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INTRODUCTION

Introduction: special issue on the environment, resources and pollution – new challenges for economic development

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Abstract
This special issue contains a selection of six articles in the field of environmental and resource economics, which were presented in INFER workshops and supported events over the last two years. The topics include the effects of income inequality and freedom of the press on environmental stringency; the trade-environment nexus in China; the behavior of cross-country growth rates with respect to resource abundance and dependence; a stochastic frontier analysis to show that technological change is biased more towards energy rather than labor; how recycling and environmental taxes can affect the imbalances between the availability of and the demand for rare earth elements; and the interaction between demographic features and environmental constraints in Caribbean small island developing states. The papers include three empirical contributions and three methodological approaches, which help to improve our understanding of these topics.

Keywords: Caribbean region; China; environmental policy; income inequality; natural resources; pollution; technological change; transparency

JEL classification: O10; O13; Q3; Q56

1. Background

This special issue contains a selection of scientifically-sound and policy-relevant articles in the field of environmental and resource economics, which were presented in INFER[1]

[1]INFER is a non-profit organization supporting science and research in all areas of economics. It currently has more than 250 active members and several institutional members, across 37 countries on five continents, as well as a large circle of more than 1,000 occasional participants and supporters. INFER encourages scientific discussion during workshops on specific topics as well as hosting annual conferences. It also offers numerous publication possibilities to its members.

workshops and supported events in the last two years. These include the INFER workshop 'Economic Development Thinking the Environment' (held at the University of Coimbra, Portugal in 2019), several special sessions organized at the 20th INFER Annual Conference (held at the University of Göttingen, Germany in 2018), and the 1st International Conference 'Environmental Economics: a Focus on Natural Resources' (held at the University of Orléans, France in 2018).

The papers include three empirical contributions (Hou *et al.*, 2020; Martinez and Philips, 2020; Zhang, 2020) and three methodological approaches, the first of which develops innovative theoretical models (Ba *et al.*, 2020), the second of which illustrates trade-offs between demographic features and environmental constraints (Cassin, 2020) and the last one which improves a widely-used regression technique in economic development and environmental economics (Clootens and Kirat, 2020). The studied geographical areas include a specific application for Caribbean economies (Cassin, 2020) and one for China (Zhang, 2020), and three which cover large country-samples with up to 83 countries (Clootens and Kirat, 2020; Hou *et al.*, 2020; Martinez and Philips, 2020). This holistic approach with various methodologies facilitates the exchange of ideas between researchers from various sub-disciplines of economics, often in an interdisciplinary approach, and is suitable to improve our understanding of environmental constraints and their effects on economic development.

2. Income inequality, freedom of the press and environmental policy

The special issue opens with a very timely topic, covering the link between sustainability and transparency. In the last decade the world has experienced a sustained and dangerous increase in populist movements that has led to the emergence of new leaders, such as Donald Trump in the U.S.A. or Jair Bolsonaro in Brazil, who tend to deny the environmental consequences of climate change and accuse climate change believers of spreading fake news (Dawsey *et al.*, 2018; Tharoor, 2019), which contributes to an increasing lack of transparency and lack of freedom of the press. For instance, the index of Freedom of the Press (Freedom House, 2019) indicates that media freedom has been deteriorating around the world over the past decade. Simultaneously, mutually dependent problems such as climate change (e.g., linked to the accumulation of CO_2 in the atmosphere) and income inequality have become increasingly relevant and could be a source of discontent and could feed populist movements. For these reasons, it is crucial to investigate the extent to which these two indicators foster or hinder environmental protection in the world economy.

The first contribution, 'Freedom of the press, inequality, and environmental policy' by Inma Martinez-Zarzoso and Jennifer Phillips, presented at the INFER Annual Conference in 2018, investigates the effects of income inequality and freedom of the press on environmental stringency for two samples of developed and developing countries. The paper hypothesizes that the more unequal a society is, and the greater the oppression of the press is, the less stringent environmental policies are. The results partially confirm this hypothesis. In particular, the paper shows that low scores of press freedom go hand in hand with low levels of environmental stringency, whereas income inequality shows a non-linear effect for low- and middle-income countries. Moreover, there seems to be an environmental Kuznets curve (EKC) relation between income and environmental tax revenue, suggesting that the EKC relation between income and actual emissions may very well be driven by the ability of countries to implement regulations, but the turning point of GDP per capita is out of sample. In terms of inequality, there seems to be

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limited evidence of such a relation for all countries, although the results suggest it may apply for higher-income countries. The significant relationship between press freedom and environmental regulations may reflect other factors related to press freedom but not included in the study.

Environmental degradation is one of the most pressing global issues in the international policy arena. It is particularly relevant for developing countries, since they suffer the most from its consequences and lack the financial means to apply mitigation and adaptation measures. China is the greatest contributor to global emissions in the developing world and as such it has started to gain awareness of the implications not only for the whole planet but also for the Chinese population. China has also seen a sustained increase in its exports and become, over the last decade, 'the factory of the world'. Hence, it is important to answer the question of whether free trade is good for the environment and, in particular, for the air quality in Chinese cities. This is the matter of the next paper in this special issue.

3. Free trade and environmental quality: evidence from China

This second contribution by Yunzhi Zhang, entitled 'Free trade and the environment – evidence from Chinese cities', investigates the trade-environment nexus in China from 1998 to 2007, using firm-level and city-level data for 287 Chinese cities. The pollutant selected is particulates matter (PM2.5), which has detrimental consequences for air quality and human health. The author estimates an empirical model based on the work by Grossman and Krueger (1991) and Copeland and Taylor (1994, 1995, 2003), in which openness and entry of exporters impact environmental quality through the scale, composition and technique effects. Whereas the scale effect implies that increasing economic activity increases emissions, the technique effect goes in the opposite direction, with more environmentally-friendly techniques leading to lower emissions. The composition effect is ambiguous and depends on the pollution intensity of the sectors that expand with increasing trade liberalization. The net effect of trade liberalization on emissions is therefore an empirical question.

The main results show that, in general, trade openness has a beneficial impact on environmental quality for Chinese cities, particularly those located in the central and eastern regions. Furthermore, a higher entry rate of exporters can generate more pollution, but this result does not hold for the entry rate in less-polluting sectors. Lastly, the results differ depending on the geographic location of cities. Moreover, some evidence is found for the presence of an EKC for PM2.5 across Chinese cities.

4. Resource abundance and cross-country growth rates

In the late 1990s, and mainly motivated by Sachs and Warner's (1995) inspiring paper, a new literature emerged with a focus on the so-called *resource curse paradox*, suggesting that resource-abundant countries tend to grow at lower rates than resource-scarce ones. Among the explanations given to this puzzling paradox were rent-seeking behavior and Dutch-disease based arguments, both of which belong to the *structuralist* theories developed in the 1950s. A new consensus gained acceptance in the 2000s, which introduced the role of the quality of institutions into the puzzle. The new view, supported by several authors, indicated that only for countries with good institutions could resource abundance be a blessing, whereas it became a curse when institutions have bad quality. However, the authors went one step further, indicating that the institutional setting

was itself endogenous and this introduces another challenge for empirical research to determine the true relationship.

In this context, the paper 'Threshold regressions for the resource curse' by Nicolas Clootens and Djamel Kirat adds to this new view by endogenously splitting a global sample of countries according to the initial stages of the economies. It was presented at the INFER 2017 Annual Conference in Bordeaux and at the EERN INFER supported event in Orléans in 2018. The paper analyzes the behavior of cross-country growth rates with respect to resource abundance and dependence using a global sample of developed and developing countries with data available for 35 years. The methodology used is based on a sample-splitting approach, which allows testing for thresholds that are endogenously determined. The main innovation is to apply this novel method in a growth regression setting to answer the question of whether natural resources abundance is a blessing or a curse for countries in different stages of the development path. The natural resource effect on growth is thus dependent on the growth regime a country belongs to, which is in turn determined by economic capacity. The main results show that, for developing countries, resource dependence reduces economic growth, whereas resource abundance has the opposite effect. In contrast, for developed countries, no-significant link is found between resource abundance and economic performance.

5. A new look at technological change: a stochastic frontier approach

Despite major investments in renewable energy sources, fossil fuels continue to be heavily used in the world's energy production (IEA, 2019). This triggers concerns regarding the efficient utilization of energy inputs in production, given the non-renewable character of fossil fuels and its environmental consequences. In this setting, the role of technological change becomes crucial. The theoretical literature points out that technological change is expected to be biased towards energy inputs rather than other main production factors (labor, capital). However, macroeconomic evidence supporting this theoretical consideration is scarce. The purpose of the article, 'Directed technological change, energy and more: a modern story' by Zheng Hou, Catarina Roseta-Palma and Joaquim J.S. Ramalho, is to fill this gap by applying a stochastic frontier analysis to country-level data and estimating a translog production function with three main factors: capital, labor and energy. This allows the authors to assess the technological change in production at the macro-level and to derive a set of indicators for technological change using a dataset of 16 countries (including selected developed and developing countries located in different parts of the world, chosen according to their weight in terms of real world GDP) over the period from 1991 to 2014. They also calculate the growth rates of total production factors, which indicate the level of technological development in each country and show strong differences across the analyzed countries.

The analysis reveals specific patterns in the economic growth of developed and developing countries and clearly identifies the role of technological change in macroeconomic production. On average, the findings suggest that while the output elasticity of capital is decreasing over time, and even becomes negative in some cases, the output elasticities of energy and labor are increasing (besides, the output elasticity of energy grows at a higher rate: hence a catching up process is in place between the output elasticities of labor and energy). Moreover, while the output elasticity of labor is the highest for developed countries, that of energy is the greatest for developing countries. In addition, compared with developed countries, developing countries are more likely to enjoy higher returns to

scale in production. Nevertheless, the average production in all sample countries shows decreasing returns to scale.

The general conclusion both for the whole sample and for most countries considered individually is that technological change is biased more towards energy rather than labor. If labor is considered as a renewable input and energy – at least partly – as a non-renewable one, technological change is more likely to favor the non-renewable rather than the renewable input. However, the key determinants of the biasedness of technological change cannot be clearly identified (it could be market size, or price incentives) and require further evidence. Overall, the present results indicate significant differences in the patterns of output elasticities, total factor productivity growth rate and factor bias order for sample countries, which may provide interesting insights for policy makers (in particular, concerning the measures to be applied in relation to energy utilization).

6. Rare earth elements, the balance problem and pollution

Modern technologies, such as energy storage or energy efficient lights, related to the transition to a low carbon economy intensively use rare earth elements (REEs). These are chemically similar metallic elements (Golev *et al.*, 2014) and, given their name, one might think they are rare; however, these metallic substances are not all that rare, some being relatively abundant compared to others. The paper, 'Challenging pollution and the balance problem from rare earth extraction: how recycling and environmental taxation matter' by Bocar Samba Ba, Pascale Combes-Motel and Sonia Schwartz, theoretically examines how recycling and environmental taxes can affect the imbalances between the availability of and the demand for REEs (i.e., the balance problem) as well as the pollution generated by the extraction of REEs. To this end, the authors develop a simple two-period Cournot model in which a monopolist (*the extractor*) extracts two types of REEs: abundant and non-abundant REEs. In the second period, the monopolist competes with another firm (*the recycler*), which recycles a part of the non-abundant REEs consumed in the first period. A key finding is that recycling always reduces extracted quantities and thus mitigates the balance problem and environmental damages.

The other results depend on whether or not the recycling activity is bounded by the available quantity of extracted REEs in the first period. In this framework, the condition under which the monopolist in primary production (*the extractor*) exerts its power to restrict (or not) the recycling activity in the second period, is set. In other words, the recycling activity depends on whether *the recycler* can recycle the whole quantity of scrap it wants: if its activity is not limited, the first period extracted quantities do not change; otherwise, *the extractor* will adopt a strategy that will limit the extraction in the first period. Neither of the two cases (bounded recycling activity or not) is optimal as there are distortions in the economy (pollution and market power). An additional policy instrument is necessary to reduce these distortions and to ensure optimal recycling: a government can decide to introduce an environmental tax (a Pigouvian tax) on extracted quantities, in each period. The authors show that the properties of the optimal taxation of pollution depend on the condition under which *the extractor* exerts its power, as mentioned previously. The environmental tax reduces extraction and increases recycled quantities when recycling is not limited by the available scrap; however in the opposite case (when recycling is limited by available scrap), environmental taxation can decrease recycling activities.

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Within this framework, the government has to carefully set environmental taxation in order to indirectly favor recycling. In addition, it is shown that the second-best levels of environmental taxes depend on the marginal damage, on the market power as well as on the recycling. These theoretical findings provide valuable insights concerning the proper functioning of a circular economy.

7. Analysis of factors affecting economic development in Caribbean economies

The case of pollution is also put forward in the paper, 'The effects of migration and pollution on cognitive skills in Caribbean economies: a theoretical analysis', by Lesly Cassin. The author examines the interaction between demographic features and environmental constraints in Caribbean small island developing states (SIDSs). In particular, an overlapping generations (OLG) model (with three generations: children, adults and retirees) is developed to investigate the effects of migration and pollution on economic development through their effects on children's cognitive skills. The theoretical OLG framework, which puts a particular focus on the long-term general equilibrium, is supported by numerical simulations on Jamaica and Barbados. Considering emigration and intergenerational transfers when studying the link between human capital and pollution is particularly relevant for the Caribbean SIDSs as these economies are impacted both by brain drain and environmental issues.

In a first step, at theoretical level, it is shown that migration can have a positive impact on the population size if the increase in fertility that it induces (i.e., it is assumed that if children who emigrate help their retired parents by providing remittances, other adults will have more incentives to have children) is higher than the loss due to departures. At this stage, the author hypothesizes that the economy is not affected by pollution. The relation between population size and migration takes the form of an inverted U-shaped curve.

However, if production activities generate pollution and if the efficiency of human capital accumulation depends on exposure to pollution during childhood, two other scenarios can be developed. In the first one, pollution damages can be offset by an environmental policy consisting of a tax on emissions and a publicly funded maintenance. In this case, the economy has the same dynamics (on a green growth path) and characteristics as economies unaffected by environmental degradation. In the second scenario, environmental damages are too large to be eliminated through the environmental policy (or the latter is inefficient to reduce pollution, due to institutional vulnerabilities). In this situation, the pollution stock hampers human capital accumulation. If migration is low, an increasing rate of emigration might end up generating a larger population size, more production activities and therefore a higher pollution stock. This limits economic gains from migration, and emerges despite the incentives induced by migration (through remittances) to invest in human capital. If the migration exceeds a certain limit (and is rather high), the population size is reduced as the larger number of children that will be born cannot compensate for the loss of adults through migration. As a consequence, the capital stock is reduced (as the number of savers diminishes and as a substitution effect between savings and investment in children's education emerges). This reduction of physical capital generates a decrease in production. At this stage, migration has a positive effect on utility per capita as follows. The decrease in production reduces the pollution stock, which leads to an increase in human capital and households' income. This positive income effect will lessen the negative substitution impact on savings; thus, despite the contraction of physical capital, the increase in human capital results in gains

in utility per capita. Furthermore, the decrease in production is slower than the one in population: hence, both (local) environmental and economic gains can be achieved concurrently.

8. Summary

The contributions in this special issue cover a range of topics of current interest, utilizing different methodological approaches. They provide new insights and further knowledge about key issues in the area of resource and environmental economics and economic development.

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