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Reassessing the effects of environmental taxation when pollution affects health over the life-cycle☆

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ABSTRACT

We introduce the link between pollution, morbidity and productivity over the life-cycle in a two-period overlapping generations model. As the environmental tax improves the health-profile over the life-cycle, it influences saving, investment in health, labor supply and retirement. As a result, we identify effects of environmental taxation beyond the standard crowding-out and productivity effects captured by the past literature. We show that whether those effects are positive or negative for the economy crucially depends on the degree of substitutability between young and old labor. Our numerical examples suggest that that those new effects alleviate the negative effects of environmental taxation on output and decrease potential positive welfare effects.

1. Introduction

What is the economic effect of environmental taxation when pollution affects morbidity? Past contributions have addressed this question without accounting for the effect of pollution on health over the life-cycle. By contrast, we build a two-period overlapping generations model, which captures the link between pollution, morbidity and productivity over the life-cycle. We contribute to the theoretical literature by identifying new effects of environmental taxation on the economy, and we provide numerical simulations to assess the magnitude of those effects.

The effect of pollution on morbidity is well established in the epidemiological literature. Pollution is known as a causal factor for certain chronic diseases, especially cancer, cardiovascular disease and respiratory diseases, that have durable detrimental impacts in terms of illness and disability.[1] According to Briggs (2003) about 8–9% of the total disease burden may be attributed to pollution in developed countries. While direct and indirect impacts of illness on productivity are the object of growing interest,[2] the overall fraction of pollution-related health problems that affect productivity is unknown. Nevertheless, the empirical literature focuses on some specific types of pollution and finds that the negative effect of pollution on productivity is quantitatively significant. Hausman et al. (1984) estimate that a 1 unit (μg/m^3) increase in particulate matter pollution increases lost work days by 0.7%. Hansen and Selte (2000) show that sick leaves are significantly linked to particulate matter pollution (PM10). Hanna and Oliva (2011) find that a one percent increase in sulfur dioxide results in a 0.61 percent decrease in the hours worked in Mexico City. Graff Zivin and Neidell (2012) find that a 10 ppb decrease in Ozone concentrations increases worker productivity by 4.2%. With respect to the effect of outdoor air pollution on the productivity of indoor workers, Chang et al. (2014) "suggest that nationwide reductions in PM2.5 from 1999 to 2008 generated $19.5 billion in labor cost savings, which is roughly one-third of the total welfare benefits associated with this change."

Thus, the theoretical literature has explored the effect of environmental policy taking into consideration the link between pollution and health in infinite horizon models, with the idea that productivity gains and decreased medical expenditure related to pollution reduction generally mitigate the costs of environmental policies (See Huhtala and Samakovlis, 2007; Mayeres and Van Regemorter, 2008; Ostblom and Samakovlis, 2007). Williams (2002) proposes a general equilibrium model in which reduced pollution increases health or productivity. In contrast to the previously cited studies, this author finds that the resulting effects on labor supply can magnify or diminish the benefits of reduced pollution. Williams (2003) further shows that interactions

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[1] See Brauer et al. (2011), Ruckerl et al. (2011), Gold and Mittleman (2013), Rajagopalan and Brook (2012), Brook et al. (2010) regarding air pollution; Paulu et al. (1999), Valent et al. (2004) for water pollution and Nadal et al. (2004), Chen and Liao (2006), Schuhmacher and Domingo (2006) for industrial pollution.

[2] See Bloom et al. (2004), Devol and Bedroussian (2007) and Zhang et al. (2011), for example.

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with health effects from pollution reduce the optimal environmental tax rather than increasing it as in Schwartz and Repetto (2000). In a growth model with research and development, Aloi and Tournemaine (2011) find that environmental taxation has a positive effect on growth and welfare through productivity gains and reallocation of resources toward R&D.

Those models ignore the interactions between pollution, morbidity, and productivity over the life-cycle, thereby missing some of the channels through which environmental policy affects the economy. There is however empirical evidence that the health profile is susceptible to modification by pollution. Indeed, pollution contributes to chronic diseases, which primarily affect people age 15 to 59 according to the WHO. There is also empirical evidence that the health profile influences the productivity profile (Bhattacharya et al., 2008; Lakdawalla et al., 2004; Perlkowski and Berger, 2004). Furthermore, the empirical literature indicates that the health profile is internalized and weights in life-cycle saving, labor and retirement (Dwyer and Mitchell, 1999; Deschryvere, 2006, amongst others). Additionally, as pointed out by Cropper (1981), individuals' investment in health during the first part of their lives interacts with pollution, which modifies their health profile. Thus, a decreased investment in health can potentially offset some of the benefits of environmental taxation on health.

Therefore, we propose to study the effects of environmental taxation in a two-period overlapping generations model which captures the link between pollution, morbidity and productivity over the life-cycle. Our model includes the following new features. First, we explicitly model the health status as a stock that increases with investment in health and decreases with pollution. Second, we make the link between health and productivity over the life-cycle explicit: Efficient labor is a function of health status and hours worked. Third, we model retirement decisions, allowing individuals to choose whether to continue to work or to retire during the second stage of their lives. Fourth, while past overlapping generations models generally assume perfect substitution between young and old workers, our model allows for labor by the young and the old to be complements or substitutes. Indeed, young and old workers' skills are not perfect substitutes. The literature on economic growth finds that young and old workers' comparative advantage in different complementary tasks explains why convergence is not instantaneous (Kremer and Thomson, 1998). The analysis of pension reforms and their effect on youth employment shows that employment of old workers is positively correlated to employment of young workers (Börsch-Supan and Schnabel 2010; Gruber et al., 2010; Kalwij et al., 2010). Furthermore, only a few empirical contributions have estimated the elasticities of substitution or complementarity between age groups and there is no clear consensus in the empirical literature on whether workers of different ages are complements or substitutes as skills and age are closely related. Murphy and Welch (1992) find complementarity between young and old workers within or outside the same education group and Hebbink (1993) finds that workers of different age groups are complements. Card and Lemieux (2001) find that for both high school and college educated workers from different age groups are imperfect substitutes, and Ottaviano and Peri (2012) estimate that workers within the same education group but different levels of experience are imperfect substitutes. Additionally, it seems important to allow for substitutability or complementarity between young and old workers in light of the recent life-cycle literature, which shows that accounting for complementarity may influence policy outcomes (Cassou et al., 2013; Imrohoroglu and Kitao, 2009). Finally, we model investment in health as time individuals derive from leisure rather than as an amount they spend on health services. Accounting for investment in health in the form of both time and expenditure would render the model intractable. Whereas the past literature focused on health expenditure, a contribution of our paper is to focus on time invested in health, which is an important factor in health outcomes. Additionally, time investment in health is also particularly relevant to study in a life-cycle framework which accounts for substitution between young and old labor. Our modeling choice is also justified by the fact that, in publicly financed health care systems, health care spending is not an important source of income uncertainty and does not significantly influence the consumption-saving choice of individuals (Chou et al., 2003; Domeij and Johannesson, 2006). Independent of the health care system, another justification for this modeling choice comes from the empirical literature on the determinants of health. Cawley and Ruhm (2011a,b) point out that the determinants of health include medical care, time investment and the environment. “However, in industrialized countries where morbidity and mortality are primarily related to chronic rather than infectious diseases, health behaviors are particularly important.” Furthermore, Folland et al. (2013) find that health care consumption expenditure does not result in better health whereas lifestyle choices matter. The empirical literature suggests that time spent on activities such as sleeping, diet and physical exercise, smoking, or drinking is an important factor in health outcomes (Contoyannis and Jones, 2004; Mullahy and Robert, 2008, 2010; Xu, 2010, 2013, and the 2008 Physical Activity guidelines for Americans edited by the US department of Health and Human services). Thus, while the past literature focused on preventive health expenditure, we focus on time investment in health as an important form of prevention. Additionally, in the same way as preventive health expenditure decreases as individuals age (Cropper, 1977), empirical evidence shows that lifestyle choices are concentrated on working years. For example, the 2008 US Time Use Survey indicates that 80.3% of individuals practicing sports and exercise are age 15–54. Thus, our model assumes that preventive time investment in health is done by the young and that the benefits of this investment are reaped by the old.[3] Therefore, our health investment function accurately captures characteristics of investment in health that matters for health outcomes.

Our work fills a void in the overlapping generations literature. Indeed, Pautrel (2012) assumes a constant health profile. Mathieu-Bolh and Pautrel (2011) and Raffin (2012) assume an ad-hoc link between pollution and productivity and do not model health. Furthermore, in those articles, the age-productivity profile is not internalized by individuals.[4] Last, neither those past contributions allow individuals to choose between work and retirement in the second period of their lives, nor they explore various characteristics of young and old labor. By contrast, we model the link between pollution, health and productivity over the life-cycle. We show that when individuals internalize changes in the health profile, environmental taxation yields new effects. The main results of the paper are as follows:

1. We provide a decomposition of the effects of the environmental taxation on output and identify new effects. A first new effect is the “health-saving effect” describing changes in saving. The environmental tax limits the decline in health over the life-cycle and modifies investment in health. Changes in the health profile are internalized and modify the efficient wage profile, which triggers changes in saving. The efficient wage profile is modified in different ways depending on the complementarity or substitutability of labor across periods of life. As a result, when old and young workers are substitutes (complements), the health-saving effect is negative (positive). We show that if the life-cycle characteristic of the health profile is ignored and investment in health is exogenous, the health-saving effect disappears.
2. Our model captures the effects of environmental taxation on aggregate efficient labor. When time investment in health changes, it

[3] There is no investment in health in the second stage of life because individuals die at the end of the second stage. Furthermore, empirical evidence indicates that in the second stage of life, the nature of health expenditure changes from preventive toward curative (Ozkan, 2011).

[4] In Mathieu-Bolh and Pautrel (2011), the exogenous age-productivity profile only influences aggregate variables through intergenerational redistribution. By contrast, in our framework, health and retirement decisions are internalized. Thus environmental taxation influences the health profile, individual decisions, and thereby the aggregate economy.

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