlates of seasonal flu vaccination in Canada between 2000 and 2011. In terms of the socio-economic characteristics of the population that relate to higher take-up, my findings are consistent with the previous literature. Specifically, the most important predictors of vaccination are the risk factors: age and chronic conditions. My results also suggest that both novel respiratory disease outbreaks and provincial immunization program design are important determinants of the seasonal flu vaccine take-up. The absence of a separate vaccine intended to protect from a novel virus during its epidemic could increase the seasonal flu vaccine take-up. In cases when a separate vaccine is offered, the seasonal flu vaccine take-up depends on the timing of vaccines' delivery and the extent of prior influenza immunization coverage for a specific population subgroup in a province.

List of Abbreviations Used

BMI	Body Mass Index
CADTH	Canadian Agency for Drugs and Technologies in Health
CCHS	Canadian Community Health Survey
CDC	Centers for Disease Control and Prevention
COPD	Chronic obstructive pulmonary disease
CPI	Consumer Price Index
HC	Health Canada
NACI	National Advisory Committee on Immunization
OLS	Ordinary Least Squares
PHAC	Public Health Agency of Canada
SARS	Severe Acute Respiratory Syndrome
UIIC	Universal Influenza Immunization Campaign
WHO	World Health Organization

Acknowledgements

I would like to express my gratitude to my supervisor, Dr. Shelley Phipps, and my readers, Dr. Courtney Ward and Dr. Casey Warman for their patience, guidance and encouragement in the process of writing this thesis, and for being a great source of inspiration throughout my time at Dalhousie University. For reminding me that in the midst of choosing the best model one should never forget about getting the standard errors right, a special thank you goes out to Dr. Courtney Ward and Dr. Casey Warman. I am very thankful to Heather Hobson from the Atlantic Research Data Centre for her support, understanding and collaboration. I would like to acknowledge Dr. Carolyn Stanford from the PEI Department of Health and Wellness, Elaine Sartison from Alberta Health, and Kellie Navitka from Manitoba Health for the generously provided information on provincial influenza immunization programs. Finally, thank you to my parents Elena and Valery, and to my grandfather, Lev; none of this would have been possible without you.

Chapter 1

Introduction

Influenza poses a substantial threat to public health. In Canada, 1 in 10 000 deaths are attributed to influenza annually. Among seniors aged 65 and over this rate is eight times higher. In severe epidemic seasons, influenza is the sixth major cause of death after cancer, heart disease, stroke, chronic obstructive pulmonary disease (COPD) and pneumonia (Schanzer et. al 2007). Although influenza associated deaths are uncommon among children, research links early infection to negative long-term effects: impaired health outcomes, including increased rates of physical disability, reduced educational attainment, lower income and lower socio-economic status (Almond and Mazumder 2005; Almond 2006).

Influenza is associated with a substantial economic burden. The disease is responsible for an average of 6.5 out of every 10 000 hospitalizations in Canada, with a rate of 27-34 influenza associated admissions per 10 000 for seniors (Schanzer et. al, 2008). In the US, influenza accounts for 31.4 million outpatient visits, 3.1 million hospitalized days and 44 million days of work absenteeism annually. The total economic burden of the disease based on the 2003 population and dollars is evaluated at 87.1 billions with 64 percent of the burden borne by those over 64 years (Molinaria et. al 2007).

An effective way to prevent influenza is to get vaccinated. This paper utilizes 10 years of data to analyze correlates of vaccination in Canada. Firstly, the paper estimates association of the seasonal influenza vaccine take-up with socio-economic characteristics of the Canadian population. In terms of socio-economic characteristics, I primarily consider the so-called risk factors: age and presence of at least one chronic condition that may cause influenza-related complications. Other demographic determinants of vaccination analyzed in this paper include measures of health behaviour, employment, income, education, and family structure. I also examine changes in the seasonal flu vaccination behaviour during the Severe Acute Respiratory Syndrome (SARS) outbreak and the H1N1 2009 pandemic which posed a significant threat to public health in the first decade of the century. The final component of this paper is to correlate the seasonal flu vaccine take-up with influenza immunization programs implemented in Canadian jurisdictions.

The results are useful in several ways. Although vaccination coverage rates have been growing in some provinces, nationally, even for the elderly, they are below the target[1]. Socio-economic determinants of individual decisions to vaccinate could inform public health policy makers about instruments appropriate to improve the vaccine take-up. Additionally, recent empirical evidence (Ward, forthcoming) suggests that understanding the demographic composition of the take-up is crucial to the assessment of overall and external gains yielded by vaccination programs.

My findings shed light as well on vaccination behaviour during the H1N1 2009 influenza pandemic. Since pandemic flu seasons occur several times a century, presented insights could benefit the formulation of optimal policy responses to these significant public health events. I also attempt to identify which of the vaccination programs employed by provinces during the pandemic were successful in achieving their goals. To my best knowledge, this has not yet been discussed in the economic literature.

The remainder of the paper proceeds as follows. Chapter 2 provides background information on the influenza virus, vaccines, immunization policies in Canada, and vaccination program designs during the H1N1 pandemic season. Chapter 3 describes data and summarizes trends in influenza vaccination over the past decade. Chapter 4 presents the empirical strategy for multivariate analysis. Chapter 5 reports and discusses the results. Chapter 6 concludes.

[1] 2005 National Consensus Conference on Influenza set target vaccination rate coverage of 80% for adults aged 65 and over (Kwong et. al. 2007). In the USA, this target is set at 90% (CDC 2010).

Chapter 2

Background

2.1 Influenza Virus and Vaccine

Influenza virus mutates frequently, and immunity resulting from either infection with or vaccination against one subtype does not fully protect from its future genetic variations. In order to obtain maximum protection from the virus, seasonal flu vaccination needs to be repeated annually. Influenza vaccine stimulates production of antibodies that provide a defense from targeted virus strains. Ability of the immune system to respond to vaccination is age-related. The vaccine is the least effective in preventing illness among adults aged 65 and older, and the most effective among healthy younger adults (CDC 2010).

The World Health Organization (WHO) constantly monitors information on circulating influenza viruses. Each spring it releases recommendations for a new vaccine recipe which contains two subtypes of influenza A virus (H3N2 and H1N1) and one subtype of influenza B virus. Quality of vaccine varies from season to season depending on how well strains in the recipe match circulating influenza strains.

In Canada, Health Canada licenses the vaccine and the Government of Canada purchases the vaccine on behalf of the provinces and territories. The distribution begins in October (this month is a conventional start of each new influenza season) through public health clinics, doctor's offices and sometimes through local pharmacies. The majority of yearly vaccination takes place before December (Ward, forthcoming; Health Canada 2007; WHO 2005).

2.2 Influenza Immunization Policies in Canada

Publicly funded influenza immunization programs in Canada go back to the 1990s. In 1993, the National Consensus Conference on Influenza in Canada recommended that individuals at high risk of influenza complications, including seniors and people with specific chronic conditions, should receive a flu vaccine annually[2]. By 2000, all provinces with the exception of New Brunswick and Prince Edward Island provided publicly funded flu shots to people 65 years and older, and only Prince Edward Island did not offer free vaccination to people with medical conditions. In the fall of 2000, Ontario, however, was the only province to make flu shots available to all residents at no charge through a Universal Influenza Immunization Campaign (UIIC) (Johansen et. al 2004). For the most part of the next decade the other provinces continued with targeted vaccination programs. In 2004 and 2007 respectively, the National Advisory Committee on Immunization (NACI) added healthy children aged six to 23 months and healthy pregnant women to the list of people with a high risk of influenza complications. Following these recommendations, most provinces expanded the focus of their publicly funded vaccination programs to include one or both of these groups.

Major changes in influenza immunization policies were triggered by the H1N1 pandemic in 2009. Four provinces - Nova Scotia, Manitoba, Saskatchewan and Alberta - adopted universal vaccination programs. Alberta already offered seasonal flu vaccine free of charge to all residents in the fall of 2009, while the other three provinces extended the coverage in the fall of 2010 (Elaine Sartison, Alberta Health, pers. comm.; Kellie Navitka, Manitoba Health, pers. comm.; Saskatchewan Ministry of Health 2012; Nova Scotia Department of Health and Wellness 2009). Although Prince Edward Island has been providing influenza vaccine at no charge since 2004, a fee has been collected for administering flu shots. In 2009, the fee was eliminated for pregnant women and young children, and in 2012 the full coverage was extended to seniors (Carolyn Stanford, PEI Department of Health and Wellness, pers. comm.).

2.3 H1N1 2009 Pandemic and Influenza Immunization Program Design

The pandemic H1N1 influenza virus emerged in the spring of 2009. The virus originated from animal influenza and was unrelated to seasonal H1N1 strains

---

[2] These conditions are: chronic cardiac and pulmonary disorders, cancer and other immune compromising conditions, diabetes, renal disease and anemia. In the 2012-2013 influenza season NACI added morbid obesity (BMI>40) on the list of chronic conditions.

generally circulating among humans. Antibodies to seasonal H1N1 strains offered no protection from the pandemic virus, and a large population had no natural immunity to it. Both H1N1 2009 and the seasonal flu viruses circulated in 2009-10, but H1N1 2009 was considered to be predominant that season. People aged 65 and over were more likely to get infected with the seasonal flu. The risk of contracting H1N1 2009 in this age group was lower due to some natural immunity older people had through exposure to similar strains in the more distant past. On the contrary, younger people, including those otherwise healthy, were at a greater risk of infection with the new virus (PHAC 2010).

Since two flu strains circulated in 2009-10, both the seasonal flu and H1N1 2009 vaccines were prepared for distribution. An uncertainty about the timing of the seasonal flu vaccination emerged when in the fall of 2009 a preliminary draft of the then-unpublished Canadian study (Skowronski et al. 2009) suggested that individuals with previous seasonal flu vaccination had twice the risk of getting sick with H1N1 flu (CADTH 2010). These findings were widely cited in the Canadian media.

Provinces responded differently to this information. While Manitoba health officials, for instance, publicly expressed their concerns about undesirable consequences of seasonal flu vaccination during the H1N1 pandemic, New Brunswick public health representatives discredited the study (Manitoba Health and Healthy Living 2009a; Office of the Chief Medical Officer of Health for New Brunswick, 2009). Overall, Prince Edward Island, Ontario and Saskatchewan chose an interrupted delivery of the seasonal flu vaccine during the H1N1 immunization campaign. In these provinces, the seasonal flu vaccine was offered to the elderly in October, and then the program was temporarily disrupted to administer H1N1 vaccine. Manitoba proceeded with a concurrent seasonal influenza vaccination, but provincial health officials recommended seasonal flu shots only to people aged 65 and older (Manitoba Health and Healthy Living, 2009b). Quebec was the only province to postpone all seasonal flu vaccination until January 2010 when the H1N1 program was completed. The remaining provinces permitted concurrent administration of the seasonal flu and H1N1 vaccines. However, there is some evidence that concurrent administration, although permitted, was not established as a practice in Newfoundland and Labrador (CADTH 2010).

Provincial vaccination strategies could have impacted the seasonal flu vaccine take-up during the pandemic. Provinces with separate vaccine administration (except for Quebec) intended to maximize seasonal flu coverage rates among the elderly, since risk of infection with the virus was higher in this age group, and acted cautiously on the front of immunizing younger adults. In these provinces, seasonal flu shots became available to younger adults only after H1N1 vaccination was completed. Given that vaccination is time costly, younger adults might have found it inconvenient to return for the seasonal flu shot several weeks after they got the H1N1 shot. Of course, other factors affected vaccination decisions during the pandemic too. Individual perceptions of relative risks of infection and fears spread by the media, including publicity of results from Skowronski et al. (2009), likely influenced vaccination behaviour along with the seasonal flu immunization program design.

Chapter 3

Data and Descriptive Statistics

This analysis uses master files for the first eight cycles of the Canadian Community Health Survey (CCHS). The CCHS is a cross-sectional survey that collects information on health status and behaviour, medical care utilization, and socio-economic characteristics of the Canadian population. The first three cycles were conducted in 2000-01 (cycle 1.1), 2003 (cycle 2.1) and 2005 (cycle 3.1). Starting with 2007, data collection for the CCHS occurs on an ongoing basis with annual releases. Thus, the remaining five cycles cover 2007, 2008, 2009, 2010 and 2011. The survey includes population aged 12 and older in 10 provinces and three territories, however observations pertaining to the territories are dropped from this study. I pool eight cross-sections of the CCHS using normalized survey weights[3]. The CCHS respondents are interviewed throughout the year, and all master files of the survey contain a variable that identifies the exact date of each interview. Based on the month of an interview and using the definition of a flu season running from October 1st to September 30th of the following year, I regroup the eight CCHS cycles into 13 flu seasons[4]. Out of these, five flu seasons have an insufficient number of representative months and are dropped to avoid noise in the data[5].

Dependent variable is *Current Flu Shot*. In each CCHS cycle, respondents are asked: "Have you ever had a seasonal flu shot?" Those who had are asked: "When was your last seasonal flu shot?" Since annual seasonal flu vaccination starts in October, respondents who had their last seasonal flu shot less then one year ago and are interviewed in the period from October to September of the next year are considered to be actively vaccinated.

---

[3] Weight variables in each of the seven data files are normalized to sum up to one.

[4] The earliest interviews in the pooled dataset are from September 2000, the latest are from December 2011. Interviews from September 2000 belong to the 1999-00 flu season, and interviews from December 2011 - to the 2011-12 flu season.

[5] The 1999-00 flu season includes only one month, September. In this month questions about seasonal flu vaccination were not asked in all provinces. The 2001-02 season includes two months: October and November. The 2003-04, 2005-06 and 2011-12 seasons include months from October to December. Since immunization programs start in October and are usually completed by some time in December, seasons that include only the first few months tend to either overestimate or underestimate the true rate of vaccine uptake.

To better understand the nature of changes in seasonal flu vaccination rates during the pandemic, I analyze trends in reasons for having no current flu shot. In the CCHS, respondents who had their last seasonal flu shot more than one year ago are asked: "What are the reasons that you have not had a seasonal flu shot in the past year?" Respondents are offered a list of 15 (14 in the early CCHS cycles) possible answers that are not mutually exclusive. Each season, the top four answers are "did not think it was necessary", "have not gotten around it", "bad reaction to previous shot" and "fear of shot". Along with these, I consider the answer "doctor did not think it was necessary" to see if changes in the recommendations of health professionals played any role in the seasonal flu vaccine take-up during the pandemic.

Previous studies examined socio-economic determinants of vaccination in the U.S. (Mullahy 1999), and among the elderly in Germany (Maurer 2009) and Europe (Schmitz and Wübcker 2011). Additionally, two Statistics Canada's reports summarized domestic trends in influenza vaccination, including demographic predictors of getting a flu shot, in the period from 1996-97 to 2005 (Jefferson et al. 2004; Kwong et al. 2007). Generally, a set of socio-economic covariates of vaccination in these studies includes measures of health, health behaviours, income, education, employment, and family structure. I follow this convention. I include sex, age, presence of a chronic condition, self-rated health status, smoking status, measures of labour supply, income, education, and indicators for having a partner, presence of children under 5 years in the household and urban residence as covariates of a decision to vaccinate[6]. With age being the most important predictor of vaccination behaviour and a determinant of relative risks of infection with either H1N1 or seasonal flu viruses during the pandemic, the multivariate analysis focuses on two population subgroups: persons 25 to 64 years who are not students and those over 64 years.

[6] Although Body Mass Index (BMI) is an important determinant of vaccination behaviour, BMI based dummies are omitted from the analysis because of the CCHS cycle 1.1 limitations: in this cycle information on BMI was not collected from persons over 64 years. Exclusion of BMI dummies does not affect results of the paper.

Unfortunately, the CCHS does not collect information on the full list of chronic conditions for which influenza vaccination is recommended. In this paper, a dummy for the presence of a chronic condition takes on the value 1 if survey respondents report being diagnosed with any of the following: asthma, chronic bronchitis, emphysema, chronic obstructive pulmonology disease, diabetes, heart disease, effect of a stroke or cancer. Some additional medical conditions that are not asked about in the CCHS are anemia and hemoglobinopathy, renal disease, immunodeficiency. Clearly, the group identified here represents only a part of the high-risk population traditionally targeted with immunization programs.

Definitions of some of the remaining covariates are obvious, for others additional explanation is appropriate. The self-rated health measure is based on the CCHS question: "In general, would you say your health is excellent, very good, good, fair or poor?" A dummy indicating presence of poor health takes on the value 1 if a respondent characterizes their health as "fair" or "poor", and 0 otherwise. Three dummies describing smoking behaviour are *Never Smoked, Former Smoker* and *Smoker.* Two binary indicators of labour supply are used in the analysis: *Works Part-Time* and *Not in the Labour Force.* I aggregate educational attainments in four categories: *Less then High School*, *High School Graduation*, *Some Postsecondary* and *Postsecondary Graduation*. To construct an informative measure of income I convert the CCHS data on total annual household income from all sources in constant dollars using Statistics Canada consumer price index (CPI) series. Then, to account for needs of families of different size, I rescale the inflation adjusted household income according to the square root method[7]. For the purposes of regression analysis a log of adjusted equivalent income is used. A dummy indicating presence of a partner takes on the value 1 if a respondent is married or in a common law relationship, and 0 otherwise.

Table 1 summarizes vaccination rates by age group and province across eight flu seasons. At the national level, vaccination rate peaked in 2004-05, decreased slightly right after and remained essentially unchanged until 2009-10. During the

[7] To obtain a measure of individual income, inflation adjusted household income is divided by the square root of household size.

H1N1 2009 season, the take-up rate dropped sharply to reach the lowest level in the entire decade. Then, it partly rebounded in the first post-pandemic flu season. This pattern is consistent across all age groups except the youngest, among whom seasonal flu vaccination rates did not decrease during the H1N1 pandemic.

Provincial trends in vaccination rates prior to the pandemic are similar to the national. There is a pronounced increase in the take-up rate in 2004-05 followed by several seasons of stability. However, there is significant variation across provinces in the seasonal flu vaccination rate during the circulation of the H1N1 2009 virus. Specifically, immunization rates plummeted by 9 and 7 percentage points in Quebec and Ontario respectively, which defined the national trend. In New Brunswick and Manitoba the take-up rates went up by about 3 percentage points, and in Nova Scotia – by 5 percentage points. Vaccination rates stayed mostly unchanged in the remaining five provinces.

Some explanations for the countrywide increase in the seasonal flu vaccination rates in 2004-05 are suggested in Kwong et al. (2007). The authors hypothesize that avian influenza outbreaks in the early 2000s, anticipation and growing concerns about approaching influenza pandemic and the spring 2003 epidemic of SARS coronavirus may have influenced vaccination decisions between 2003 and 2005.

Indeed, with 438 probable and suspect SARS cases, including 44 deaths, Canada was the third hardest hit region by SARS after China and Hong Kong (PAHC, 2003). Although the majority of SARS cases were concentrated in Ontario and all deaths occurred in Toronto, the epidemic could have raised the level of fear of novel infectious respiratory disease countrywide. Moreover, Health Canada stated that vaccination "will help to reduce the number of severe cases of flu coming to emergency departments and may help to reduce the number of false alarms about SARS" (HC 2003). The first Canadian cases of SARS were identified in March 2003, and the crisis should have had a larger effect on vaccination during the 2003-04 flu season. However, this season is missing in my sample. It is plausible though, that the jump in the vaccine take-up observed in the 2004-05 flu season is still related to the outbreak.

Heterogeneous response of provincial vaccination rates to the H1N1 pandemic is likely related to varying influenza immunization strategies in Canadian jurisdictions that season. In Quebec, the postponed seasonal flu immunization campaign is a reasonable explanation of a 9-percentage point drop in the vaccination rate. However, among the four provinces with interrupted delivery of the seasonal flu vaccine, only Ontario demonstrates a large decline in take-up. Accounting for an influenza immunization program design in each province prior to the pandemic could be useful in understanding this difference. Before October 2009, Ontario was the only province with a universal influenza immunization program, recommending and subsidizing seasonal flu shots for all. When in the face of the H1N1 pandemic the province decided to postpone seasonal flu vaccination for healthy younger adults, it possibly affected incentives of getting a flu shot in this population subgroup. Although I do not show a breakdown of provincial vaccination rates by age here, a 7-percentage point decrease in Ontario in 2009-10 is almost entirely due to a drop in the vaccine take-up among people below 65 years. Immunization programs in Prince Edward Island, Newfoundland and Labrador and Saskatchewan, on the contrary, mostly targeted the elderly and other high-risk groups prior to the fall of 2009, which explains why postponed vaccination of younger adults may have resulted in no particular decline in take-up in these provinces.

To further explore the nature of changes in the seasonal flu vaccine take-up during the pandemic season, I turn to the CCHS data on reasons for having no current flu shot. Table 2 reports response rates for each of the four reasons unconditional on vaccination decision. This additional summary evidence seems to support the argument that incentives to vaccinate against seasonal flu were differentially affected across provinces during the pandemic. In Quebec and Ontario, the two provinces with the largest decline in vaccination rates during the H1N1 flu season, the proportion citing “did not think it was necessary” as a reason for not getting a flu shot rose by 8 and 10 percentage points respectively. In Nova Scotia, a province where the vaccination rate increased during the pandemic, the percentage who felt that seasonal influenza immunization was unimportant declined slightly.

The remaining provinces are in between these two extremes, generally with a gain from 3 to 6 percentage points in the proportion deeming seasonal influenza vaccination unnecessary during the H1N1 pandemic (Figure 1). Interestingly, both in provinces with concurrent and interrupted or postponed seasonal influenza vaccine administration, fewer people reported that they had not gotten around to getting the seasonal flu shot. Also, there is no evidence that in any of the provinces doctors altered recommendations regarding seasonal flu vaccination during the H1N1 pandemic. The proportion of people stating that they had no flu shot because doctor did not think it was necessary remained essentially unchanged across all provinces. The percentage reporting not being vaccinated because of fear of shot or previous bad reaction either decreased or remained the same (Figures 2-11).

Finally, I consider socio-economic characteristics that are associated with an increased probability of getting a flu shot. Table 3.1 presents average immunization rates for the period between 2000 and 2011 by demographics for two subgroups: people 25 to 64 years who are not students, and people aged 65 and over. These summary results are consistent with previous research. The up-take is higher for persons with a chronic condition and those in poor health. Former smokers are more likely to get a flu shot than people who never smoked, while current smokers are considerably less likely to do so. Vaccination rates decline with intensity of labour supply and increase with income and education (with the exception of those without postsecondary graduation). Female sex is an important determinant of getting a flu shot among younger adults, but older men and women are equally likely to vaccinate. Interestingly though, having a partner is associated with a higher take-up among the old and the young. In summary statistics, presence of young children in a household is associated with lower vaccine take-up in both age groups. Possibly, descriptive statistics are masking underlying heterogeneity in parental education. As expected, the take-up is lower in rural areas. In terms of heterogeneity by province (Table 3.2), residing in Newfoundland and Labrador is associated with the lowest probability of getting a flu shot, and, surprisingly, in Nova Scotia – with the highest. Without a universal influenza immunization program the province was able to surpass Ontario in terms of vaccination rates. Overall the summary evidence demonstrates that there is much less variability in take-up by demographics among the elderly, which likely reflects similarities in underlying health in this group. Also, the most important determinant of vaccination is age.

Chapter 4

Empirical Strategy

The purpose of subsequent analysis is to confirm descriptive patterns found in the data using multivariate techniques, which allow for control of demographic changes in analyzing differences in vaccination behaviour by program design. Sharp differences in the seasonal influenza vaccine take-up by age group require separate estimation. I consider two subsamples: persons 25 to 64 years who are not students, and persons 65 years and older. Like Mullahay (1999) and Schmitz and Wübcker (2011), I employ the linear probability model as a functional form in regression analysis. Standard errors are clustered at the province level to account for serial correlation of observations within one province over flu seasons.

To start, I estimate the following specification:

$$(4.1) \quad Y_{ipt} = \beta_0 + \beta_1 X_{ipt} + \beta_2 H1N1_t + \beta_3 SARS_t + \beta_4 Prov_p + u_{ipt}$$

Here, Y_{ipt} is a binary outcome indicating if an individual *i* who resides in province *p* in flu season *t* has a current flu shot. X_{ipt} is a set of covariates which includes age, age^2, dummies for the presence of a chronic condition, poor self-rated health, smoking status, part-time work, being out of the labour force, highest educational attainment, female sex, having a partner, presence of children under five years in the household, urban residence, and a log of inflation adjusted equivalent household income. Among the three dummies defining smoking status, *Smoker* is left out as a comparison group. In the set of education dummies, default category is *Less then High School*. $Prov_p$ represents a set of province fixed effects with Ontario left out as a base. $H1N1_t$ is a dummy that takes on the value 1 if a flu season is equal to 2009-10, and 0 otherwise.

Although there is no direct evidence that a countrywide spike in immunization rates during the 2004-05 flu season relates to the SARS outbreak, I attempt to model the tentative effect of this novel disease. A dummy variable $SARS_t$

takes on the value 1 for a 2004-05 flu season, the season after the SARS crisis, and 0 otherwise.

In equation (4.1), the coefficient β_2 captures a change in influenza immunization rate in the pandemic season relative to all other flu seasons, and on average for provinces with concurrent, interrupted and postponed seasonal flu vaccine delivery, and universal and targeted influenza vaccination programs. To identify the separate influences associated with distinct types of influenza immunization strategies, I modify equation (4.1) to account for program design:

$$(4.2) \quad Y_{ipt} = \beta_0 + \beta_1 X_{ipt} + \beta_2 Univ_{pt} + \beta_3 Interup_{pt} + \beta_3 Postp_{pt} + \beta_4 Univ_{pt}*Interup_{pt} + + \beta_5 Seas_t + \beta_6 Prov_p + u_{ipt}$$

Here, $Univ_{pt}$ is a dummy that takes on the value 1 if a province has a universal influenza immunization coverage in a given flu season, and 0 otherwise. Prior to the 2009-10 season, this dummy is equal to 1 whenever a province is equal to Ontario. In the 2009-10 flu season, the dummy takes on the value 1 if a province is either Ontario or Alberta. In the 2010-11 flu season, the dummy takes on the value 1 if a province is Ontario, Alberta, Nova Scotia, Manitoba or Saskatchewan. $Interup_{pt}$ is a dummy that indicates if a province ran an interrupted seasonal flu immunization program in 2009-10. The dummy takes on the value 1 if a province is Newfoundland and Labrador, Prince Edward Island, Ontario, or Saskatchewan. $Postp_{pt}$ is a dummy that takes on the value 1 if a province is Quebec and a season is the H1N1 pandemic season. During the pandemic, Quebec was the only province that postponed all seasonal flu vaccination till January 2010. The "effect" of such program on the take-up could be different from that of an interrupted program, especially for the older age group, and thus needs to be modeled separately. The coefficient β_4 on the interaction term $Univ_{pt}*Interup_{pt}$ captures the difference in vaccination for a universal influenza immunization program with an interrupted delivery of the seasonal flu vaccine during the pandemic. $Seas_t$ is a full set of flu season fixed effects with 2000-01 as a base category.

Chapter 5

Results

5.1 Baseline results

Table 4 reports OLS linear probability estimates of Equation (4.1). Overall, the multivariate analysis confirms the descriptive patterns found in the data. The discussion that follows next centers on socio-economic determinants of immunization and associations of SARS and H1N1 2009 outbreaks with the seasonal flu vaccine take-up.

Analysis of socio-economic covariates of vaccination reveals few surprises. The age pattern of the probability to immunize is consistent with findings of Mullahy (1999). For younger adults, the uptake decreases with age at a decreasing rate (is convex). For the elderly, it increases with age at a decreasing rate (is concave). Overall, higher uptake among the elderly is consistent with traditional recommendations for immunization of people with increased risk of influenza related complications.

In terms of other risk factors, presence of a chronic condition is the single most important predictor of vaccination both among the younger adults and the elderly. Holding everything else constant, at least one chronic condition increases the probability of getting a flu shot by 13 percentage points for persons 25 to 64 years, and by 15 percentage points for those over 64 years. Even after controlling for chronic conditions, poor self-rated health status raises the likelihood of vaccination by another 4 percentage points (non-elderly) or 7 percentage points (elderly). All estimates are statistically significant. The same patters of "effects" of chronic conditions and self-rated health status are observed in Mullahay (1999) and Schmitz and Wübcker (2011).

Smoking status is a measure of health behaviour in my specification. Estimated coefficients on smoking status dummies suggest there is a statistically important and sizable relationship between smoking and vaccination behaviour. Compared to smokers, younger adults who never smoked are *cet. par*. 5 percentage points more likely to get a flu shot, and those who gave up smoking are 4 percentage points more likely to do so. For the elderly, being a former smoker is associated already with an 8-percentage points higher propensity to vaccinate, all else being equal. The relationship between vaccination and smoking decisions possibly reflects individual time preference or risk aversion. These unobserved factors are likely further amplified by arrival of medical conditions in the case of former smokers. Once again, the results are similar to what has been already established in the literature. Specifically, both Jefferson et al. (2004) and Kwong et al. (2007) find that being a current smoker is associated with decreased odds of vaccination in the sample of Canadians aged 12 and older. Schmitz and Wübcker (2011) report that smoking decreases propensity to vaccinate among Europeans aged 65 and older (although, not among those younger than 65 years).

Mullahy (1999) estimates that the relationship between labour supply and vaccination is negative, and in most cases not statistically significant. My results are somewhat different, or perhaps more detailed. Younger adults who are not in the labour force are 4 percentage points less likely to vaccinate; this estimate is statistically significant at 5 percent. Those who work part time are more likely to get a flu shot, but the difference is statistically and economically close to zero. The estimated "effects" of part-time work is statistically significant and large in magnitude for the elderly, increasing a likelihood of getting a flu shot by 9 percentage points. Since labour market participation among the elderly is limited, I focus on younger adults.

More information about the association of labour supply with vaccination decisions of younger adults could be obtained by looking at men and women separately. The estimates are not reported here, but in the subsample of younger women time spent working "increases" propensity to vaccinate. On the contrary, younger men who are not in the labour force or work part-time are more likely to vaccinate. One possible explanation is that different unobserved factors are driving labour market and vaccination behaviour of men and women. For working-age men, lower intensity of labour supply and higher propensity to obtain immunization are likely related to poor health. Risk aversion seems to be a plausible explanation for the behaviour of younger women.

Estimated "effects" of income and education (with the exception of incomplete postsecondary and, for those aged 65 and older, high school graduation) on immunization propensities are positive, statistically significant, and considerable in magnitude in both subsamples. In terms of education, a completed postsecondary degree "increases" propensities to vaccinate *cet. par.* by 6 percentage points for younger adults and by 8 percentage points for the elderly if compared to high school dropouts. The literature suggests that such correlations of preventive care consumption with income and education should be expected (Grossman 1972; Manning 1987).

All else equal, women are more likely to vaccinate than men, but female sex is a weaker predictor of vaccination behaviour among the elderly. Likely, this is a result of older men being in a worse state of health than older women. Having a partner is associated with a statistically significant increase in propensities to vaccinate in both subsamples, but in this case the "effect" is substantial in magnitude (a 5-percentage points increase) only for the elderly. Again, this finding is very similar to that of Mullahy (1999). In the European sample of the elderly of Schmitz and Wübcker (2011) having a partner is a statistically significant determinant of vaccination only among those aged 65 and older. Among younger adults, presence of children under 5 years in the household relates to a statistically significant and positive 4 percentage point change in the probability of getting a flu shot, once parental education is controlled for. Among the elderly, the estimate is a statistically significant increase of 20 percentage points. Canadian families rarely have three generations under one roof, and people aged 65 and older could be residing with their children and grandchildren because of bad health, which also raises their propensity to vaccinate. Interestingly, number of children in the household has a significantly negative association with the propensity to vaccinate of Europeans aged 65 and older (Schmitz and Wübcker 2011).

Holding demographics constant, tentative effects of SARS and H1N1 outbreaks on immunization rates preserve their direction. In the subsample of younger adults, SARS is potentially responsible for a statistically significant 5-percentage point rise in the take-up among those 25 to 64 years in the 2004-05 flu season, but the estimate is smaller and not statistically different from zero in the subsample of the elderly. On the contrary, the coefficient on the H1N1 season is statistically significant only in the subsample of the elderly. The novel flu virus is associated with a 10-percentage point decrease in the propensities to vaccinate among those aged 65 and over. This finding is somewhat unexpected, given that many provinces attempted to focus seasonal flu immunization campaigns largely on the elderly during the pandemic. Equation (4.1) estimates the average associative effect of the pandemic for provinces with all types of vaccination strategies. Separating the "effect" of distinct immunization programs might reveal more information about the differences in take-up by age group.

5.2 Vaccination Propensities and Program Design

Coefficients from Equation (4.2) are presented in Table 5 for younger adults and in Table 6 for the elderly. The model tests for an association between influenza immunization program designs and the seasonal flu vaccine take-up during the H1N1 pandemic.

Column (1) of each table reports estimates from the most basic specification of Equation (4.2), where only a dummy for a universal influenza immunization program is included. As expected, a universal program is a strong predictor of vaccination for those aged 25 to 64. The coefficient on the dummy is statistically significant and, all else being equal, relates to an 8-percentage point increase in the propensity of getting a flu shot. In this age group, it is the second most important determinant of vaccination after the presence of a chronic condition. In the subsample of the elderly, the coefficient on the dummy is neither economically nor statistically meaningful, which is consistent with the fact that this age group remains unaffected when a universal program is introduced. The coefficient on the H1N1 2009 flu season is still inversely related to the vaccine take-up. Since a full set of season fixed effects are included in this specification, the coefficient informs about a change in the take-up relative to the 2000-01 season. In the subsample of younger adults, a 4-percentage points decrease associated with the pandemic is not statistically significant. Thus, the vaccine take-up during the H1N1 season among adults aged 25 to 64 is the same as in the 2000-01 season. For the elderly, the pandemic relates to a statistically significant 11-percentage point reduction in the propensity to vaccinate.

Column (2) of Table 5 reports coefficients for the subsample of younger adults in a specification where dummies for the postponed and an interrupted delivery of the seasonal flu vaccine are added. These program designs are statistically significant and substantively meaningful determinants of immunization in this age group, too. The coefficients on both dummies enter negatively. An interrupted delivery of the seasonal flu vaccine is associated with a 12-percentage points *cet. par.* decrease in the seasonal flu vaccine take-up. The postponed seasonal flu vaccination relates to a 5-percentage points *cet. par.* decrease in the propensity to vaccinate. The inverse relationship is expected: younger adults in provinces with such programs in place were offered H1N1 vaccine first, and needed to return for the seasonal flu shot several weeks later. Since immunization is time-costly, and risks of H1N1 infection were higher for the young anyways, it is plausible that many chose to go without the seasonal flu shot. The coefficient on the dummy for a universal influenza immunization program is still highly statistically significant, but after inclusion of another two policy dummies its magnitude reduces from a positive 8 to 6 percentage points. Once the dummies for interrupted and postponed administration of the seasonal flu immunization are introduced, the coefficient on the pandemic season flips its sign, but remains insignificant. That is, for the base category of provinces with a concurrent delivery of the two vaccines, the pandemic is associated with no change in the propensity to vaccinate if compared to the 2000-01 season.

In the subsample of older adults (Column (2) of Table 6), coefficients on the dummies for postponed and interrupted seasonal flu immunization programs are also negative, however only the postponed program has a statistically and economically important association with the take-up. It relates to a 15-percentage point *cet. par*. decrease in the propensity to vaccinate among the elderly. These results accord with expectations. Interrupted programs did not considerably change the timing of access to the vaccine among the elderly. In provinces with interrupted seasonal flu shots delivery, people aged 65 and over had an opportunity to obtain the seasonal flu shot in October 2009, before the beginning of influenza activity. On the contrary, Quebec, which ran the postponed program, permitted vaccination for older adults only in January 2010. Although the vaccine delivered as late in the season as January could still be beneficial, the benefit is likely smaller compared to that of an early vaccination. These differences in the timing of access to the vaccine and, consequently, in costs and benefits of immunization could explain a substantial decrease in the take-up in Quebec and the absence of a statistically significant change in the take-up in provinces with interrupted programs. Once both policy dummies are controlled for, the coefficient on the pandemic season fixed effect reduces in magnitude from 11 to 8 percentage points, but remains negative and statistically significant. Hence, for the base category of provinces that permitted concurrent delivery of the two vaccines, the seasonal flu vaccine take-up during the pandemic among the elderly is 8 percentage points below what it was in the beginning of the decade.

Column (3) of Table 5 presents estimates from the full specification of Equation (4.2) for the younger age group. The coefficient on the interaction term enters with a negative sign and is statistically significant. In a province that runs a universal influenza immunization program, interrupted seasonal flu vaccination is associated with a 13-percentage points *cet. par.* decrease in the take-up among the young. Another interpretation of the coefficient on the interaction term is that it captures the effect of the pandemic season for Ontario, the only province with a universal influenza immunization program and an interrupted delivery of the seasonal flu vaccine. The base "effect" of a universal influenza immunization program is still positive and statistically significant: for all provinces and flu seasons on average, such a program relates to a 6-percentage points *cet. par.* increase in the vaccination propensity among the young. Once the interaction term is added, the coefficient on the dummy for an interrupted vaccine administration is no longer statistically significant. Hence, statistically, an interrupted program relates to a lower take-up among younger adults only in the case of Ontario, which previously offered a universal influenza immunization program. This result is logical. A universal influenza immunization program creates additional incentives to vaccinate and raises vaccination rates among younger adults (in the case where older adults are already covered). When a province with such a program in place limits access to the vaccine for the young, reduction in the propensity to obtain flu shots in this age group should be greater compared to that in a province with a targeted vaccination program. As for the "effect" of the remaining program designs on the take-up, the coefficients on dummies for the postponed seasonal flu vaccination and the 2009-10 season fixed effect remain essentially unchanged in the final specification. The model suggests that the postponed seasonal flu vaccination relates to a 5-percentage point lower take-up, and a program with a joint delivery of the two vaccines during the pandemic is associated with no change in the propensity to vaccinate.

Coefficients from the full specification of Equation (4.2) for the elderly are presented in Column (3), Table 6. Unlike what is observed in the subsample of younger adults, for the old, the "effect" of an interrupted seasonal flu shots delivery on the take-up does not depend on the extent of influenza immunization coverage in a province. The coefficient on the interaction term is not statistically different from zero. This makes sense since, as previously mentioned, both targeted and universal immunization programs provide identical vaccination incentives and coverage for the elderly in Canada. The postponed seasonal flu shots delivery adopted in Quebec continues to be associated with a statistically significant change in the propensity to vaccinate among the elderly during the pandemic. This program relates to a 15-percenatge points decrease in the take-up, all else being equal. In the final specification, the coefficient on the H1N1 2009 flu season is still negative and statistically significant at 8 percentage points. That is, even though the postponed program is the only one that considerably limited access of the elderly to the seasonal flu vaccine during the pandemic, the take-up among those aged 65 and older fell by at least 8 percentage points in every province regardless of the vaccination program design. One possible explanation of such a change in the vaccination behaviour of the elderly during the H1N1 2009 season is the media hype around the study of Skowronski et al. (2009). It could be the case that older people followed the news about influenza vaccination more closely and became more exposed to the information about the findings of the study, or that they were more inclined to believe these findings. Despite the fact that the elderly were considered to have a higher risk of contracting the seasonal flu virus, they could have opted out of the seasonal flu vaccination because of the fear they would get infected with the novel disease.

What are the implications of changes in the take-up for the seasonal flu infection rates during the pandemic? The associated effects estimated here suggest that none for the programs employed during the pandemic might have provided intended protection of the elderly from the seasonal flu virus. Holding the quality of the vaccine constant, infection rates among the elderly could have gone up in every province solely due to an 8-percentage point decrease in the coverage rates in this age group. Although an interrupted administration of the seasonal flu vaccine during the pandemic does not additionally suppress immunization propensity of the elderly, it relates to a lower take-up among younger adults in Ontario - the only province with a universal influenza immunization program prior to the pandemic. Hence, in this province, there could exist negative spill over effects from the young to those aged 65 and older. Ward (forthcoming) provides direct evidence of positive external benefits to older adults arising from increased vaccine take-up among the young, even when coverage rates among the old are already high. Her interpretation of this effect accords with medical literature (CDC 2010). Specifically, as younger adults have a stronger immune response to influenza vaccines, vaccination in this age group might deliver higher returns to the elderly compared to their "own" effect of vaccination. Reduction in the size of external benefits that spill over from the young to the old could have also contributed to a rise in the seasonal flu infection rates among the elderly in Ontario. Quebec did not seem to set the protection of the elderly from the seasonal flu as a priority during the pandemic, however it is necessary to point out that infection rates among older adults in this province have likely increased too. In Quebec, higher infection rates could have arose due to both negative spill over effects and a much lower propensity to vaccinate among the old. Of course, this is just a hypothesis, testing of which requires additional research.

5.3 Limitations of the Study

The coefficients on policy design dummies have no causal interpretation. Along with program design and demographics, other things are potentially affecting vaccine take-up, including recent history of flu strains severity in each province and past vaccines' quality. During the H1N1 pandemic, at least two additional factors potentially impacted propensities to immunize against seasonal flu. Wide citation of results from Skowronski et al. (2009) in the Canadian media might have caused people to avoid seasonal flu vaccination out of the fear of infection with H1N1 flu. Additionally, the seasonal flu virus was not a predominant one in 2009-10, so people could have considered the risk of contracting it to be low. Coefficients on program design dummies likely capture the influences of all these factors along with true effects of immunization programs.

Chapter 6

Concluding Remarks

This paper encompasses eight influenza seasons to analyze correlates of seasonal flu vaccination in Canada. With respect to socio-economic determinants of vaccination, the findings are similar to those in the previous literature. The most important predictors of getting a seasonal flu shot are the risk factors: age and presence of at least one chronic condition. Even after controlling for chronic conditions, poor self-rated health still relates to a statistically significant increase in the propensity to obtain a seasonal flu shot. Health behaviour as proxied by smoking status is an important covariate of vaccination too, implying that individuals who care about their health are more likely to vaccinate. This study suggests that different factors could drive the relationship of labour supply with vaccination for younger men and women. For women, vaccination propensity increases with time spent working, which could be explained by risk aversion. For men, the inverse relationship likely reflects the fact that working age men who are not in the labour force or work part-time are in poor health. A hypothesis of higher risk aversion among women is also consistent with the fact that they are more likely to obtain a flu shot than men. Both education and income increase vaccination propensities, which is a well-established association of these factors with preventive care consumption. Having a partner or small children is positively associated with a probability of getting a flu shot. People living in a conjugal relationship could be concerned about transmitting the infection to each other. Also, since women are more likely to vaccinate, they could be encouraging vaccination of their male partners. Higher propensity to vaccinate among those who have young children in the household is also expected given that early life exposure to influenza could result in serious long-term developmental effects. However, this result is likely conditional on parental education. Finally, limited availability of healthcare in rural locations as well as underlying demographic differences of rural population determine higher take-up in urban areas.

The second part of this paper is focused on the association between novel respiratory disease outbreaks and the seasonal flu vaccine take-up, and on the correlation between take-up and influenza immunization program designs. Results suggest that both factors are important determinants of vaccination. The seasonal flu vaccine take-up during an epidemic likely depends on availability of a separate vaccine designed to protect from a novel virus. Absence of a separate vaccine could increase the seasonal flu vaccine take-up. In cases when a separate vaccine is offered, the seasonal flu vaccine take-up depends on the timing of vaccines delivery and the extent of prior influenza immunization coverage for a specific population subgroup. My results suggest that the take-up decreased in provinces which restricted the timing of access to the seasonal flu vaccine for population subgroups that previously enjoyed full influenza immunization coverage. However, spread of the information about potential risks associated with the seasonal flu vaccination in the fall of 2009 could have affected the take-up among the elderly even in provinces which did not restrict the timing of access to the seasonal flu vaccine for this age group. Further research on the implications of the decreased take-up for the seasonal flu infection rate, hospital admissions and work absenteeism would shed light on the size of forgone benefits. Here, based on the insights from the previous literature, it may be the case that targeting the elderly left them more exposed due to a displacement effect among the young. Such a hypothesis is the subject of future work.

References

Almond, Douglas and Bhashkar Mazumder. 2005. *The 1918 Influenza Pandemic and Subsequent Health Outcomes: An Analysis of SIPP Data.* American Economic Review 95(2): 258-262.

Almond, Douglas. 2006*. Is the 1918 Influenza Pandemic Over? Long-Term Effects of the Utero Influenza Exposure in the Post-1940 U.S. Population.* Journal of Political Economy 114(4): 672-712.

Canadian Agency for Drugs and Technologies in Health (CADTH). 2010. *H1N1 and Seasonal Influenza Vaccine Practices across Canadian Jurisdictions.* CADTH Technology Overviews 1(3): 36-38.

Centres for Disease Control and Prevention (CDC). 2010. *Prevention and control of seasonal influenza with vaccines: recommendations of the Advisory Committee on Immunization Practices* (ACIP). MMWR 59(RR-8).

Currie, Janet, and Enrico Moretti (2003). *Mother's Education and the Intergenerational Transmission of Human Capital: Evidence from College Openings.* Quarterly Journal of Economics, 118(4) 1495–1532.

Grossman, Michael. (1972). *On the Concept of Health Capital and the Demand for Health.* The Journal of Political Economy 80(2), 223–255.

Health Canada. 2004. *Severe Acute Respiratory Syndrome (SARS).* It's Your Health. Ottawa: Her Majesty the Queen in Right of Canada, represented by the Minister of Health, 2004. Available at: http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/diseases-maladies/sars-sras-eng.php, accessed June 21, 2013).

Health Canada. 2007. *Access to the Seasonal Flu Vaccine in Canada - How the Flu Shot Makes Its Way from the Laboratory to the Doctor's Office*. Ottawa: Her Majesty the Queen in Right of Canada.

Johansen, Helen, Kathy Nguyen, Luling Mao, et al. 2004. *Influenza Vaccination.* Health Reports (Statistics Canada, Catalogue 82-003) 15(2): 33-43.

Kwong, Jeff C., Laura C. Rosella, and Helen Johnansen. 2007. *Trends in Influenza Vaccination in Canada, 1996/1997 to 2005.* Health Reports (Statistics Canada, Catalogue 82-003) 18(4): 1-11.

Manitoba Health and Healthy Living. 2009a. *Flu Bulletin #1. Manitoba Launches Modified Start to Its Seasonal Flu Campaign.* News Releases. Available at: http://news.gov.mb.ca/news/index.html?archive=2009-9-01&item=6821, accessed June 1, 2013).

Manitoba Health and Healthy Living. 2009b. *Flu Bulletin #2.* News Releases. Available at: http://www.gov.mb.ca/chc/press/top/2009/10/2009-10-21-141700-7026.html, accessed June 1, 2013).

Manning, Willard G., Joseph P. Newhouse, Naihua Duan, Emmett B. Keeler, Arleen Leibowitz, and M. Susan Marquis. 1987. *Health Insurance and the Demand for Medical Care: Evidence from a Randomized Experiment.* American Economic Review 77(3): 251-277.

Maurer, Jürgen. 2009. *Who Has a Clue to Preventing the Flu? Unraveling the supply and Demand Effects on the Take-Up of Influenza Vaccinations*. Journal of Health Economics 28(3): 704-717.

Mullahy, John. 1999. *It'll Only Hurt a Second? Microeconomic Determinants of Who Gets Flu Shots.* Health Economics 8(1): 9-24.

Nova Scotia Department of Health and Wellness (former Health Promotion and Protection). 2009. *Influenza. Nova Scotia's 2009-2010 Influenza Immunization Program Q&A.* Available at: http://www.ehsmfr.ca/H1N1/documents/2009-10_Immunization_program.pdf, accessed June 1, 2013).

Office of the Chief Medical Officer of Health for New Brunswick. 2009. *Province Launches Seasonal Flu Vaccination Campaign.* News Releases. Available at: http://www2.gnb.ca/content/gnb/en/news/news_release.2009.10.1470.html, accessed June 1, 2013).

Public Health Agency of Canada (PHAC). 2003. *Learning from SARS – Renewal of Public Health in Canada.* Ottawa: Her Majesty the Queen in Right of Canada. Available at: http://www.phac-aspc.gc.ca/publicat/sars-sras/pdf/sars-e.pdf, accessed June 1, 2013).

Public Health Agency of Canada (PHAC). 2010. *Lessons Learned Review: Public Health Agency of Canada and Health Canada Response to the 2009 H1N1 Pandemic.* Ottawa: Her Majesty the Queen in Right of Canada. Available at: http://www.phac-aspc.gc.ca/about_apropos/evaluation/reports-rapports/2010-2011/h1n1/pdf/h1n1-eng.pdf, accessed June 1, 2013).

Saskatchewan Ministry of Health. 2012. *History of Immunization in Saskatchewan.* Saskatchewan Immunization Manual. Available at: http://www.health.gov.sk.ca/immunization-manual, accessed June 1, 2013).

Schmitz, Hendrik, and Ansgar Wübker. 2011. *What Determines Influenza Vaccination Take-Up of Elderly Europeans?* Health Economics 20(11): 1281-1297.

Skowronski , Danuta M., Gaston De Serres, Natasha S. Crowcroft, et al. 2009. *Association between the 2008–09 Seasonal Influenza Vaccine and Pandemic H1N1*

Illness during Spring-Summer 2009: Four Observational Studies from Canada. PLOS Medicine 7(4): 1-15.

Ward, Courtney J. Forthcoming. *Influenza Vaccination Campaigns: Is an Ounce of Prevention Worth a Pound of Cure?* American Economic Journal: Applied Economics.

World Health Organization (WHO). 2005. *WHO Position Paper on Influenza Vaccines.* Weekly Epidemiological Record 33 (19 Aug): 279-287.

Appendix A

Tables and Figures

Table 1: Vaccination Trends in Canada, by Age Group and Province

	2000-01	2002-03	2004-05 (SARS)	2006-07	2007-08	2008-09	2009-10 (H1N1)	2010-11
All population	0.290	0.275	0.339	0.318	0.313	0.316	0.270	0.294
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
By age group								
Age 65 +	0.656	0.665	0.712	0.694	0.671	0.661	0.609	0.629
	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Aged 25 to 64	0.247	0.231	0.301	0.270	0.272	0.276	0.221	0.243
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
Age 18 to 24	0.150	0.122	0.166	0.152	0.152	0.164	0.137	0.148
	(0.005)	(0.003)	(0.004)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)
Age 12 to 17	0.202	0.179	0.242	0.248	0.238	0.219	0.222	0.247
	(0.005)	(0.004)	(0.005)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)
All population by province								
Newfoundland and Labrador	0.131	0.155	0.219	0.225	0.250	0.260	0.244	0.256
	(0.006)	(0.007)	(0.008)	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)
Prince Edward Island	0.202	0.225	0.309	0.324	0.300	0.277	0.275	0.315
	(0.007)	(0.011)	(0.011)	(0.015)	(0.014)	(0.015)	(0.014)	(0.016)
Nova Scotia	0.234	0.318	0.391	0.401	0.406	0.389	0.444	0.494
	(0.011)	(0.008)	(0.008)	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)
New Brunswick	0.179	0.228	0.277	0.284	0.305	0.291	0.325	0.378
	(0.006)	(0.007)	(0.007)	(0.010)	(0.009)	(0.009)	(0.010)	(0.010)
Quebec	0.175	0.202	0.250	0.251	0.268	0.265	0.182	0.218
	(0.005)	(0.003)	(0.003)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
Ontario	0.339	0.348	0.428	0.374	0.361	0.357	0.285	0.317
	(0.003)	(0.002)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Manitoba	0.229	0.198	0.284	0.275	0.264	0.282	0.315	0.268
	(0.009)	(0.005)	(0.006)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)
Saskatchewan	0.214	0.239	0.286	0.268	0.290	0.293	0.279	0.316
	(0.006)	(0.006)	(0.006)	(0.008)	(0.007)	(0.008)	(0.007)	(0.008)
Alberta	0.224	0.231	0.275	0.279	0.265	0.297	0.296	0.306
	(0.007)	(0.007)	(0.012)	(0.005)	(0.007)	(0.006)	(0.006)	(0.006)
British Columbia	0.264	0.270	0.329	0.322	0.295	0.313	0.306	0.295
	(0.007)	(0.004)	(0.004)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)

Notes: Statistics are calculated using master files for the CCHS cycles 1.1, 2.1, 3.1, 2007, 2008, 2009, 2010, and 2011. Results are weighted using normalized survey weights. Standard errors are in parenthesis. The table reports estimates for each age group and province by flu season.

Table 2: Reasons for Having No Flu Shot, All Population by Province, Rates Unconditional on Vaccination Status (Table continues on the next page)

	2002-03	2004-05 (SARS)	2006-07	2007-08	2008-09	2009-10 (H1N1)	2010-11
Newfoundland and Labrador							
Haven't gotten around it	0.102	0.098	0.099	0.082	0.102	0.091	0.088
Resp. didn't think nec.	0.679	0.579	0.601	0.598	0.566	0.596	0.582
Doctor didn't think nec.	0.032	0.026	0.022	0.018	0.015	0.015	0.017
Fear	0.025	0.031	0.038	0.024	0.038	0.024	0.029
Bad reac. to prev. shot	0.044	0.023	0.025	0.026	0.035	0.023	0.026
Prince Edward Island							
Haven't gotten around it	0.143	0.121	0.120	0.123	0.137	0.096	0.157
Resp. didn't think nec.	0.537	0.477	0.461	0.495	0.495	0.550	0.423
Doctor didn't think nec.	0.028	0.012	0.032	0.017	0.014	0.013	0.010
Fear	0.025	0.023	0.035	0.047	0.027	0.023	0.042
Bad reac. to prev. shot	0.042	0.028	0.025	0.029	0.049	0.028	0.035
Nova Scotia							
Have not gotten around it	0.103	0.111	0.148	0.110	0.128	0.075	0.091
Resp. didn't think nec.	0.441	0.377	0.374	0.392	0.404	0.400	0.335
Doctor didn't think nec.	0.061	0.025	0.030	0.014	0.013	0.015	0.009
Fear	0.039	0.023	0.033	0.033	0.030	0.023	0.037
Bad reac. to prev. shot	0.056	0.030	0.036	0.041	0.044	0.028	0.027
New Brunswick							
Haven't gotten around it	0.103	0.105	0.122	0.130	0.114	0.076	0.086
Resp. didn't think nec.	0.551	0.509	0.508	0.470	0.496	0.529	0.447
Doctor didn't think nec.	0.044	0.018	0.016	0.013	0.017	0.009	0.010
Fear	0.023	0.027	0.033	0.032	0.030	0.029	0.029
Bad reac. to prev. shot	0.059	0.028	0.041	0.047	0.050	0.026	0.037
Quebec							
Haven't gotten around it	0.062	0.062	0.078	0.077	0.078	0.068	0.067
Resp. didn't think nec.	0.626	0.571	0.605	0.589	0.581	0.663	0.645
Doctor didn't think nec.	0.027	0.011	0.013	0.012	0.010	0.011	0.009
Fear	0.029	0.016	0.022	0.020	0.022	0.015	0.020
Bad reac. to prev. shot	0.057	0.021	0.030	0.029	0.030	0.024	0.024
Ontario							
Haven't gotten around it	0.100	0.108	0.130	0.141	0.128	0.100	0.107
Resp. didn't think nec.	0.422	0.345	0.415	0.415	0.423	0.521	0.484
Doctor didn't think nec.	0.029	0.013	0.016	0.018	0.016	0.016	0.014
Fear	0.038	0.027	0.037	0.029	0.036	0.033	0.037
Bad reac. to prev. shot	0.060	0.030	0.038	0.044	0.052	0.046	0.044

Table 2: Continued. Reasons for Having No Flu Shot by Province, Rates Unconditional on Vaccination Status

	2002-03	2004-05 (SARS)	2006-07	2007-08	2008-09	2009-10 (H1N1)	2010-11
Manitoba							
Haven't gotten around it	0.105	0.088	0.106	0.120	0.125	0.083	0.106
Resp. didn't think nec.	0.589	0.493	0.555	0.518	0.498	0.528	0.549
Doctor didn't think nec.	0.040	0.032	0.016	0.020	0.013	0.012	0.014
Fear	0.029	0.018	0.031	0.026	0.033	0.020	0.031
Bad reac. to prev. shot	0.050	0.023	0.023	0.033	0.033	0.031	0.020
Saskatchewan							
Haven't gotten around it	0.085	0.104	0.160	0.146	0.160	0.114	0.133
Resp. didn't think nec.	0.569	0.497	0.497	0.489	0.482	0.531	0.481
Doctor didn't think nec.	0.032	0.010	0.020	0.014	0.011	0.008	0.009
Fear	0.040	0.016	0.025	0.034	0.024	0.029	0.028
Bad reac. to prev. shot	0.043	0.030	0.034	0.031	0.034	0.036	0.039
Alberta							
Haven't gotten around it	0.100	0.112	0.136	0.127	0.153	0.104	0.111
Resp. didn't think nec.	0.563	0.485	0.503	0.513	0.475	0.528	0.502
Doctor didn't think nec.	0.021	0.014	0.016	0.012	0.010	0.010	0.009
Fear	0.036	0.020	0.025	0.028	0.023	0.020	0.024
Bad reac. to prev. shot	0.053	0.026	0.034	0.035	0.043	0.035	0.035
British Columbia							
Haven't gotten around it	0.087	0.087	0.123	0.113	0.127	0.102	0.109
Resp. didn't think nec.	0.540	0.473	0.474	0.499	0.473	0.515	0.497
Doctor didn't think nec.	0.028	0.017	0.021	0.016	0.010	0.014	0.011
Fear	0.032	0.019	0.025	0.023	0.033	0.028	0.039
Bad reac. to prev. shot	0.046	0.025	0.032	0.034	0.035	0.028	0.039

Notes: Statistics are calculated using master files for the CCHS cycles 1.1, 2.1, 3.1, 2007, 2008, 2009, 2010, and 2011. Results are weighted using normalized survey weights. The table reports only the top four out of 14 possible responses, along with the response "doctor did not think it was necessary". Responses are not mutually exclusive. Response rates are unconditional on vaccination decision (the base is all survey respondents). The table reports estimates by flu season. In the cycle 1.1 of the CCHS, the question: "What are the reasons that you have not had a seasonal flu shot in the past year?" was only asked of people aged 65 and older, thus statistics for 2000-01 is not reported. In all the other cycles of the survey the question was asked of everyone.

Table 3.1: Influenza Vaccine Take-Up by Demographics, Average Across All Flu Seasons

	Age 25 to 64	Age 65 +
Chronic condition	0.410	0.733
	(0.002)	(0.002)
No chronic condition	0.247	0.615
	(0.001)	(0.002)
SRH: poor or fair	0.367	0.712
	(0.003)	(0.003)
SRH: excellent, very good, good	0.249	0.649
	(0.001)	(0.002)
Never smoked	0.276	0.661
	(0.002)	(0.002)
Former smoker	0.286	0.692
	(0.001)	(0.002)
Smoker	0.218	0.600
	(0.001)	(0.003)
Works full-time	0.242	0.500
	(0.001)	(0.007)
Works part-time	0.286	0.594
	(0.003)	(0.007)
Not in the labour force	0.321	0.645
	(0.002)	(0.002)
Income < 30K	0.244	0.647
	(0.001)	(0.002)
30K < Income < 50K	0.257	0.708
	(0.002)	(0.003)
Income > 50K	0.285	0.694
	(0.002)	(0.005)
Less then high school	0.254	0.642
	(0.002)	(0.002)
High School graduation	0.243	0.683
	(0.002)	(0.003)
Some postsecondary	0.238	0.664
	(0.003)	(0.006)
Postsecondary graduation	0.270	0.682
	(0.001)	(0.002)
Female	0.295	0.666
	(0.001)	(0.002)
Male	0.227	0.661
	(0.001)	(0.002)
Has a partner	0.269	0.679
	(0.001)	(0.002)
No partner	0.239	0.640
	(0.001)	(0.002)
Lives with children <5 years	0.221	0.622
	(0.003)	(0.002)
No children <5 years in	0.270	0.664
household	(0.001)	(0.001)
Urban residence	0.266	0.675
	(0.001)	(0.002)
Rural residence	0.242	0.618
	(0.002)	(0.003)
Full sample obs.	348,542	139,910

Notes: Statistics are calculated using master files for the CCHS cycles 1.1, 2.1, 3.1, 2007, 2008, 2009, 2010, and 2011. Results are weighted using normalized survey weights. Standard errors are in parenthesis.

Table 3.2: Influenza Vaccine Take-Up by Province, Average Across All Flu Seasons

	Age 25 to 64	Age 65 +
Newfoundland and Labrador	0.164	0.524
	(0.003)	(0.008)
Prince Edward Island	0.221	0.620
	(0.005)	(0.009)
Nova Scotia	0.344	0.749
	(0.004)	(0.006)
New Brunswick	0.220	0.602
	(0.003)	(0.007)
Quebec	0.193	0.579
	(0.002)	(0.003)
Ontario	0.313	0.722
	(0.001)	(0.002)
Manitoba	0.209	0.659
	(0.003)	(0.005)
Saskatchewan	0.217	0.629
	(0.003)	(0.005)
Alberta	0.237	0.651
	(0.003)	(0.005)
British Columbia	0.257	0.665
	(0.002)	(0.004)
Full sample obs.	348,542	139,910

Notes: Statistics are calculated using master files for the CCHS cycles 1.1, 2.1, 3.1, 2007, 2008, 2009, 2010, and 2011. Results are weighted using normalized survey weights. Standard errors are in parenthesis.

Table 4:Baseline Regression Results - Probability of Having a Current Flu Shot

	Age 25 to 64	Age 65 +
Age	-0.0012	0.1440
	(0.0022)	(0.1533)
Age^2	0.0001^{***}	-0.0009
	(0.0000)	(0.0011)
Chronic condition	0.1280^{***}	0.1479^{***}
	(0.0072)	(0.0178)
Poor health	0.0361^{***}	0.0661^{*}
	(0.0071)	(0.0299)
Never smoked	0.0459^{***}	0.0579^{**}
	(0.0038)	(0.0223)
Former smoker	0.0370^{***}	0.0774^{***}
	(0.0065)	(0.0148)
Works part-time	0.0006	0.0892^{***}
	(0.0103)	(0.0061)
Not in the labour force	-0.0435^{**}	0.0335^{*}
	(0.0151)	(0.0180)
Log Income	0.0230^{***}	0.0532^{***}
	(0.0039)	(0.0089)
High School graduate	0.0169^{*}	0.0373
	(0.0085)	(0.0207)
Some postsecondary	0.0080	-0.0143
	(0.0095)	(0.0229)
Postsecondary graduate	0.0574^{***}	0.0764^{***}
	(0.0088)	(0.0083)
Female	0.0741^{***}	0.0259^{*}
	(0.0057)	(0.0134)
Has a partner	0.0115^{***}	0.0505^{*}
	(0.0023)	(0.0240)
Children < 5 years in household	0.0419^{***}	0.1993^{*}
	(0.0098)	(0.0889)
Urban residence	0.0241^{***}	0.0416^{*}
	(0.0048)	(0.0224)
SARS (season 2004-05)	0.0534^{***}	0.0301
	(0.0156)	(0.0221)
H1N1 season (season 2009-10)	-0.0353	-0.0986^{**}
	(0.0308)	(0.0316)
Province fixed effects	Yes	Yes
Constant	-0.2588^{***}	-5.8261
	(0.0652)	(5.2310)
N	165535	7325
Adj. R^2	0.068	0.084

Notes: Dependent variable is Current Flu Shot. The table reports coefficients from a linear probability model. Statistics are calculated using master files for the CCHS cycles 1.1, 2.1, 3.1, 2007, 2008, 2009, 2010, and 2011. Results are weighted using normalized survey weights. Clustered standard errors are in parenthesis. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Probability of Having a Current Flu Shot and Influenza Program Design, Adults Aged 25-64

	(1)	(2)	(3)
Universal influenza program	0.0843***	0.0625**	0.0639**
	(0.0233)	(0.0195)	(0.0198)
Interrupted seas. flu vaccine delivery		-0.1240***	-0.0118
		(0.0190)	(0.0212)
Postponed seas. flu vaccine delivery		-0.0527***	-0.0523***
		(0.0156)	(0.0157)
Universal*Interrupted			-0.1255***
			(0.0136)
H1N1 season (season 2009-10)	-0.0361	0.0345	0.0342
	(0.0448)	(0.0241)	(0.0242)
Age	-0.0015	-0.0014	-0.0014
	(0.0023)	(0.0023)	(0.0023)
Age^2	0.0001***	0.0001***	0.0001***
	(0.0000)	(0.0000)	(0.0000)
Chronic condition	0.1278***	0.1280***	0.1279***
	(0.0067)	(0.0067)	(0.0067)
Poor health	0.0357***	0.0358***	0.0358***
	(0.0070)	(0.0071)	(0.0071)
Never smoked	0.0457***	0.0460***	0.0461***
	(0.0045)	(0.0045)	(0.0045)
Former smoker	0.0379***	0.0381***	0.0382***
	(0.0037)	(0.0037)	(0.0037)
Works part-time	0.0009	0.0007	0.0007
	(0.0103)	(0.0103)	(0.0103)
Not in the labour force	-0.0333*	-0.0328*	-0.0325*
	(0.0155)	(0.0155)	(0.0155)
Log Income	0.0223***	0.0222***	0.0221***
	(0.0034)	(0.0034)	(0.0034)
High School graduate	0.0163*	0.0163*	0.0163*
	(0.0075)	(0.0074)	(0.0074)
Some postsecondary	0.0066	0.0067	0.0066
	(0.0081)	(0.0081)	(0.0080)
Postsecondary graduate	0.0559***	0.0558***	0.0557***
	(0.0065)	(0.0065)	(0.0065)
Female	0.0740***	0.0740***	0.0740***
	(0.0056)	(0.0056)	(0.0056)
Has a partner	0.0120***	0.0120***	0.0121***
	(0.0024)	(0.0025)	(0.0025)
Children < 5 years in household	0.0417***	0.0413***	0.0412***
	(0.0094)	(0.0095)	(0.0095)
Urban residence	0.0239***	0.0239***	0.0238***
	(0.0045)	(0.0045)	(0.0045)
Province fixed effects	Yes	Yes	Yes
Other season fixed effects	Yes	Yes	Yes
Constant	-0.3312***	-0.3069***	-0.3072***
	(0.0596)	(0.0634)	(0.0634)
N	165535	165535	165535
adj. R^2	0.069	0.070	0.070

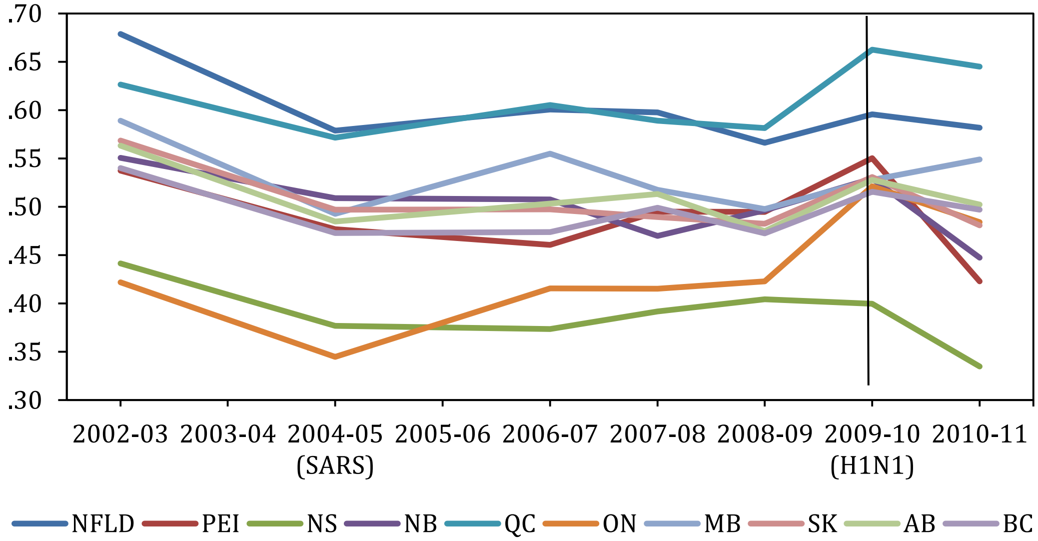
Notes: Dependent variable is Current Flu Shot. The table reports coefficients from a linear probability model. Statistics are calculated using master files for the CCHS cycles 1.1, 2.1, 3.1, 2007, 2008, 2009, 2010, and 2011. Results are weighted using normalized survey weights. Clustered standard errors are in parenthesis. Specification includes a full set of season fixed effects with 2000-01 as a base category. To conserve space, only the coefficient on the H1N1 season is reported. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Probability of Having a Current Flu Shot and Influenza Program Design, Adults Aged 65 +

	(1)	(2)	(3)
Universal influenza program	0.0071	-0.0016	-0.0032
	(0.0547)	(0.0597)	(0.0577)
Interrupted seas. flu vaccine delivery	-	-0.0070	-0.0632
		(0.0255)	(0.0515)
Postponed seas. flu vaccine delivery	-	-0.1540***	-0.1543***
		(0.0272)	(0.0268)
Universal*Interrupted	-	-	0.0618
			(0.0532)
H1N1 season (season 2009-10)	-0.1115***	-0.0795**	-0.0792**
	(0.0336)	(0.0310)	(0.0308)
Age	0.1439	0.1457	0.1445
	(0.1611)	(0.1620)	(0.1621)
Age^2	-0.0009	-0.0009	-0.0009
	(0.0012)	(0.0012)	(0.0012)
Chronic condition	0.1492***	0.1489***	0.1490***
	(0.0188)	(0.0192)	(0.0191)
Poor health	0.0656*	0.0675**	0.0675**
	(0.0298)	(0.0292)	(0.0292)
Never smoked	0.0375*	0.0383*	0.0381*
	(0.0177)	(0.0179)	(0.0179)
Former smoker	0.0589	0.0601	0.0599
	(0.0332)	(0.0339)	(0.0339)
Works part-time	0.0898***	0.0895***	0.0894***
	(0.0057)	(0.0055)	(0.0055)
Not in the labour force	0.0335**	0.0332**	0.0332**
	(0.0118)	(0.0118)	(0.0118)
Log Income	0.0541***	0.0544***	0.0545***
	(0.0087)	(0.0088)	(0.0088)
High School graduate	0.0377	0.0361	0.0363
	(0.0226)	(0.0238)	(0.0239)
Some postsecondary	-0.0140	-0.0185	-0.0183
	(0.0232)	(0.0242)	(0.0242)
Postsecondary graduate	0.0793***	0.0771***	0.0773***
	(0.0110)	(0.0121)	(0.0122)
Female	0.0268*	0.0274*	0.0273*
	(0.0137)	(0.0133)	(0.0132)
Has a partner	0.0508*	0.0494*	0.0493*
	(0.0229)	(0.0222)	(0.0222)
Children < 5 years in household	0.2103**	0.2066**	0.2053**
	(0.0866)	(0.0837)	(0.0841)
Urban residence	0.0409*	0.0397	0.0399
	(0.0221)	(0.0228)	(0.0229)
Province fixed effects	Yes	Yes	Yes
Other season fixed effects	Yes	Yes	Yes
Constant	-5.8142	-5.8672	-5.8241
	(5.5152)	(5.5421)	(5.5430)
N	7325	7325	7325
adj. R^2	0.086	0.087	0.087

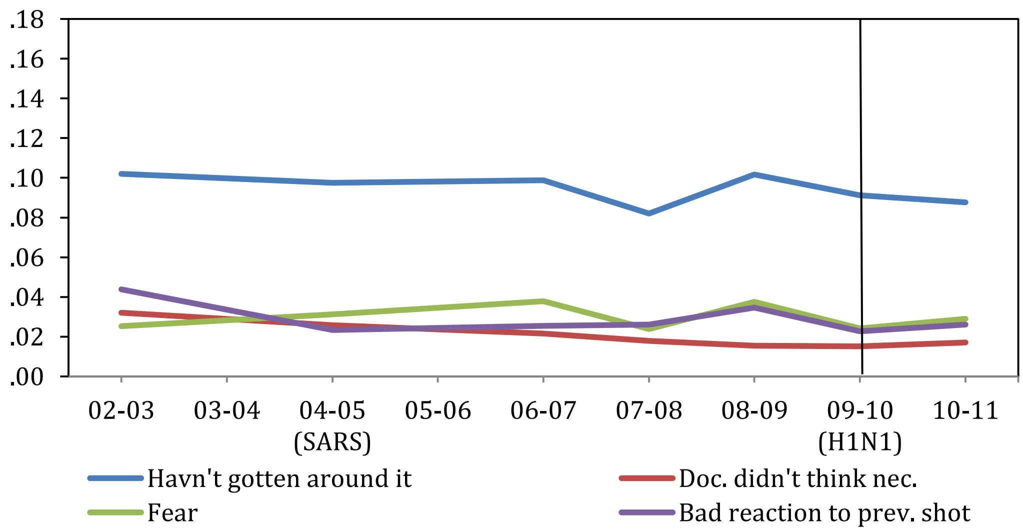
Notes: Dependent variable is Current Flu Shot. The table reports coefficients from a linear probability model. Statistics are calculated using master files for the CCHS cycles 1.1, 2.1, 3.1, 2007, 2008, 2009, 2010, and 2011. Results are weighted using normalized survey weights. Clustered standard errors are in parenthesis. This specification includes a full set of season fixed effects with 2000-01 as a base category. To conserve space, only the coefficient on the H1N1 season is reported. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 1: Proportion of Respondents Considering Flu Vaccination Unnecessary, by Province and Flu Season



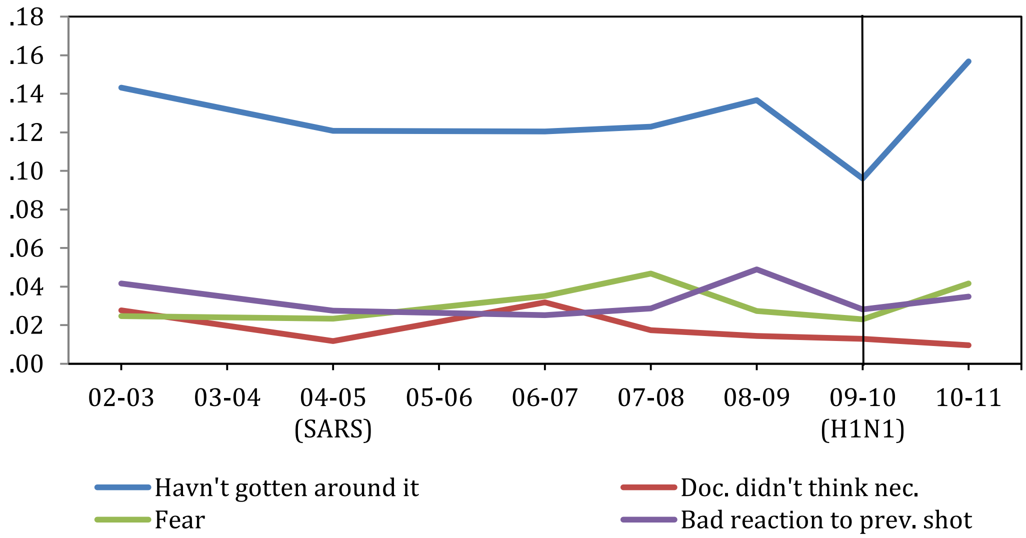
Notes: Y-axis plots the proportion of respondents who cited "didn't think it was necessary" as a reason for having no current flu shot. The base is all survey respondents regardless of vaccination decision. Rates are calculated using the data from master files for the CCHS cycles 1.1, 2.1, 3.1, 2007, 2008, 2009, 2010, and 2011.

Figure 2: Reasons for Having No Flu Shot, Newfoundland and Labrador, by Flu Season



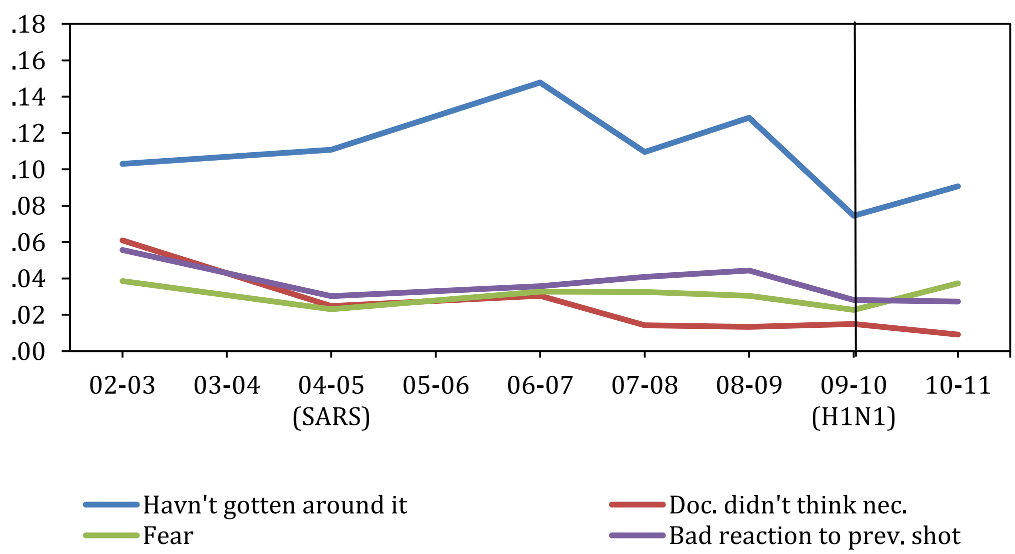
Notes: Y-axis plots the proportion of respondents who cited "haven't gotten around it", "fear", "bad reaction to previous shot" or "doctor didn't think it was necessary" as reasons for having no current flu shot. The base is all survey respondents in Newfoundland and Labrador regardless of vaccination decision. Rates are calculated using the data from master files for the CCHS cycles 1.1, 2.1, 3.1, 2007, 2008, 2009, 2010, and 2011.

Figure 3: Reasons for Having No Flu Shot, Prince Edward Island, by Flu Season



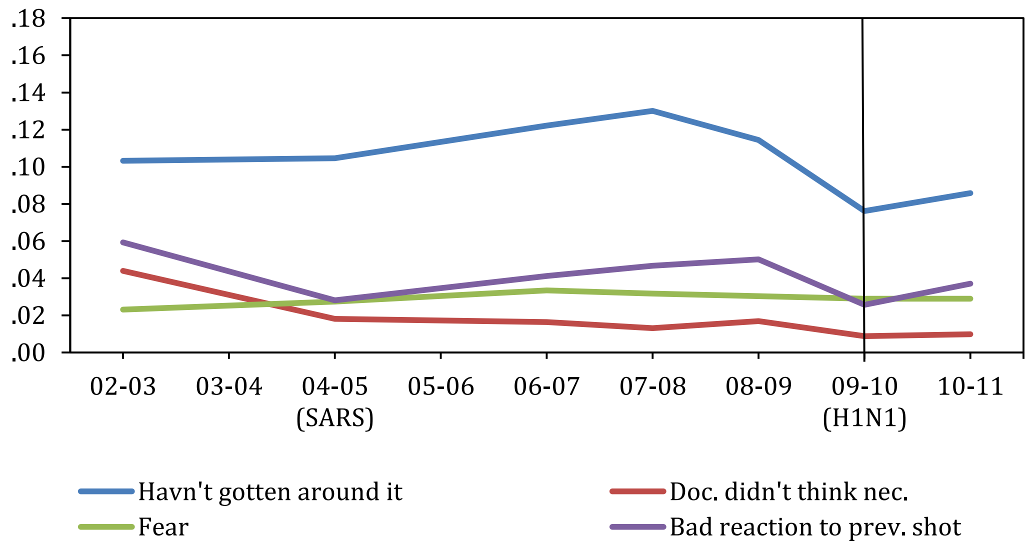
Notes: Y-axis plots the proportion of respondents who cited "haven't gotten around it", "fear", "bad reaction to previous shot" or "doctor didn't think it was necessary" as reasons for having no current flu shot. The base is all survey respondents in Prince Edward Island regardless of vaccination decision. Rates are calculated using the data from master files for the CCHS cycles 1.1, 2.1, 3.1, 2007, 2008, 2009, 2010, and 2011.

Figure 4: Reasons for Having No Flu Shot, Nova Scotia, by Flu Season



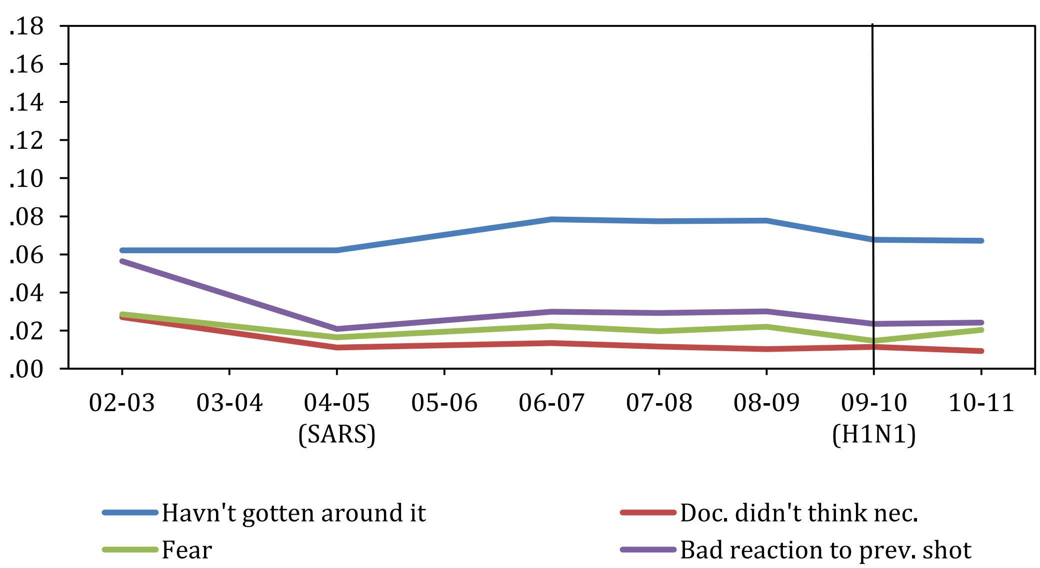
Notes: Y-axis plots the proportion of respondents who cited "haven't gotten around it", "fear", "bad reaction to previous shot" or "doctor didn't think it was necessary" as reasons for having no current flu shot. The base is all survey respondents in Nova Scotia regardless of vaccination decision. Rates are calculated using the data from master files for the CCHS cycles 1.1, 2.1, 3.1, 2007, 2008, 2009, 2010, and 2011.

Figure 5: Reasons for Having No Flu Shot, New Brunswick, by Flu Season



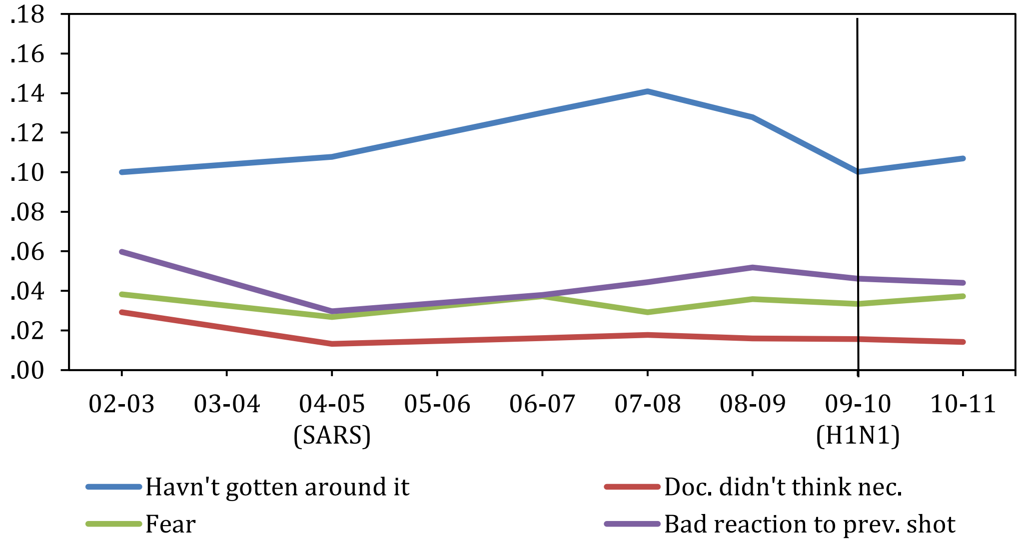
Notes: Y-axis plots the proportion of respondents who cited "haven't gotten around it", "fear", "bad reaction to previous shot" or "doctor didn't think it was necessary" as reasons for having no current flu shot. The base is all survey respondents in New Brunswick regardless of vaccination decision. Rates are calculated using the data from master files for the CCHS cycles 1.1, 2.1, 3.1, 2007, 2008, 2009, 2010, and 2011.

Figure 6: Reasons for Having No Flu Shot, Quebec, by Flu Season



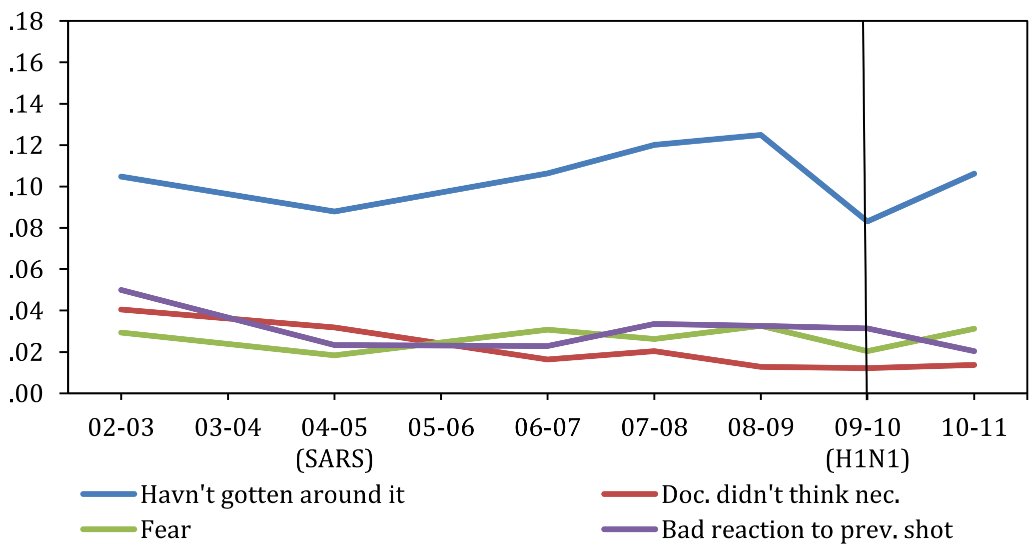
Notes: Y-axis plots the proportion of respondents who cited "haven't gotten around it", "fear", "bad reaction to previous shot" or "doctor didn't think it was necessary" as reasons for having no current flu shot. The base is all survey respondents in Quebec regardless of vaccination decision. Rates are calculated using the data from master files for the CCHS cycles 1.1, 2.1, 3.1, 2007, 2008, 2009, 2010, and 2011.

Figure 7: Reasons for Having No Flu Shot, Ontario, by Flu Season



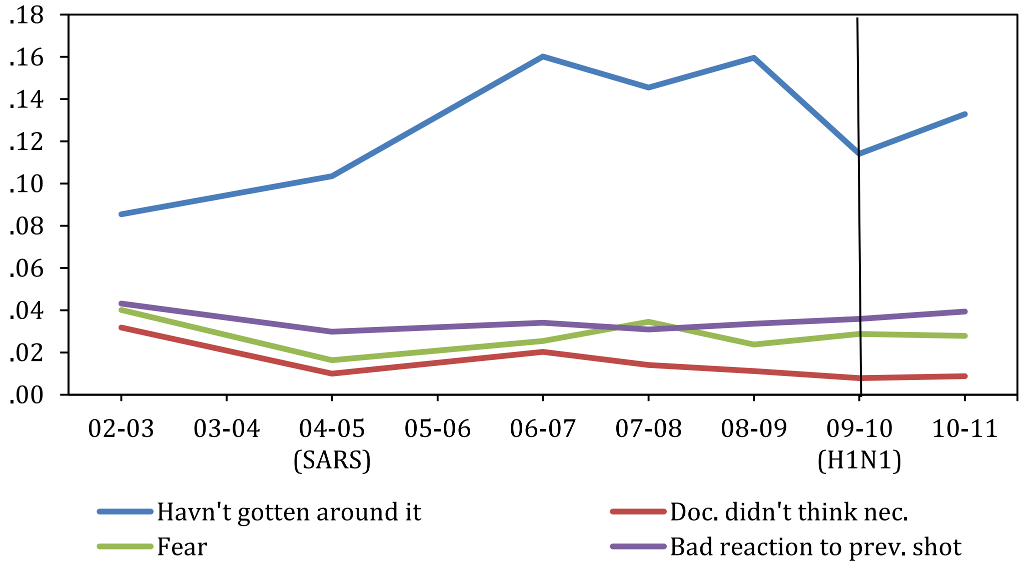
Notes: Y-axis plots the proportion of respondents who cited "haven't gotten around it", "fear", "bad reaction to previous shot" or "doctor didn't think it was necessary" as reasons for having no current flu shot. The base is all survey respondents in Ontario regardless of vaccination decision. Rates are calculated using the data from master files for the CCHS cycles 1.1, 2.1, 3.1, 2007, 2008, 2009, 2010, and 2011.

Figure 8: Reasons for Having No Flu Shot, Manitoba, by Flu Season



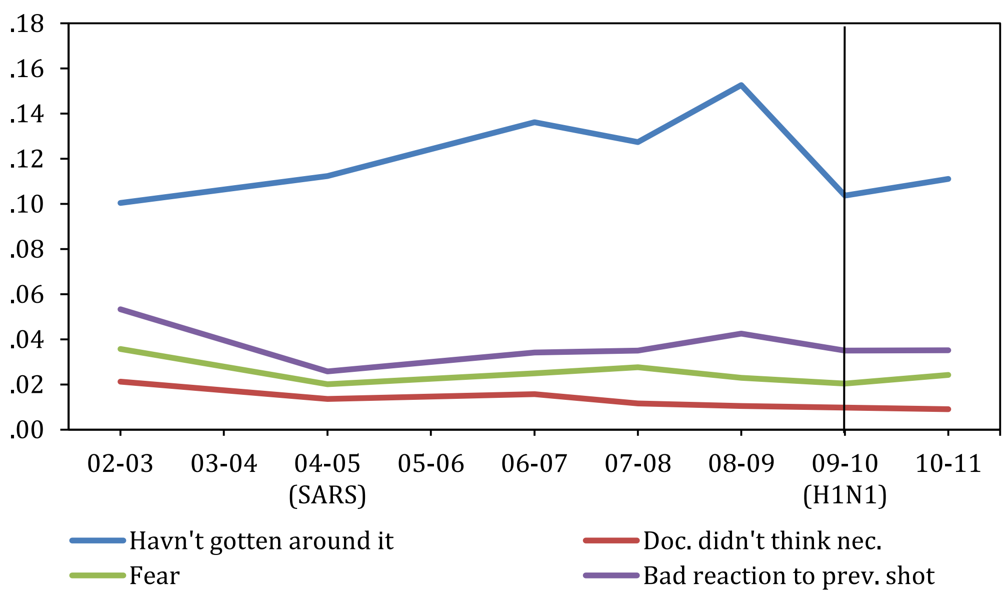
Notes: Y-axis plots the proportion of respondents who cited "haven't gotten around it", "fear", "bad reaction to previous shot" or "doctor didn't think it was necessary" as reasons for having no current flu shot. The base is all survey respondents in Manitoba regardless of vaccination decision. Rates are calculated using the data from master files for the CCHS cycles 1.1, 2.1, 3.1, 2007, 2008, 2009, 2010, and 2011.

Figure 9: Reasons for Having No Flu Shot, Saskatchewan, by Flu Season



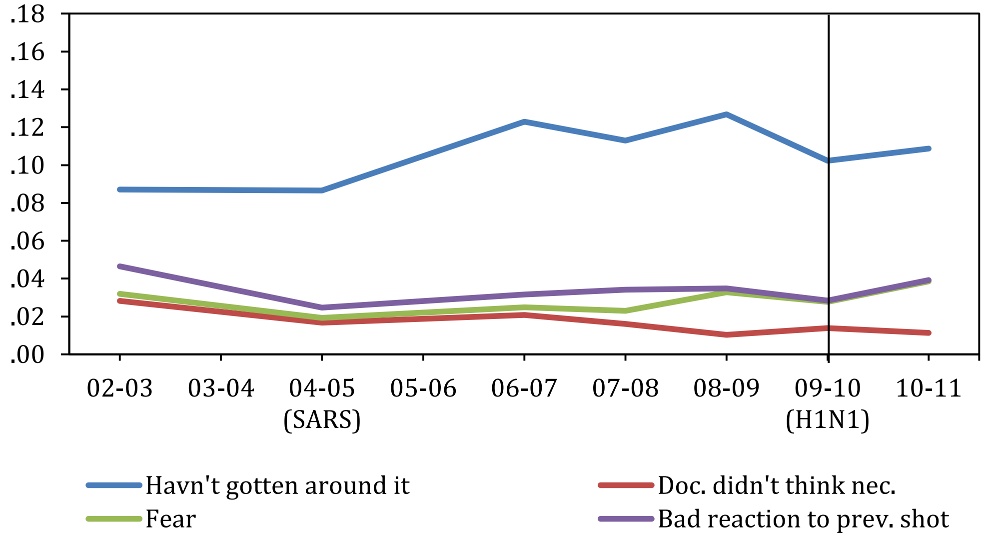
Notes: Y-axis plots the proportion of respondents who cited "haven't gotten around it", "fear", "bad reaction to previous shot" or "doctor didn't think it was necessary" as reasons for having no current flu shot. The base is all survey respondents in Saskatchewan regardless of vaccination decision. Rates are calculated using the data from master files for the CCHS cycles 1.1, 2.1, 3.1, 2007, 2008, 2009, 2010, and 2011.

Figure 10: Reasons for Having No Flu Shot, Alberta, by Flu Season



Notes: Y-axis plots the proportion of respondents who cited "haven't gotten around it", "fear", "bad reaction to previous shot" or "doctor didn't think it was necessary" as reasons for having no current flu shot. The base is all survey respondents in Alberta regardless of vaccination decision. Rates are calculated using the data from master files for the CCHS cycles 1.1, 2.1, 3.1, 2007, 2008, 2009, 2010, and 2011.

Figure 11: Reasons for Having No Flu Shot, British Columbia, by Flu Season



Notes: Y-axis plots the proportion of respondents who cited "haven't gotten around it", "fear", "bad reaction to previous shot" or "doctor didn't think it was necessary" as reasons for having no current flu shot. The base is all survey respondents in British Columbia regardless of vaccination decision. Rates are calculated using the data from master files for the CCHS cycles 1.1, 2.1, 3.1, 2007, 2008, 2009, 2010, and 2011.