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"Green Growth"

An Exploratory Review

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Abstract

The concept of "Green Growth" is a focus of much interest and considerable debate among decision makers concerned with enhancing both nearer-term economic progress and longer-term environmental sustainability. Proponents of Green Growth emphasize not only the need to protect various forms of natural capital to sustain improvements in material living standards and poverty reduction, but also the potential for strategically crafted environmental policies to achieve sustainability at low cost, perhaps even to help stimulate growth. However, there has been so far relatively little exploration of the analytical underpinnings of Green Growth, or its ambiguities. An exploratory investigation of the goals and underlying assumptions embedded in various conceptions of Green Growth facilitates consideration of how they might be interpreted vis-à-vis standard principles of intertemporal economic efficiency, including the value of the environment. Several plausible potential channels are identified for how synergy between economic growth and environmental sustainability might be more extensive than implied by standard economic theory. However, it is not possible to address their practical significance without more empirical research than is currently available. Consequently, some claims of substantial win-win opportunities between growth and the environment may be premature.

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"Green Growth:" An Exploratory Review

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"Green Growth:" An Exploratory Review

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1. Introduction

"Green Growth"[2] is a relatively new term that has become the focus of much interest and considerable debate among policy makers and other stakeholders concerned with enhancing both nearer-term economic progress and longer-term environmental sustainability. Much of the current Green Growth debate evokes discussions of sustainable development that began in the late 1980s and expanded rapidly in the first half of the 1990s.[3] However, Green Growth differs from sustainable development in a subtle but important respect. The central concern in earlier sustainable development debate was the need to ameliorate longer-term depletion and degradation of a variety of natural resources, environmental conditions, and ecosystem services in order to reduce the risk of economic regress and ecological disaster.[4] Proponents of Green Growth emphasize the need to protect various forms of natural capital to sustain improvements in material living standards and poverty reduction, but they also emphasize the view that strategically crafted environmental policies can achieve environmental sustainability at low cost, and even help stimulate growth.

Debate over requirements for sustainable development stimulated a small avalanche of research addressing, among other questions: the physical and technological feasibility of non-decreasing per-capita welfare over time given continued natural capital decline, including the role of technical innovation; the sharp (and still under-appreciated) distinction between resource shadow prices along a sustainable economic path (with non-declining per-capita welfare) versus a welfare-present-value-optimal path; and characteristics of preferences that could be consistent with a focus on sustainability.[5] A central recurring question as the research progressed became, "What more is in the concept of sustainable economic and environmental development besides an important reminder to move toward intertemporal economic efficiency?" The conventional wisdom for doing that is to correct market and

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[2] "Green development" and "green economy" are two other terms often used somewhat interchangeably with green growth. I use the term green growth to emphasize that the policy focus in debates about the concept very frequently emphasize relationships between environmental concerns and changes in conventionally measured GDP.

[3] See WCED (1987), and Toman (1994).

[4] "Strong sustainability" advocates put more emphasis on the need to safeguard certain types of natural capital, while proponents of "weak sustainability" put more emphasis on the need to ensure that any decline in natural capital was at least offset by increases in other forms of social wealth (Pearce, Markandya, and Barbier 1989).

[5] A survey of how this basic work on sustainable development evolved is found in Pezzey and Toman (2003). Smulders and Withagen (2012) provide a review of how neoclassical growth-and-environment models have developed up to the present.

policy failures with respect to different forms of natural capital, in addition to other causes of economic inefficiency, and to do so in a dynamic rather than static and myopic context. A key insight from the research was that while correcting market and policy failures is vitally important for sustainability, the issues of intergenerational distribution and physical constraints on resources that figure prominently in sustainable development policy debates are not addressed by policies that shift resource reallocations toward growth paths that maximize the present value of per-capita utility over time. The conventional sum-of-discounted utility objective needed to be modified or supplemented to confront these issues.

Green Growth is a relatively novel concept in discussion of environment and economic development, and there has been so far relatively little exploration of its analytical underpinnings or ambiguities. The aim in this paper is to offer an initial exploratory investigation of the goals and underlying assumptions embedded in current conceptions of Green Growth. To that end, the second section of the paper presents an overview of some key elements in various interpretations of Green Growth, and how they might be interpreted vis-à-vis the principles of intertemporal economic efficiency in natural capital allocation. In the third and fourth sections of the paper, these elements are explored in greater depth in order to reach some preliminary conclusions about how well they are understood, and the confidence with which normative claims based on those aspects of Green Growth can be advanced. The fifth and final section of the paper offers comments on further research and on application of Green Growth in policy contexts.

2. Concepts Underlying Green Growth

As with sustainable development before, the introduction of Green Growth as a terminology has led so far to a proliferation of interpretations. However, the three recently published definitions shown below serve to identify the kinds of issues that arise in the context of Green Growth:

> (1) "Green growth means fostering economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies." (Hallegate et al. 2011)
>
> (2) "Thus the world faces twin challenges: expanding economic opportunities for a growing global population; and addressing environmental pressures that, if left unaddressed, could undermine our ability to seize these opportunities. Green growth … is about fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. It is also about fostering investment and innovation which will underpin sustained growth and give rise to new economic opportunities……policy action requires looking across a very wide range of policies, not just explicitly 'green' (*i.e.* environmental) policies." (OECD 2011, page 18)
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> "This framework will need to account for major social impacts of natural asset losses. Hence it will also involve achieving smooth and just adjustment in labor markets by ensuring that workers have the means to find opportunity in change. More generally, the success of a green growth strategy will rest on addressing political obstacles and distributional concerns about the costs of change." (OECD 2011, page 20)

"…. a number of companies seek competitiveness gains through clean technology investment. Environmental action also generates new business opportunities. For instance, firms see the search for environmental performance as an opportunity to gain advantage over less technologically advanced rivals and to capture market shares." (OECD 2011, pages 24-25)

(3) "UNEP defines a green economy as one that results in 'improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities' ….. In its simplest expression, a green economy is low carbon, resource efficient, and socially inclusive. In a green economy, growth in income and employment should be driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services. These investments need to be catalyzed and supported by targeted public expenditure, policy reforms and regulation changes. The development path should maintain, enhance and, where necessary, rebuild natural capital as a critical economic asset and as a source of public benefits. This is especially important for poor people whose livelihoods and security depend on nature. The key aim for a transition to a green economy is to eliminate the trade-offs between economic growth and investment and gains in environmental quality and social inclusiveness…the environmental and social goals of a green economy can also generate increases in income, growth, and enhanced well-being…" (UNEP 2011, page 16)

The first definition is perhaps the closest of the three to the original idea of sustainability in terms of maintaining natural capital; nevertheless, the definition focuses on economic growth and development, and in so doing it draws attention to the importance of natural capital as a source of economic progress, in addition to something needing to be safeguarded. The second definition puts particular attention on the need to use a wide range of policy measures, not just traditional natural resource and environmental policies, for Green Growth; and on the political economy challenges arising from the resulting costs of change. The third definition also emphasizes natural capital, but it stresses as well the importance of addressing equity and social inclusion challenges in moving toward a green economy. In addition, it emphasizes the importance of addressing global-scale problems of natural capital depletion and degradation in its references to climate change and biodiversity.

The third definition, and to a more limited extent the second definition, further assert that appropriate sets of environmental and natural resource policies, along with complementary measures such as "green" innovation policies, can improve environmental sustainability without significant adverse impacts on economic growth, or even net gains. In particular, the third definition states that: "The key aim for a transition to a green economy is to eliminate the trade-offs between economic growth and investment and gains in environmental quality and social inclusiveness…the environmental and social goals of a green economy can also generate increases in income, growth, and enhanced well-being." The second definition emphasizes "…fostering investment and innovation which will underpin sustained growth and give rise to new economic opportunities……," and that "…. a number of companies seek competitiveness gains through clean technology investment. Environmental action also generates new business opportunities." The nature of tradeoffs and synergies between measures for longer-term environmental sustainability and measures for nearer-term growth acceleration are an important focus in current debates over Green Growth.

These observations suggest two opposing interpretations of the concept of Green Growth:

1. "Old wine in new bottles" – some observers will see little in Green Growth beyond the conventional wisdom of externality correction (i.e., "getting prices right" – though a variety of measures in addition to direct pricing need to be considered in practice).
2. "Strategies for synergies" – the alternative perspective we consider is that strategically integrated policies for environmental and natural resources and for economic growth can enhance longer-term sustainability of natural capital and accelerate nearer-term economic growth, beyond the impacts conventionally measured in assessing environmental and natural resource externality costs.

The primary focus in this paper is on what can or cannot be said in support of the second interpretation – the ways in which such synergies might operate, and the evidence available on their existence. The focus is on cross-policy, cross-sectoral synergies in the sense of a causal mechanism in which measures to reduce an environmental externality have positive effects on growth beyond any direct effects from the environmental externality correction; and vice versa in terms of growth policies. These synergies are in addition to any advantages from increased coordination in the timing and nature of implementation for growth and natural resource/environmental policies.

At one level, one can dispose of Green Growth vis-à-vis economic efficiency as a concept simply by reverting to standard models of policy choices for social welfare maximization that incorporate such policy spillovers. For example, an environmental externality may have direct impacts on utility and more indirect impacts on utility through changes in production and consumption possibilities. Reduced pollution can lower production costs, reduce lost work days, and reduce medical expenditures. In this context, optimal policy interventions also may include tougher standards or coverage of more pollutants if that is an efficient response to the existence of distinct sources of benefit. There also is a prospect that correcting an environmental externality will reduce growth in measured income, even as it also increases economic welfare, and economically optimal policy will depend on the balance of these effects.[6] In either case, the issue of what constitute policy spillover effects, and direct benefits versus co-benefits of policy, reduce to questions of definition and measurement.

This reasoning can be extended to second-best situations as well. For example, developing countries face their own market and institutional failures that have a direct effect on output.[7] To illustrate, regulatory standards could be used to overcome behavioral "inertia" with respect to energy efficiency initiatives (i.e. limited motivation to investigate changes to the status quo). Nonetheless, one can bring together environmental and economic considerations by evaluating the value of energy savings relative to costs of improved efficiency, the consequences of the cost savings for national output and consumption, and the consequences for social welfare and the environment.

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[6] Examples include direct utility gain through reduced statistical risk of premature mortality with reduced particulate emissions, environmental quality improvements with high amenity values, and natural resource conservation measures whose benefits reflect high non-use values. A greater focus on nearer-term income and consumption vis-à-vis the environment is one of the characteristics of the current Green Growth debate that distinguishes it from previous debates over longer-term environmental and economic sustainability.

[7] Examples include lower agricultural yields from poor management of shared water resources; and electricity subsidies that degrade the quality of service, even though consumption is subsidized, because suppliers' cannot recover costs of capital maintenance and replacement.

This raises the broader question that since the foundation for normative analysis in conventional natural resource and environmental economics is microeconomic theory built on the core concepts of preferences and individual utility: Why should the focus in Green Growth be on the environment vis-à-vis growth in conventionally measured income and material living standards? In this paper the emphasis on income-environment linkages in Green Growth as taken as a stylized fact of current Green Growth policy debate, in particular in developing countries. This in part reflects a real and justifiable concern on the part of developing countries with a need for rapid improvement in material living standards and reduced poverty, as well as longer-term considerations.[8] It also reflects in part continued practical problems in integrated versus more piecemeal policy changes (and investments), as a consequence of which there can be errors in measurement of benefits and costs when spillovers arise. This policy focus cannot be "corrected" simply by asserting that social welfare is a more appropriate criterion than income.

At the same time, however, the political economy of Green Growth issues is such that it can be more or less convenient for protagonists to draw environmental and growth issues together or keep them apart. For example, a candid acknowledgment of large social costs from natural resource degradation – or, on the other hand, significant uncertainties about such costs – may be less comfortable than advocating corrective policies on the basis of growth co-benefits. While recognizing that real-world policy determination is itself second-best compared to the benchmark of economic optimality, policy analysis for Green Growth needs to be alert to circumstances in which emphasis on environment-income linkages could lead to significant missed opportunities, or perverse outcomes, in terms of welfare improvement.[9]

3. A Simple Analytical Framework for Exploring Growth – Environment Policy Synergies

To explore growth – environmental policy synergies, we can make use of a version of the "Green Ramsey model" of economic growth with environmental components:

Environmental "state:" Z

"Extraction" of environmental goods and services: E

Physical capital: K

Gross output: $Y = f(K, E, Z),\ f_Z > 0$

Gross investment: I

Per-period utility: $U = u(C, Z),\ u_Z > 0$

Unit cost (in output terms) of extracting environmental goods and services: π

Income identity: $Y = C + I + \pi E$

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[8] Given that information is itself a scarce public good, it could also be argued that policy makers may act in ways not anticipated in standard models due to some form of myopia or "optimism bias" in expectations about potential gains from different types of policies.

[9] I am grateful to Richard Damania for his advice on these issues.

Equations of motion:

$$\dot{K} = -\delta K + I$$

$$\dot{Z} = -H(E) + R(Z)$$

where

H(E) = reduction of environmental state from utilization of environmental services, $H' > 0$

R(Z) = natural recovery or regeneration of environmental state, $R' \lesseqgtr 0$

In this model, the state of the environment affects both output and utility directly; and environmental degradation (net of natural recovery) is positively related to a generalized "extraction" of environmental goods and services (from tangible resource mining to degradation of ecosystem services). Various special cases of the model can represent an economy using depletable and/or renewable natural resources, and an economy adversely affected by climate change.[10]

While highly aggregative and stylized, the Green Ramsey model has been used to establish a number of important relationships between growth and the environment. The model has been used in particular to analyze the time path of shadow prices that reflect the value of changes in the environmental state *Z*. With incorrect shadow prices, of course, a dynamic market equilibrium path of the economy will not be an optimal path, one that maximizes the present discounted value of per-period utility.[11] Different versions of the model also have been used to explore different relationships among growth, wealth, longer-term environmental sustainability, and resource substitutability. In particular, a higher initial built capital stock implies a greater capability to meet demands for both consumption and investment in the economy while still restricting depletion or degradation of natural capital. Other things equal, then, already-richer economies also can have greater capability for green (or clean) growth. That dichotomy can be softened, if substitution away from more environmental harmful use of ecosystems goods and services (*E* above) toward less harmful services (meaning a lower *H(E)* function) and greater use of other forms of capital is made easier. That in turn is facilitated by endogenous technical innovation that favors development of greener technology or resources as a consequence of properly pricing environmental degradation.[12]

Our focus here is on the potential for causal spillover effects of environmental policies on broader input productivity and growth. To explore how such effects could arise, consider the following extension of the model sketched above:

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[10] See Smulders and Withagen (2012).

[11] Theory imposes no particular restrictions on the scale of price and quantity changes to be undertaken in correcting market and policy failures. In practice, there tends to be more focus on incremental changes. Policies to induce non-incremental changes are harder to design, implement, and assess, but are not ruled out a priori.

[12] Important earlier papers include Krautkraemer (1985) and Howarth and Norgaard (1993); Smulders and Withagen (2012) provide a broad review of the relevant literature.

$$Y = f(A_K K, A_E E, A_z Z), \qquad \dot{Z} = -A_H H(E) + R(Z)$$

where

$$A_i = A_i(X), \qquad i = K, E, Z, H; \quad A_i(0) = 1$$

$$X = (X_K, X_E, X_Z, X_H)$$

with $X_i \geq 0$ for each i ; $\frac{\partial A_i}{\partial X_i} > 0$ for $i = K, E, Z$, *and* $\frac{\partial A_i}{\partial X_i} < 0$ for $i = H$. The X_i are levels of generalized effort in factor-augmenting innovation ($i = K, E$); reduction of or adaptation to natural capital decline ($i=Z$); and reduction of environmental damages from use of ecosystems services ($i = H$). For simplicity we view these as one-shot static decisions, though obviously this can be extended to consider dynamic formulations. If we define γ_i to be the unit cost of X_i, then we can rewrite the income identity as

$$Y = C + I + \pi E + \sum \gamma_i X_i$$

By allowing each A_i to depend on the entire vector X, rather than just on X_i , we allow for potential pathways for spillover effects through which one or another X_i affects A_j for $j \neq i$.[13]

4. Spillover Examples and Uncertainties

One basic observation to make at the outset is that good empirical literature on these issues is extremely limited. A number of authors have put forward examples of successful growth – environment policy synergy in an effort to illustrate a broader potential. However, selective presentation of successful examples yields a biased sample of examples from which conclusions can be drawn. Thus, the discussion here relies on what information is available, along with intuitive reasoning on how spillovers might operate in practice.

Typically the A_i are thought of as investments in innovation that increase factor productivity through expanding knowledge capital. However, we can also think of these efforts as productivity-increasing expansion of institutional capital, as discussed below. A classical example is investment in very basic R&D whose follow-on effects potentially can raise the productivity of all factors of production in varying degrees. Another classical example is very broad-based strengthening of economic and social institutions that improve rule of law and governance. For example, such general improvement could increase the effectiveness of environmental monitoring and enforcement or reduced over-use of open access resources. The focus here, however, is on how more directed productivity-raising activities might spill over (positively, one hopes) to the productivity of other factors. Similarly, the range of market and institutional failures in public policy to support R&D are familiar and are not touched upon here. There is greater debate over the rationale for active public sector roles in more applied R&D and dissemination stages of innovation to address, e.g. risk and financing cost for first-of-kind commercial investments and different sorts of "inertia" in how markets adjust to new technologies. I also put these

[13] This goes beyond coordinating the implementation of individual institutional and technical innovations actions while focusing only on how each X_i affects production and welfare through its corresponding effect on A_i.

aside here, given that there is not yet strong evidence that these are systematically more serious problems for green versus other kinds of innovation.[14]

Various kinds of applied R&D and learning-by-doing can increase productivity of built capital. One very familiar source of spillover for this investment is improved energy efficiency as a by-product of improvement in more energy-using capital, simply because technology advance generally has shown such a trend.[15] The magnitude of energy efficiency co-benefit can vary across capital-augmenting alternatives, and there is no reason to expect that the options which maximize energy efficiency gains also have the highest net economic value; but the co-benefit nonetheless arises in many circumstances. A somewhat similar kind of effect can be observed when productivity improvements in capital for agriculture and forestry allow greater value of output with less intensive usage of ecosystem services and depletion of natural capital. A familiar counter-example is the improvement of fishery harvest technologies that exacerbate stock depletion by weakening the impact of depletion on harvest cost. Along similar lines, the intensification of the previous example also lowers costs and so could engender damaging extensification.

Activities that improve the productivity of goods and services "extracted" from the natural environment (E) can take a variety of forms. Plant varieties can be changed to obtain greater value of output for the same capital stock and the same utilization of soil fertility and other ecosystem services. Primary energy resources can be changed in ways that deliver the same final energy services at the same cost, again using the same capital stock. In terms of how X_E could affect A_H , positive and negative examples for depletion of natural capital can be identified: crop choices that reduce or increase pollution and "ecosystem health" of habitats; electricity generation with lower-carbon biomass (assuming it is cost-effective and environmentally sustainable) versus coal, but shifting from oil to liquefied coal for transportation fuels. Another familiar and important category of spillovers, though not directly reflected in the framework above, is that reduced pollution and improved natural resource productivity can improve human health, with positive implications for productivity as well as utility.[16]

There does not seem to be a clear tendency for activities that improve the productivity of environmental services also to affect the productivity of built capital itself, positively or negatively. We can in that context consider innovation in non-carbon renewable energy as a particular form of innovation in different forms of built capital (generation units, "smart grids") that in turn allow greater value of national output to be captured from the same or lower utilization of primary fossil energy. The nature of

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[14] The overarching caveat to these points is that the demand for green innovation is to a substantial extent created "artificially" through policy, as distinct from arising within markets as a response to those incentives. Because environmental and natural resource policies are inherently subject to uncertainty, this leads to investment and financing risks that do not arise for market-driven innovation.

[15] This is the "autonomous energy efficiency improvement" (AEEI) rate.

[16] An interesting measurement question here concerns the separate identification of more "direct" or "indirect" effects of benefits from reduced environmental degradation. Studies of the benefits of air pollution reduction include estimates of reduced medical costs, reduction in lost work days and corresponding output, and direct improvements in well-being from reduced episodic or chronic illness. This covers both direct and spillover impacts in terms of the framework put forward here.

spillovers thus seems more from capital to energy, as with energy efficiency, rather than the other way around.

Another category of productivity-enhancing actions involves institutional improvements, as noted above. One important example of a specific spillover effect from environmental actions to the broader economy can be policies reducing degradation of natural environments that also reduce exposure of built capital to natural disasters (assuming disaster risk probabilities are not properly reflected in private investment decisions or land-use policies). Policies to stimulate reforestation programs can slow the rate of CO_2 accumulation in the atmosphere, reduce erosion and water contamination, and provide direct monetary and non-monetary benefits. More debate surrounds the effects of environmental measures on the productivity of built capital, knowledge and institutional capital, and thus productivity of the economy as a whole.

Perhaps the best-known of these arguments is the "Porter hypothesis," that stricter and even more prescriptive environmental regulation also can increase productivity and thus enhance growth (Porter and van der Linde 1995). The basic argument is that tougher regulation motivates greater attention to previously unrecognized opportunities for general improvements in productivity, and that innovative efforts to address environmental requirements also spill over to improve general productivity.[17]

While Porter-type arguments continue to draw attention, in particular as a consequence of what would appear to be successful examples of their application, there is to date little empirical evidence in support of the hypothesis (Ambec et al 2011). However, there may be other circumstances in which synergies between environmental policy and economic progress could arise. Coordination of individual efforts to improve management of a common property resource also could help coordinate and improve the allocation of different labor services (Gibson, Williams and Ostrom 2005). It is also possible, in a second-best world, that efforts to reduce natural capital degradation also can have a co-benefit in reducing persistent structural unemployment. [18] The question remains, however, as to environmental and other policies compare in reducing unemployment and increasing overall welfare.

The last point highlights that one must consider market or policy failures other than those related to natural capital in assessing Green Growth possibilities. A category of economy-wide policy interventions that has been the focus of much attention and debate involves different types of "coordination problems." Included in this category are path dependencies in technology development and diffusion as a consequence of different types of economies of scale and scope. Innovation can depend on specific knowledge and human capital built up over the course of past innovation. Adoption

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[17] Embedded in the Porter hypothesis is the idea that for various reasons associated with limited information and managerial capacity, latent opportunities for improving productivity do not rise to the top of managerial attention until regulation requires that this take place.

[18] I am grateful to Stéphane Hallegate for drawing my attention to this point. The latter example illustrates that care is needed to distinguish the direct and spillover effects of changes in policies and institutions. Increases in natural capital have positive effects on employment as part of the general-equilibrium improvement in economic efficiency resulting from policies to improve the efficiency of natural capital investment and use. A different question would be: given distortions in labor markets that have engendered persistent unemployment, what are the ancillary effects of environmental and natural resource policies on the circumstances surrounding longer-term unemployment, over and above any changes in employment induced by policies that reverse excessive depletion of natural capital?

cost likewise will depend on past experience, both aggregate and investor-specific, leading to preferences for further improvement on the status quo versus a sharp departure from it.[19]

Economy-wide coordination problems are invoked by authors such as Rodrik (2008) and Lin and Monga (2010) to argue for a more interventionist "industrial policy" to resource reallocation in pursuit of faster and more robust economic development. Actions include differential tax treatment or provision of subsidies to encourage more rapid expansion of certain sectors seen to have potential for increased competitiveness due to economies of scale and learning-by-doing; and support of strategically targeted support for technology innovation and diffusion, and for "clustering" of development across certain industries to promote economies of scope in innovation and supply chain development.[20] An important target in designing industrial policies with synergistic effects includes a shift in production and trade toward some type of "latent comparative advantage" not yet developed within the economy.

The extent to which coordination problems are serious enough to provide a rationale for industrial policies, and the extent to which industrial polices can deliver more benefits than costs, remain controversial topics. Even less can be said with any assurance at this stage about particular advantages and disadvantages of more or less green approaches to industrial policies, for the economy or the environment. Uncertainty about the larger economic consequences of including green measures in industrial policies follows in part from the lack of empirical support for the Porter hypothesis, as pointed out previously. In addition, while one might envisage certain latent but emergent comparative advantages for supplying green technologies, based on growing demands for them, changes in market incentives and policies (fossil fuel price changes or adjustments of economic and environmental policies to economic crises) also introduce significant uncertainty in how these demands might evolve.

5. Concluding Remarks

This exploratory review has focused on potential channels through which Green Growth incorporates real opportunities for environmental sustainability and increased welfare beyond what would be captured through effective implementation of established policy wisdom in the economics of environmental and natural resource economics, in addition to applying established wisdom in growth and development policy in a reasonably coordinated way. Some opportunities for economic and environmental gain, like improved energy efficiency, already are well understood, and the debate continues to be more around the pros and cons of different instruments (fuel prices, efficiency standards). Other potential opportunities for use of established-wisdom policies are more difficult to evaluate because of limited experience, in particular due to political economy issues (e.g., water pricing and trade in use rights); nevertheless, there is no reason to doubt the potential to do more in these areas.

The current evidence on green-growth economy-environment synergies through policy spillovers seems weak and contradictory. Where opportunities may be found, there is some reason to think that they may

[19] Jaffe, Newell, and Stavins (2005) discuss these issues in the context of innovation and diffusion relevant to energy efficiency and "clean energy," among other environmental technologies.

[20] Industrial policy also is practiced through trade restrictions, though under WTO rules this cannot be done through explicit import barriers or export promotion subsidies.

arise more in the area of general investment in institutional capital (and human capital) than in policies specifically directed at factor-augmenting productivity improvement. Such institutional capital improvements in turn can have benefits even if environmental sustainability considerations are not a priority. These observations have implications for the political economy of Green Growth, in that the basis for advocating stronger environmental measures through anticipated growth co-benefits may be weaker, so far, than advocates would expect.

The empirical challenges for identifying and assessing the importance of these interactions is made more daunting given the difficulties in identifying the different factors potentially contributing to economic growth and changes in natural capital stocks. From a policy perspective, however, empirical research on green growth confronts a more basic question: Even where green-growth policy synergies are identified, to what extent is a package of green growth policies more welfare-enhancing than other, less-green policy packages? This observation emphasizes again that except for cases involving mitigating relatively large and high-risk environmental threats, policy options that maximize environmental sustainability and those that maximize overall environmental benefits are not necessarily that well-aligned. It thus is important to examine, for example, the extent to which technology adoption or industrial development policies have different consequences across developing countries for economic growth and poverty reduction as well as environmental sustainability. In circumstance in which individually rational economic development policies add up to a collective global threat to economic as well as environmental sustainability, then the first challenge will be providing incentives for developing countries to increase emphasis toward environmental sustainability in their policies without imposing what they would regard as unacceptable limits on growth prospects.

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