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Industrialization and environmental externalities in a Solow-type model

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ABSTRACT

In this paper we examine the role played by environmental externalities in shaping the dynamics of an economy with two sectors (a farming sector and an industrial one), free inter-sectoral labor mobility and heterogeneous agents (workers/farmers and industrial entrepreneurs). We find that, in the presence of the environmental pressure of the economic activity of the industrial sector, the stability properties of the equilibria and their features in terms of environmental preservation, welfare outcomes and sectoral allocation of labor are sensitive to the level of carrying capacity. We show that an endogenous process of industrialization associated with a reduction in farmers/workers' welfare can emerge.

1. Introduction

Industrialization is usually considered a necessary, albeit not a sufficient, condition for poverty reduction. The expansion of the industrial sector is indeed a key feature of the growth processes of those countries which have been successful in combating poverty and in ensuring satisfactory living conditions for vast sections of the population. The fact that several countries have experienced higher labor productivity and industrialization without poverty reduction is often traced back to low absorption of labor in higher productivity sectors and to a lack of labor transfer from rural subsistence to modern activities with the consequent expansion of the urban informal sector (Easterly, 2003; Ocampo et al., 2009). Within this conceptual framework, less attention has been paid to the role that environmental externalities may have for economic growth and poverty reduction during the industrialization processes.

This paper attempts to make a contribution towards filling this gap. To this end, in order to concentrate on the effects of industrial pollution on capital accumulation and welfare, we adjust the framework proposed by Matsuyama (1992). In this seminal work, he suggests that the link between labor productivity in farming and manufacturing growth changes according

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to the degree of trade openness. In small open economies, if productivity in the agricultural sector is low, then the industrial sector could benefit from a large supply of labor at low cost and, in this way, the economy could gain a comparative advantage in manufacturing production. The opposite relation holds for closed economies. In our paper, by focussing on the study of an open economy, we also find that low productivity in the farming sector can be an engine of the industrialization process. However, in our model the industrialization process generates environmental degradation and, consequently, a reduction in labor productivity in the farming sector. In other words, industrialization may be associated with a decrease in workers' welfare.

This extension appears to be important since, in recent decades, the growth of industrial activities has expanded the industrial frontier in many poor and middle income countries. Positive and negative interactions between small producers in resource-dependent activities and industrial firms have therefore increased. A few figures are enough to describe this trend. First of all, between 1990 and 2010 the share of world industrial value added accounted for by low and middle income countries almost doubled from 17.5 to 33.5 percent, while their rural population share declined more slowly from 65 to 55 percent.[1] Moreover, in the same period, it has been estimated that the domestic footprint of sulphur dioxide (SO_2) for low and middle income countries climbed from about 52,000 to more than 93,000 gigagrams (Gg) compared to a decline from 54,000 to about 18,000 Gg in high income countries.[2] An emblematic example of the possible effects of pollution when natural resources are used as productive inputs by small producers is reported in Reddy and Behera (2006, pp. 530–534). By analyzing the impact of industrial water pollution in a village of Andhra Pradesh, they find that the "majority of the cattle is becoming sick over the years […]. The amount of land under cultivation has declined substantially (88%) due to the incidence of pollution […]. Most of the people who were depending on agriculture before pollution have shifted to industry, business and other sources. The majority of them have become daily laborers." The extension and severity of air, water and soil contamination of industrial activities, such as textile and leather industry, are also well documented in China (Economy, 2004; Greenpeace International, 2012) and in Bangladesh (Human Rights Watch, 2012) and recently acknowledged also by their governments.[3]

In what follows we analyze the interactions between economic development, sectoral output composition and the environment by modeling an economy where environmental degradation affects workers' incentive to move out of the environmentally sensitive sector. This reduces workers' dependence on natural resources, but it can also fuel a self-reinforcing process of growth in industrial production and pollution. In doing this, we contribute to a growing body of literature which studies how, in multisectoral economies where natural resources are used as productive inputs, structural change processes and reallocation of labor across sectors can emerge as endogenous adjustments to a reduction in natural capital affecting economic growth and social welfare (see López et al., 2007; López, 2010; Bretschger and Smulders, 2012; Peretto, 2012; López and Schiff, 2013). Most of these models are concerned with the role of both the substitution between natural resources and man-made inputs (or labor) and the change in natural resource prices in driving the economy towards a sectoral shift which allows sustainable growth. These models, however, abstract from the distributional implications associated with such processes and, with the exception of López (2010), identify resource-using and resource-impacting activities. We build on this literature by taking a broader distributional perspective. More precisely, we analyze a two-sector model with free access to renewable natural resources as factors of production. The physical capital is specific to the industrial sector whereas the natural capital is specific to farming. Both sectors employ labor, but only the industrial sector produces environmental externalities which, in turn, affect labor costs and labor productivity. There are no constraints to inter-sectoral labor mobility and, as a consequence, labor productivity gains in the economy are equally shared among workers and there is no risk that possible benefits of industrialization are offset by a low absorption of labor in higher productivity sectors. Moreover, we exclude the impact of domestic food supply and domestic demand on the prices of the goods produced by the two sectors. In this way, we concentrate on the role of resource-based activities in setting the basic opportunity cost for labor in the whole economy. Our model is complementary to that proposed by López and Schiff (2013). We analyze a similar setting (i.e., one with a resource-dependent sector, a manufacturing sector which is more capital intensive, exogenous prices and open access environmental resources) but with a crucial difference. In our model the polluting sector is the man-made capital intensive sector and not the resource-dependent sector. We consider a poor economy where the resource-dependent sector is represented by small producers engaged in primary activities as in López and Schiff (2013), but the main environmental threat is posed by the capital intensive sector. In other words, we concentrate on welfare and environmental dynamics generated by the pollution of non-primary activities instead of on the problem of over-harvesting and over-exploitation by primary and commodity activities which do not internalize the environmental impact. We confirm that a decline in labor share employed in the natural resource-intensive sector can arise in the absence of biased technological progress and can be an endogenous response to low labor

[1] Data from World Development Indicators accessed in December 2013.

[2] The largest sources of SO_2 emissions are from fossil fuel combustion in the energy and industrial sectors. These emissions are a primary cause of acid rain and have a negative impact on forest and agriculture crops and on aquatic ecosystems in addition to adverse effects on human health (World Bank, 1999). The figures given in the text are our own elaboration from the Eora MRIO dataset (Lenzen et al., 2012, 2013), accessed in November 2013. If SO_2 embedded in imports are subtracted and those embedded in exports are added to domestic SO_2, the total SO_2 emissions at home for low and middle income countries are 56,864 Gg in 1990 and 107,747 Gg in 2011.

[3] In February 2012, Chinese premier Wen Jiabao said that "Water pollution is mainly resulting from industrial and sewage waste water and is now in very serious situation." (reported in Greenpeace International, 2012). Li Yang, Vice-President of the Chinese Academy of Social Sciences, in February 2013, said that "China's real economic growth rate would only be around 5%, if economic losses caused by ecological degradation and environmental damage are subtracted from the overall GDP," (http://English.news.cn/, 2013-02-28). Finally, in November 2013, Bangladesh's governments planned to relocate the leather industry from central Dhaka to another area where there are several centralized waste-treatment facilities (http://asiafoundation.org/in-asia/, November 13, 2013).