Comments on "Resource Depletion, Climate Change, and Economic Growth," by Andrew Steer

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This paper lays out the core case for incorporating a set of variables in models of economic growth that are insufficiently accounted for in more conventional models. These variables include

- climate risk, which affects the steady-state growth pathway as a potentially negative exogenous shock and as a source of uncertainty, on both direct and policy-related dimensions, which results in lower investment rates and hence lower aggregate growth
- the potential for endogenous technological progress in key sectors (energy, transport, building materials, agriculture) to accelerate as a result of low-carbon policies, contributing to faster overall economic growth[1]
- the potential to drive resource efficiency (in water, energy, land-use, carbon) by correcting for a set of market failures and imperfections.

The paper makes the point that the low-carbon economy model is not a priori likely to deliver more or less growth than the high-carbon model. Under certain circumstances (including a high climate change scenario or high induced rates of technological progress), the low-carbon model may actually deliver a higher rate of growth (the paper does not push the "strong" version of the argument). The paper argues that the thesis applies as much, if not more, to low-income countries as it does to high-income countries, given that low-income countries are disproportionately exposed to natural resource and environmental risk. At the heart of the narrative is also the proposition that the right combination of technology, markets, and policy can accelerate the

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[1] Investing to accelerate progress on "clean technologies" would presumably be at the expense of other R&D investments, which might have higher economic returns, unless the argument is that the world would simply increase its rate of R&D spending.

transition to a low-carbon economy with no or little impact on aggregate growth. This proposition requires considerable institutional sophistication to work in practice, given the risk of gaming, asymmetric information, and poorly designed policies (captured by specific interests).

The paper is probably the most comprehensive and compelling synthesis of the case for "green growth" currently available. It pulls on many different threads of the literature and integrates a highly diverse field, from natural resource economics to behavioral economics (with respect to investor conduct) and endogenous growth theory.

The mystery of why it is so hard to land the argument with policy makers and investors in a decisive fashion remains. Currently, key decision makers (both public and private) continue to invest in options that appear small relative to both the risks of climate change and the benefits of a more resource-efficient, clean-technology-intensive model. China provides a particularly challenging case in point. The direction of change—in the sense of the Kuznets environmental curve—is toward a more resource-efficient, lower-carbon economy. However, China's hugely successful transition from low-income to middle-income status was based largely on a resource-intensive, carbon-intensive economic model, fuelled largely by cheap coal. Other countries—from Vietnam to Turkey—have followed or are following a similar paradigm. For their part, the developed economies have not shifted their economic models in any significant way, other than offshoring a large share of their historic emissions (to China), as Denmark has done. The theory of green growth appears to be significantly ahead of the reality—and the gap does not appear to be closing particularly quickly, if at all.

Given my broad agreement with the overall contents of the paper and its framing of the theoretical case for a shift to a low-carbon economy, let me simply point to four potential areas where further research would be helpful:

- the challenge presented by cheap hydrocarbons, especially gas
- the technology/industrial policy challenge
- the distributional impact of the shift to a low-carbon model

- the case for a greater focus on local environmental goods.

Cheap Hydrocarbons

The expanded supply of hydrocarbons is a serious problem for the transition to a low-carbon economy. Shale gas (and oil shale) represents the most profound energy revolution currently playing out, affecting investment decisions across the world economy, from China to Brazil. Until three to five years ago, a central element of the low-carbon narrative was that it would simultaneously solve two problems—climate and energy security—not just one. Now, this story is much harder to tell, for three reasons. First, accessible hydrocarbon supplies appear to be increasing, given technological shifts. Second, the expansion of gas complicates the picture, because it crowds out coal but also crowds out renewable energy (and reduces energy costs). Third, the biggest owners of hydrocarbon assets—especially oil, still the most valuable form of energy per unit—have no or little incentive to leave their resources in the ground. The design of any kind of incentive or payment system for countries or companies not to exploit their hydrocarbon resources is a critical technical (and political) challenge. Given relative values, the challenge will be an order of magnitude more difficult than designing the (highly complex) features of the market to incentivize reduced deforestation (through reducing emissions from deforestation and forest degradation [REDD] credits). Under what set of conditions would it ever be incentive compatible for countries/companies not to exploit their hydrocarbon assets—or to do so in a way that sequesters the majority of the associated carbon emissions?

The Technology/Policy Challenge

The paper touches lightly on the question of technology. At the macro level, accelerated progress on clean technologies—across a number of sectors—is a necessary condition for the transition to a low-carbon economy. At the micro level, accelerated, large-scale deployment of low-carbon technologies is likely to be a major challenge in almost every sector. For many low-carbon technologies, deployment at scale remains challenging at carbon prices less than $40–$50 a tonne (and in some

cases, such as carbon capture and sequestration, electric vehicles, and offshore wind, the costs may be well over $100 for early vintages).[2]

The main problems of accelerated progress relate to two key features of the relevant technology set. First, many of these technologies play into a commodity market. In practice, it is hard to distinguish green electrons from brown electrons, at least in terms of their functionality. As a result, it is hard to generate a differentiated market proposition that can, absent policy support, tap into an autocatalytic segment of early adopters. Second, many green technologies are relatively capital intensive, and their cost performance improves through additional deployment rather than more R&D (an example is PV solar energy). These features make the coupling of policy support and technological progress particularly tight—and analytically different from, for example, traditional approaches justifying government investment in basic R&D as a public good. These two features compound each other in critical technology bets, such as carbon capture and storage, which take on more of the characteristics of defense procurement programs than conventional public R&D.

In general, given the current rate of stock accumulation of carbon dioxide equivalent (CO_2e) in the atmosphere, a number of big technology bets will be essential if concentrations are to stay within the 450–550 parts range or the world is to adapt to the consequences of higher CO_2e levels. The selection, design, and institutional arrangements/economics for these big bets (including their cross-country dimensions) deserve significant further attention, as a matter both of theory and practice.

Distributional Implications

The distributional implications of a low-carbon economic model are hard to predict. The most obvious losers appear to be carbon-intensive players, although the incidence depends as ever on policy design (and lobbying power).[3] But there are significant concerns about the potential impact of a low-carbon, resource-efficient economic model on poorer segments of the world's population. This seems paradoxical, as the

[2] Some technologies yield a pure resource efficiency gain. These technologies are economically attractive as long as institutional and behavioral barriers can be overcome.
[3] In the European Trading System (ETS) for CO_2, precisely the opposite result played out, with the most carbon-intensive players receiving the most permits and hence capturing the lion's share of economic value from the new currency. Polluting pays, it seems!

poor are highly dependent on a stable natural environment and hence much more exposed to weather, energy, and food volatility. However, many mainstream economists argue that policies that increase energy or food prices (by shifting to renewable energy or pricing water) may have a disproportionately negative impact on poor households. They also argue that low-carbon technologies are typically more capital intensive than high-carbon technologies and hence, absent suitable capital market interventions, disproportionately penalize the poor.

Reality is, as ever, much more complex. Many poor households pay very high effective prices for their energy, food, and water, when one takes account of quality factors; associated costs (for example, to health); and labor input requirements (water is never free). Systematically analyzing the impact of low-carbon versus high-carbon models on the "bottom of the pyramid" is a key unresolved area, on which further research is needed.

Local Environmental Goods

The paper focuses on the global public good of climate change. There is a good case for doing so. Addressing climate change makes many of the local environmental challenges much easier. At the same time, it is worth recognizing that all politics—and most policies—are local. It is hard to imagine most politicians—or citizens, for that matter—putting global environmental risks above local pollution and damage to the local environment. The catalyst for China's transition to a lower-carbon economy is much more likely to be air pollution and water pollution—local effects—than anything global. Strengthening and accelerating the case for local environmental goods is critical, especially for rapidly industrializing nations, which are most likely to experience major lock-in effects as they develop their infrastructure and urban footprints.

There is a useful discussion of the Kuznets environmental curve at the start of the paper. It would be good to see that set of issues addressed more systematically in future research. Arguably, the biggest challenge to the environment—both local and global—is the rapid process of industrialization and urbanization, both in China and in the next wave of countries. So far, there is little evidence that the critical phase of middle-income growth (which lifts the next 1–2 billion people out of poverty) can be

achieved through a low-carbon model. More profoundly, there is little evidence that it can be achieved through a model that requires changing preferred tradeoffs between faster economic growth and environmental costs (whether local or global). Defining an environmentally efficient, politically attractive model of middle-income growth—for Indonesia, India, Pakistan, Nigeria, and the wave of countries that follows them—may be the most acute practical challenge to the agenda presented in this excellent paper.

This paper represents a major step forward in synthesizing many of the key aspects of the "green growth" case. There are, as ever, unanswered questions, some of which are highlighted above. There are also the perennial debates, not specific to this paper, about the effectiveness and efficiency of government intervention. Although market failures and imperfections associated with resources/environmental capital are rampant, so are government failures and public-private rent-seeking partnerships. I have not sought to address these issues, although they have some acute features in the natural resource sector. However, it is precisely these problems that may be the Achilles' heel of transitioning to a cleaner, greener model of economic growth.