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Foreign direct investment, development, and overshoot

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A R T I C L E I N F O

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A B S T R A C T

Overshoot of the earth's carrying capacity is an acute concern for sustainability initiatives that seek to equalize access to the natural resources that are requisite to meet the basic needs of humanity. Demands on nature that exceed ecological capacities compromise critical ecosystem functions that provision the inputs necessary for life. This paper draws on concepts and analytical frameworks from the natural, physical, and social sciences to assess the drivers of sustainability at the global and national level. Integrative theoretical predictions are tested in a structural equation model that advances empirical research on overshoot and outflows of foreign investments that is relatively lacking in the literature. Findings highlight the differential impacts of key aspects of economic globalization on both development and overshoot across nations.

1. Introduction

Current ecological crises, bouts of economic instability, and seemingly insurmountable social problems such as hunger and disease permeate virtually all nations in the world and underscore the importance of sustainability initiatives that seek international solutions that comprehensively address all three dimensions. As articulated by the United Nations (1987) report, "Our Common Future," the concept of sustainability comprises three pillars of consideration (i.e., environmental, economic, social) for meeting current and future needs, but emphasis on the environment is significant for at least two reasons. First, the sustainability approach to development pioneers the view in the international policy arena that environmental concerns deserve equal weight to social and economic ones. Second, ecological inputs are necessary for social well-being and economic advance. Resources garnered from the environment provision the imperatives for human life such as food, clothing, and shelter; harnessing energy and harvesting resources are essential components of production processes that contribute to economic advance. Thus, the foundational importance of the environmental dimension should not be overlooked.

This paper advances a conceptual framework for understanding of sustainability by introducing the laws of thermodynamics—with particular emphasis on the role of "entropy" and its relation to overshoot of resource capacities. While a number of empirical examinations in the social sciences interrogate the effects of various global and national phenomena to explain components of environmental degradation, this paper makes a unique contribution to the literature in assuming an explicit interdisciplinary approach to analyze the drivers of overshoot, which is an essential aspect of sustainability. Another novel feature of this paper is the consideration of outward and inward foreign direct investments (FDI), which have not yet been treated in tandem. The inclusion of these terms in the models advances the empirical evidence on global investment dynamics that are crucial to a number of theoretical perspectives in the social sciences. Further, the application of

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structural equation modeling (SEM) permits the assessment of both facets of FDI on domestic development and ecological sustainability.

After detailing the strategies to quantify overshoot, an overview and preliminary synthesis of the physical, natural, and social science perspectives guiding the analysis is offered. Key dynamics are assessed in cross-national structural equation models of overshoot that chart strategies to measure and analyze outward investments. In doing so, this paper contributes to the literature by: (1) developing a conceptual basis to understand and measure sustainability, (2) advancing interdisciplinary approaches to analyze the global and national dynamics that impact sustainability, and (3) offering empirical refinements to test key predictions of the developmental and ecological effects of outward foreign investments. Conclusions and implications of the results, including comparisons to prior efforts and possible future applications, are discussed.

2. Sustainability, entropy, and overshoot

Carrying capacity, as introduced by Catton (1980), is a biophysical accounting of the demands and numbers of species that an ecosystem can support in perpetuity.[1] Populations with demands on nature that exceed carrying capacity are relatively less sustainable than those whose demands are below carrying capacity. Overshoot is a term coined by Catton (1980) that captures the former scenario; a society is in overshoot when its activities (e.g., population growth, excessive consumption) violate and compromise the biophysical carrying capacity of its environment. Overshoot exploits and weakens the ecological bases that support life and thus is consequential to sustainability pursuits. Carrying capacity is defined in biophysical terms precisely because it is the availability of energy and matter that enable an ecosystem to support life. But not all energy and matter are equal in their life-sustaining capabilities; as we use and apply these resources they become more entropic and less useful. The physical basis of carrying capacity is best understood when viewed through a thermodynamic lens, as expounded below.

The first law of thermodynamics states that no energy can be created or destroyed, which suggests nothing is lost as we use resources. However, it is the second law of thermodynamics, or the entropy law, that captures what is lost. Specifically, all matter and energy tend toward a state of high entropy, and an inverse relationship exists between entropy and the potential usefulness of materials to humankind (Georgescu-Roegen 1971; Prigogine, 1967). Entropy refers to disorder, chaos, and a general lack of utility; waste is the ultimate embodiment of entropy. Taken together, the laws of thermodynamics offer that the quantity of energy and matter is constant, but the quality is dynamic and tends toward entropy.

All natural resources—whether land, air, water, minerals, fossil fuels, food, or fiber—exist in ordered states of low entropy. Low-entropy natural resources provide sustenance, protection in the form of shelter and clothing, and are the base materials for work to be done. Entropy increasingly characterizes the quality of energy and matter embodied in natural resources as they are used and applied in production or to meet consumption demands (Daly and Cobb, 1989). Entropy, then, is a qualitative change that limits future applications of resources that are needed for socioeconomic advance; thus, entropic dynamics are the locus of environmental degradation that imperils sustainability (see e.g., Daly, 2007). In particular, consumption in excess of available resources and the generation of waste beyond our capacity to assimilate it (i.e., overshoot) is unsustainable.

The tendency towards entropy is an inexorable truth that cannot be overcome; however, humankind does have the ability to accelerate or decelerate its generation, depending on how sustainably we use our resources. As explained by Catton (1980), ecological principles demonstrate that the earth is amazingly capable of regenerating itself to support the continuance of life. However, demands on nature in excess of the earth's regenerative capacities result in states of overshoot that then reduce carrying capacity, as metabolic activities are disrupted and productivity is compromised. Thus, overshoot is analogous to the acceleration of entropy in the environment as both constrict our future room to maneuver.

2.1. Modeling the causal determinants of entropy

Substantial progress has been made in sustainability studies to elaborate the interconnected nature of the biophysical and social world. Of particular significance are those developments in the area of coupled human and natural systems (CHN) (Liu et al., 2007a,b) that articulate the complex interactions of nature and society that include reciprocities, feedback loops, and telecoupling processes (Liu et al., 2013) that shape the sustainability of local and distant places. In an increasingly globalized world, refinements in CHN analyses evidence a growing emphasis on the flows of materials and energy across sending and receiving systems, and the spillover effects they produce. That is, the effects of nation-to-nation exchanges are not confined to the countries engaged in trade but spillover to impact, in principle, all other nations whether by disrupting historic trade networks or initiating information exchanges or introducing invasive species along the transportation routes used to complete transactions (Liu et al., 2013). Most important to the present effort, CHN analyses offer a framework for simultaneously considering socioeconomic and environmental interactions spanning systems from the local to the global level. These innovations point to the increasing importance of myriad facets of global integration to sustainability outcomes, some of which are represented in the models below.

Inspired by the work of Catton (1980), the ecological footprint is a commonly employed indicator of sustainability that quantifies the biologically productive land area requirements to support production and consumption activities and absorb

[1] The implication is an inverse relationship exists between the demands and numbers of species to maintain carrying capacity.