Forecasting the Effects of Smoking in Latin American Mortality

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Introduction

In a recent paper (Palloni, Novak and Pinto 2012) we showed that the tug of past smoking behavior weighs heavily on current mortality levels and patterns. The effects are felt mostly at ages above 50, the only age segment within which changes in mortality risks could alter life expectancy more than trivially. The paper made the case for five countries that spanned the range of experiences with the smoking epidemic. For these countries the estimated foregone life expectancy at age 50 was of the order of 4 to 5 years. In this paper we generalize the procedures used before to a set of 15 countries and show that our findings are very general and apply to all countries included.

The goal of this paper is to forecast the potential losses in life expectancy that could be expected in the next fifteen to twenty years as a result of changes in the composition by past smoking behaviors in birth cohorts who will reach age 50 after the year 2005. The countries we include in our analysis are: Argentina, Chile, Colombia, Costa Rica, Cuba, Ecuador, Guatemala, Mexico, Panama, Uruguay, and Venezuela. Argentina, Chile, Colombia, Cuba, Panama, Uruguay, and Venezuela are in an advanced stage of the epidemic while Costa Rica, Ecuador, Guatemala, and Mexico are in earlier stages (Ezzati and Lopez 2004).

Background

It is known that as a response to the increasing vigilance and massive public health campaigns against tobacco consumption that began in the US after the mid-sixties, the tobacco industry initiated an aggressive program to open new markets in Europe, Asia, and Latin America (Bianco et al 2005, Le Monde 2012, Tobacco-Free Kids 2009). A number of socio-demographic factors, sharp price reductions, legislative maneuvers, and a sophisticated publicity machine contributed to a massive market expansion for tobacco (Crosbie et al. 2012, da Costa e Silva and Koifman 1998). As a result, the prevalence of cigarette consumption increased first among forerunners of mortality decline in LAC (Argentina, Uruguay, Cuba, and Chile) and, albeit with lags, in Mexico, Brazil, Colombia, Costa Rica, and Panama. Laggards in the mortality decline in LAC (Peru, Ecuador, Bolivia, Paraguay, and the majority of Central America and the Caribbean) are undergoing the initial stages of the smoking epidemic (Champagne et al. 2010, Menezes et al. 2009).

Cause specific deaths rates and the signature of past smoking

There is considerable empirical evidence suggesting that at the very least two conditions will become more prevalent among those exposed to smoking: lung cancer and chronic obstructive pulmonary disease (COPD) (Glei et al. 2011, Streppel et al. 2007, Menezes et al. 2005, Bosetti et al. 2005). This evidence also implicates smoking as a significant causative factor of other types of cancers (Doll et al. 2005) and cardiovascular diseases (CVD) (Chen and Boreham 2002). Declines observed in CVD is largely attributable to medical and technological innovations as well as to widespread screening which offset the deleterious effects of smoking and the reduction in mortality due to circulatory diseases is due mostly to the attenuation of risk factors that more than compensate for the reinforcement of risks associated with smoking. Mortality rates over age 50 due to smoking-related causes of death (lung cancer, other forms of cancer, COPD, and diseases of the circulatory system) in LAC countries show that smoking has already left a scar in some countries of these countries and will, in all likelihood, influence similarly the mortality experience of countries where trends in smoking prevalence are still in the early phases. The issue is not if the impact of smoking will be felt but rather when and how large it will be.

Data and Methods

In the absence of suitable longitudinal information about smoking behavior, health, and mortality, we resort to indirect methods to estimate the fraction of adult deaths attributable to smoking.

<u>Data</u>

We use a new (adjusted for errors in vital statistics) database for Latin American mortality (LAMBdA) that contains national life tables (two for every decade) from 1850 to 2010 for 18 countries of the LAC region. Data on causes of deaths starting in 1945 were obtained from WHO databases and modified to conform to corrected total mortality.

Because mortality associated with smoking is very low below age 50 we confine our analyses to five-year age groups starting at age 50 and ending in 85+.

Model

The model we estimate, which is a modified version of the model proposed by Preston et al. (2010), is as follows:

$$\ln M_J = \Sigma_i \varphi_{iJ} Z_i + \gamma_J M_L + \Sigma_i \alpha_{iJ} * I_i + \sigma_J * M_{Ill}/M_J + \sigma_L M_{Ill}/M_L + \varepsilon_J$$

where M_L and M_J are, respectively, the observed age-specific mortality rates due to lung cancer and cause J *in the population*; Z_i is a set of dummy variables including age, country, and calendar time, I_i's are first order interaction terms between M_L and age, country, and calendar time, and ε_J is an error term. The parameters φ_{iJ} , γ_J and α_{iJ} are regression coefficients associated with the variables Z_i, M_L, I_i, respectively, and are assumed to vary with cause of death J. Instead of calendar years we use year-1980. Models with a full set of dummies for countries were found to have a fit scarcely better than a more parsimonious version with a single dummy variable to identify countries more advanced in the smoking epidemic. This dummy variable attains a value of one for those countries in an advanced stage of the tobacco epidemic and zero otherwise. There are two extra terms in the equation. These involve the mortality rates due to ill-defined causes (M_{ill}). These terms are necessary to adjust for differential propensities of deaths due to lung cancer and to cause J to be classified as ill-defined. We use empirical estimates of the parameter γ_J and an estimate of the fraction of all deaths due to lung cancer not associated with smoking to derive estimates of the total number of deaths due to cause J attributable to smoking.

We use this method to obtain a time series for the mortality rates attributable to smoking from 1980 up to 2010 and then apply the Lee-Carter (Lee and Carter 1992) method as well as other standard techniques to forecast mortality during the period 2010-2030.

Forecasting: alternative strategies

To evaluate the magnitude of life expectancy losses for each country that should be expected solely as a result of an increase in the proportion of past smokers among those older than 50, we pursue three different strategy.

Strategy 1

The most obvious ways to forecast future life expectancy while taking into account the influence of smoking is to use the yearly fraction of smoking attributable deaths at time t, t-1, t-k …and estimate a standard ARIMA time series model. The forecasts derived from the time series can be combined with conventional projection of overall mortality to compute the magnitude of life expectancy at various ages over 50 that would be experienced if smoking had was eliminated

Strategy 2:

The second procedure is to estimate a Lee-Carter model for lung cancer death rates and then assume stability of the relation estimated between lung cancer mortality and mortality due to other causes. We can then combine the forecasts of lung cancer mortality rates retrieved from the Lee-Carter estimation with the estimated coefficients relating lung cancer and other causes of mortality. This will lead to values of smoking-attributable mortality for years for which we have forecasts of lung cancer mortality rates

Strategy 3:

A modification of strategy 3 is to generate a time series of lung cancer mortality which is predicted by controlling for estimated smoking prevalence among those aged 50+. These values can be obtained for a handful of about six of the fourteen countries in our sample. The advantage of the resulting time series is that we will be in a position to estimate better the connection between lung cancer mortality that is NOT due to smoking

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