Economic Structural Change and Cancer Incidence - An International Examination

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Abstract.

After heart disease, cancer is the most common cause of death in many developed countries. In this paper, we discuss the relationship between economic growth and cancer incidence. The purposes of the paper are to describe and measure the influence of an increasing real per capita income on the overall incidence of cancer. Using cross-sectional data for 162 countries, regression results with crude and age-standardised rates allow us to measure the elasticity of cancer incidence with respect to per capita income, and to decompose the elasticity coefficient into two components: age-effect and lifestyle-effect.

Introduction

In every human society, quality of life is an outcome of many different variables. Some of these variables, however, show a positive and significant correlation with per capita income, usually measured by the ratio of real gross national income (GNI) to population. This is why the real GNI per capita is often used as the first and basic indicator of standard of living.

Health is a fundamental dimension of quality of life. In fact, almost all indices of economic and social well-being contain at least one variable for measuring health conditions. There are some important exceptions, but in the long-run, higher values of real per capita income usually correspond to better hygiene and sanitary conditions. During growth, however, each society undergoes several important changes in both demand and supply of health care. Thereby, the process of economic growth modifies the composition and order of importance of the main population health problems.

Understanding and measuring how cancer incidence evolves during economic growth can be useful for forecasting the economic impact of cancer and for governing the process of resource allocation in planning health services. However, it is necessary to emphasise that this is not a study about social and economic factors causing cancerous diseases. The purpose here is not to infer a causal relationship but to highlight some basic empirical regularities and theoretical insights to be considered for further research in order to develop an economic theory of cancer incidence.

Basic measures of cancer frequency

In order to describe and measure the frequency of cancerous diseases, epidemiology utilises three main indicators: incidence, prevalence and mortality. Incidence and mortality are flow variables, measured retrospectively. They indicate the number of new cancer cases and the number of deaths due to cancer, respectively, which occur in a specific population over a given period (usually 1 year). Prevalence is a stock variable, measurable at one particular time point. It indicates the number of cancer cases in a specific population at a given point in time (Last, 2001).

Data on incidence, prevalence and mortality are usually expressed as absolute numbers or as rates. Rates can be crude or age-standardised. A crude rate is calculated by dividing the absolute number of new cases, cases or deaths by the corresponding number of people in the population at risk. An age-standardised rate is a weighted average of the age-specific crude rates, where the weights are the proportion of people in the corresponding age groups of a specific standard population. These age-adjusted rates are calculated to allow comparison between populations with different age structures, and they are particularly useful in making international comparisons. In this case, the most frequently used standard population is the world standard population (WHO, 2003) and the results are usually presented as annual rates per 100,000 persons at risk.

Where raw data are regularly collected by local cancer registries, these basic measures of cancer frequency can be computed for each type of cancer, usually classified according to the International Classification of Diseases (ICD) or for all cancerous diseases as a whole (WHO, 2005). In this latter case, epidemiologists usually refer to the overall prevalence rate as a measure of society's cancer burden. In the same way, since incidence is regarded as a useful approximation to the average risk of developing any type of cancer, the overall incidence rate is considered as an index of the level of cancer risk factors that exist in a given society, during a given period. Finally, the overall mortality rate provides an approximation to the average risk of dying from some type of cancer.

International evidence

Economic growth can affect cancer incidence, prevalence and mortality in various ways. In this paper we focus on the influence of a long-term increase in real per capita income on the overall incidence rate of all types of cancer. Using data from the World Bank (WB) and the World Health Organization (WHO), we develop an empirical analysis of the relationship between economic growth and cancer incidence. For this purpose, we use cross-sectional data on per capita income and cancer incidence in 2012, for 162 countries included in WB and WHO statistical databases, and for a subset of these 162 countries, which consist of a more homogeneous group of 41 countries, that are characterised by a "Western lifestyle". In this subset there are 36 European countries plus Australia, Canada, New Zealand and the USA (from now, we simply refer to the whole set as the World group and to the subset as the Western group).

Real per capita income is measured by the ratio of GNI to population and it is expressed in current international dollars, using purchasing power parity (PPP) rates (World Bank, 2007). Cancer incidence is measured by the crude and the age-standardised rates of all types of cancer ("all sites, but non melanoma skin", according to the ICD classification) provided by the WHO within *Globocan project* (Bray *et al*., 2004). In fact, International Agency for Research on Cancer (IARC) publishes free software with worldwide estimation of cancer incidence, prevalence and mortality. For cancer incidence, these data include absolute numbers of new cancer cases, and crude and age-standardised rates, in both the male and female population.

This analysis, however, neglects the powerful influence of sex and age on cancer incidence. Thus, it is necessary to repeat OLS estimation using crude and age-standardised rates (ASR), in both the male and female populations (again in linear, quadratic and double-log specifications). Changes in per capita income, however, continue to explain an important part of the change in cancer incidence. This effect is not due to the positive influence of economic growth on the average duration of life.

In particular, a straight line best describes the relationship between real per capita income and cancer incidence within the female population in both groups of data, while quadratic and double-log forms provide a reasonably close approximation to data for the male population in countries within the World and Western groups, respectively. All this seems to confirm a relevant negative effect of economic growth on the presence of cancer risk factors in different populations.

Economic growth, structural change and cancer incidence

At the microeconomic level, many studies have examined how personal income and wealth can influence individual exposure to cancer risk factors. On the contrary, macroeconomic analysis of this issue seems to be a relatively underdeveloped area of research. Previous studies in this field have highlighted that the evolution of cancer incidence in a growing economy is a very complex subject that should be approached in an interdisciplinary framework (Ukraintseva and Yashin, 2005). To contribute to this aim, here, we develop a very basic economic model that can provide some insights into building a more realistic and complex theory (Bosanquet and Sikora, 2006).

As in other stock–flow relationships, for a given average duration of the disease prevalence is a function of the incidence and mortality rates. In the following discussion, this kind of stock–flow relationship allows us to simply focus on cancer incidence and mortality, in order to develop an elementary framework where, *ceteris paribus*, changes in mortality and incidence rates during economic growth are primarily due to structural changes operating on the supply and demand sides of the economy, respectively.

More particularly, on the supply side, as real GNI per capita income increases, better medical and surgical treatments become available, and notably, better techniques for early diagnosis and screening. All these technical changes can dramatically reduce cancer mortality. This is why, other things being equal, for a given incidence rate, economic growth implies a notable increase in prevalence rate (Capocaccia *et al*., 2002). In contrast, on the demand side of the economy, long-run increases in real per capita income tend to raise the average life expectation at birth. Since the average risk of developing any type of cancer is strongly influenced by age, economic growth may lead to an increase in the overall incidence rate of cancerous diseases.

In this paper we focus only on the demand-side effects of economic growth on cancer incidence. Economic and social structural changes that characterise the processes of economic growth deeply modify the population's habits and lifestyles. Studies on cancer aetiology point out the multifactorial nature of these types of diseases and the great importance of habits and lifestyles as risk factors (Nasca, 2007). As a result, economic growth tends to modify population exposure to cancer risk factors (such as nutritional and environmental risk factors).

Considering these structural changes from the demand side of the economy, an Engel's function may be a simple, but very useful tool for analysing how cancer incidence changes during economic growth. From this perspective, exposure to cancer risk factors can be thought as the consequence of the characteristics of goods and services that enter the average consumption bundle demanded by the representative consumer at each stages of economic growth.

If there is something that we do positively know about expansion of per capita demand when real income increases, it is that per capita demand for each commodity usually does not increase proportionally (Pasinetti, 1981). This is a well-known generalisation of Engel's law: it simply states that the proportion of income spent on each type of goods and services changes as real per capita income increases, because consumers increase consumption along a hierarchy of needs. Therefore, during economic growth the composition of the average consumption bundle demanded by the representative consumer changes continually over time.

For our purposes, it is useful to think of a consumption bundle of goods and services (Q^{AC}) that reflects a lifestyle characterised by a low risk of developing any type of cancerous diseases (i.e., an *anti-cancer lifestyle*). In the presence of a hierarchy of needs (determined by biological, cultural and social factors), even the demand for the Q^{AC} consumption bundle does not increase proportionally. With regard to how the demand for an anti-cancer lifestyle consumption bundle increases in a growing economy, it seems reasonable to introduce some basic hypotheses (Figure 1). In the early stages of economic growth, the demand for a healthy lifestyle is likely to be close to zero and it may tend to increase less than proportional with respect to real per capita income (Y). However, in the subsequent stages of growth, as real per capita income increases demand and income may be linearly related. After real per capita income reaches a threshold level (Y''), the demand for an anti-cancer lifestyle may tend to increases more than proportionally.

Epidemiological data on tobacco consumption, for example, seems to support this hypothesis. In Figure 2, the age-standardised prevalence of current tobacco smoking among adults is plotted against the real per capita income. The scatter plot confirms that anti-cancer lifestyle behaves like a luxury good. At lower per capita income, economic growth pushes up tobacco consumption. Prevalence rate of current tobacco smoking is positive related to economic growth until about $15,000. After this threshold level, tobacco becomes an inferior good and the age-standardised prevalence of current tobacco smoking starts declining.

From the Engel's curve depicted in Figure 1, we can derive a function that describes how, *ceteris paribus*, the overall cancer incidence evolves in a growing economy. Figure 3 shows a possible general form of this relationship, in which cancer incidence is measured by the age-standardised rate (ASR) and economic growth is measured, again, by the real per capita income (Y). It is interesting to note that the relationship assumes the form of a type of Kuznets curve (Kuznets, 1955).

Increases in real per capita income have a more-than-proportional negative effect on the overall cancer incidence only in the early stages of economic growth. During growth, as a result of the expansion of demand for the anti-cancer lifestyle consumption bundle this more-than-proportional relationship tends to disappear. In particular, if a healthy lifestyle is a luxury good, after the early stages of economic growth the overall incidence rate will increase, but less than proportional with respect to Y (there also can be an interval of the growth process where the age-standardised rate of cancer incidence rises approximately linearly with per capita income).

Furthermore, the relationship between overall cancer incidence and real per capita income has a positive intercept on the y-axis and a turning point. In particular, ASR° measures the autonomous component of the incidence rate (namely, the component that is independent of income, because it is weakly influenced by exposure to risk factors, such as in the type of cancer with an important genetic and/or infective aetiology) and Y* is the threshold level of per capita income beyond which cancer incidence starts diminishing.

Conclusions

Describing and measuring the relationship between cancer incidence and real per capita income constitutes the first step in understanding how the process of economic growth affects population exposure to cancer causing factors.

In fact, real per capita income is not an accurate and adequate measure of a country's level of development and it is not possible to summarize in Y a set of economic, social and health features. Further research is needed to include more variables, as for example, those referring to personal income distribution, cultural habits and customs, general sanitary conditions and health policies. It is also necessary to utilise epidemiological data for each type of cancer within more homogeneous genetic populations. This paper, however, highlights some basic empirical regularities and theoretical insights that may be useful in developing an economic theory of the evolution of cancer incidence in a growing economy.

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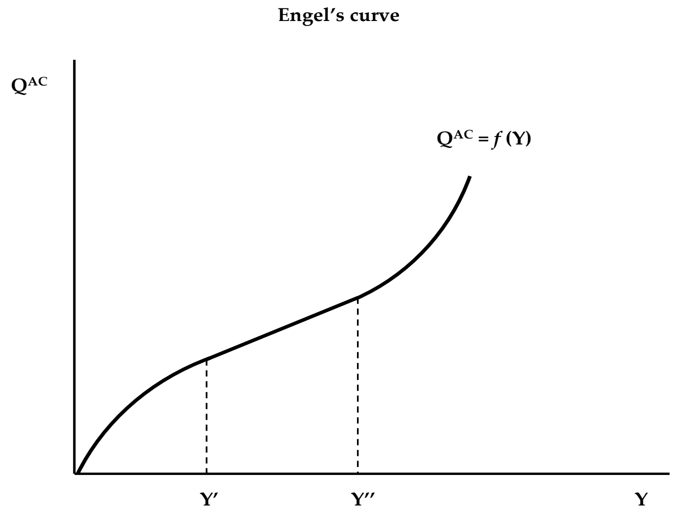

Figure 1

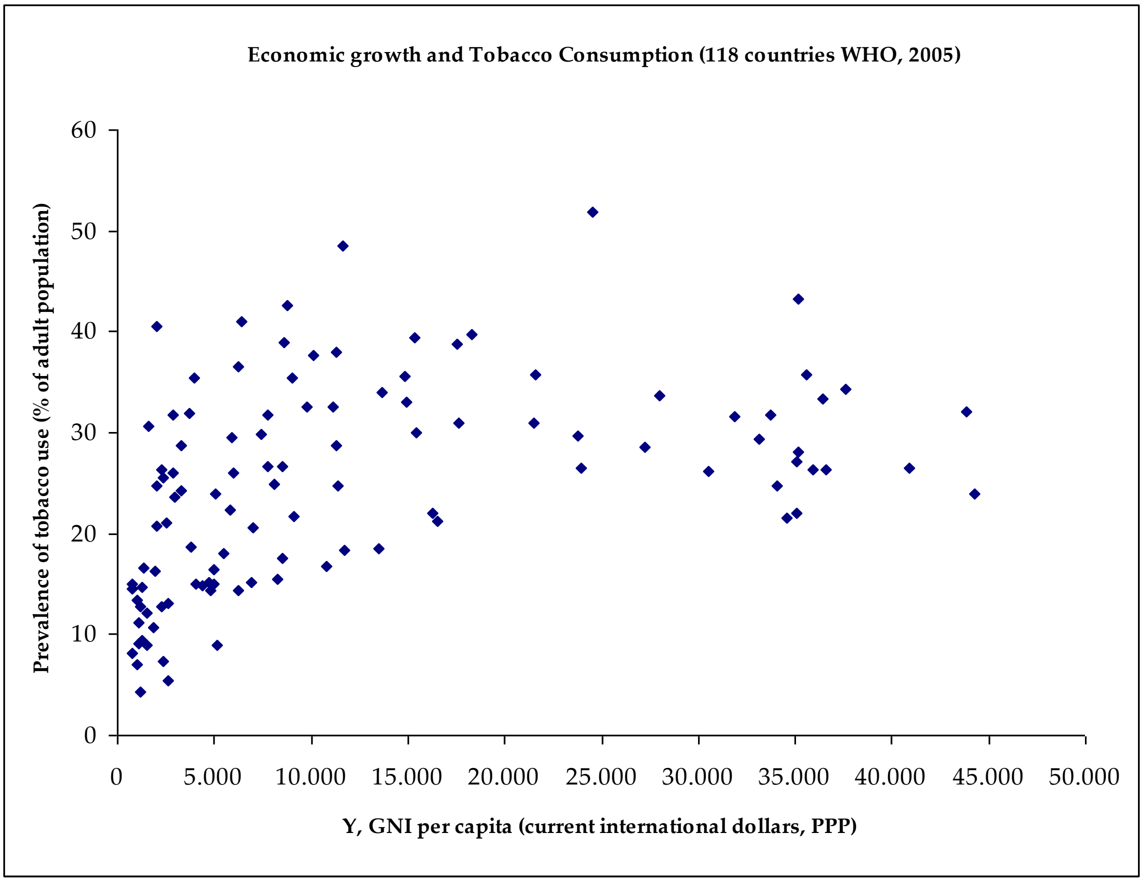

Figure 2

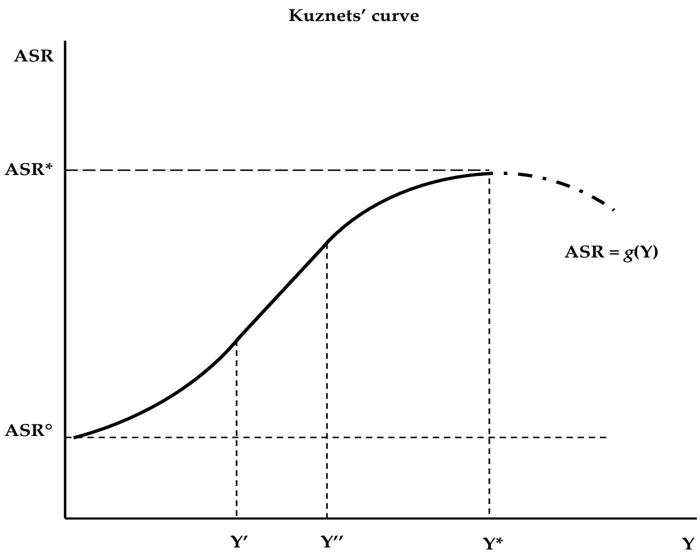

Figure 3