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Economic growth, industrialization, and the environment☆

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ABSTRACT

In this paper, I argue the compositional shift from agricultural to industrial production – industrialization – is a central determinant of changes in environmental quality as economies develop. I develop a simple two-sector model of neoclassical growth and the environment in a small open economy to examine how industrialization affects the environment. The model is estimated using sulfur emissions data for 157 countries over the period 1970–2000. The results show the process of industrialization is a significant determinant of observed changes in emissions: a 1% increase in industry's share of total output is associated with an 11.8% increase in the level of emissions per capita.

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1. Introduction

Over the past thirty years, emissions levels of key industrial pollutants have decreased in the developed world, but have increased in developing countries. This observation, known as the Environmental Kuznets Curve (or EKC), has dominated how researchers and policy makers think about the relationship

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between economic growth and the environment.[1] While there have been many attempts to explain the EKC, existing theories have not come to grips with three other puzzling features of the data: (i) there has been a great deal of cross-country convergence in pollution emissions over time, (ii) there is substantial variation in the emission intensities (the level of emissions produced per unit of output) of industrial pollutants both over time and across countries and (iii) as a fraction of GDP, pollution abatement costs have been small and constant over time in the industrialized world.

This paper provides a theory of economic growth and the environment that explains these features of the data, and offers new testable implications. Specifically, the theory predicts cross-country convergence in pollution emissions as economies industrialize. The empirical results in turn demonstrate the process of industrialization is a significant determinant of observed changes in sulfur emissions: a 1% increase in industry's share of total output is associated with an 11.8% increase in the level of emissions per capita.[2]

I develop a simple two-sector neoclassical model of economic growth and the environment in a small open economy in which growth is driven by a combination of capital accumulation and technological progress. The model features two goods, each of which is produced using a combination of capital and labor: a clean agricultural good, and a dirty industrial good that produces pollution as a joint output. I assume the agricultural good is consumed while the capital intensive industrial good is used in investment. I adopt a simple Solow-type framework with a fixed savings rate and abatement intensity. Technological progress in the production of goods and abatement is exogenous.

In this context, the compositional shift from agricultural to industrial production as an economy grows – industrialization – drives changes in pollution levels during the transition to the balanced growth path. Development begins with rapid economic growth as capital is accumulated and this growth increases emissions in two ways. With growth, more output is produced and this increase in the scale of production causes emissions to rise. As capital becomes relatively more abundant, the composition of output shifts towards pollution intensive industrial production, leading to a further increase in pollution emissions. At the same time, improvements in the techniques of production arising from ongoing technological progress in abatement work to lower emissions.

If growth is initially rapid, then compositional shifts towards industrial production overwhelm technological progress in abatement, so emissions levels rise. As development proceeds, diminishing returns to capital cause growth and compositional changes to slow. Technological progress in abatement then occurs faster than emissions growth, so emissions levels fall.

Together, changes in the scale, composition and techniques of production during industrialization give rise to the EKC.[3] While this interaction explains why an EKC could arise, it is important to note that the EKC is not a necessary result. Whether an EKC is observed depends on the initial capital stock and rate of technological progress in abatement; moreover, even when EKC patterns are produced, they differ across countries. This finding is consistent with the evidence; the EKC is not a robust feature of the data.[4]

The process of industrialization does, however, generate convergence in cross-country emissions levels during the transition to the balanced growth path. Economy-wide diminishing returns to capital cause the scale and composition effects to decrease as capital accumulates. As a result, countries that differ only in their initial capital stock will exhibit convergence in pollution emission levels; the growth rate of pollution changes faster in poor countries than in rich countries. This takes place regardless of whether pollution levels are increasing or decreasing along the balanced growth path; and arises regardless of the trade pattern. Moreover, the model tells us that convergence

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[1] For recent overviews of the literature on economic growth and the environment, see Brock and Taylor (2005) and Xepapadeas (2005). For surveys specific to the empirical literature on the EKC, see Barbier (1997) and Stern (2004). Kijima et al. (2010) survey the theoretical literature on the EKC.

[2] In the context of the literature, this finding is striking: existing empirical work has shown compositional changes are typically responsible for decreases in emissions levels. See for example, Selden et al. (1999) or Bruvoll and Medin (2003). It is however, consistent with Antweiler et al. (2001), who find strong compositional effects for sulfur.

[3] Copeland and Taylor (1994) term these the *scale*, *composition* and *technique* effects.

[4] See, for example, Stern and Common (2001) and Harbaugh et al. (2002).

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