International Studies Quarterly (2008) **52**, 579–605

Uneven Economic Growth and the World Economy's North–South Stratification

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The liberal formula for peace and prosperity in the 21st century involves substantial convergence in economic growth rates between the affluent North and the poor South, facilitating a decrease in the global North–South gap. This diminished developmental gap should lead to reduced conflict within the South and between the North and South. The problem is that long-term world economic growth is stimulated in part by intermittent upsurges in radical technology generated principally in the system's lead economy. These growth impulses diffuse outwards from the center of the North unevenly. We hypothesize that Northern economies are the primary beneficiaries of these periodic extensions of the technological frontier and that much less trickles down to the South. We test this question of uneven diffusion with time series data dating back to 1870 on systemic leadership growth, Northern economic growth, and Southern economic growth. We find that technological gains in the North have been more likely to expand the North–South gap than to close it. To the extent that the South and Southern turmoil are a function of uneven growth and stratification, neither is apt to disappear anytime soon.

International relations are characterized by a number of dualities. One that seems to have emerged more recently, beginning or becoming more apparent at least by the early nineteenth century, pits a relatively small group of affluent states, to which we refer to as the global North, against the rest of the world, the global South. Economic inequalities are hardly a novelty in the history of international relations. In some respects, the North–South divide resembles the imperial center-periphery structures that have been around as long as there have been empires and hinterlands. Yet the North is not a centralized empire; nor is the South an undifferentiated hinterland. Instead, we have some 192 sovereign states—some of which are relatively rich while others are vastly poorer.

While the North might prefer to ignore the many problems of the South, the South tends to hold the North responsible for its disadvantaged plight. A South characterized by variable mixtures of failed states, terrorism, genocide, internal warfare, human rights violations, nuclear proliferation, major power

Author's note: Replication data and command files are available via the Dataverse Network Project (http://dvn.iq.harvard.edu/dvn/dv/isq) and the ISA data archive page (http://www.isanet.org/data_archive).

interventions, high population growth, migration pressures, debt crises, respiratory and viral disease incubation, energy source insecurities, humanitarian crises, environmental degradation, and the miseries of poverty and malnutrition, in any event, is not so easy to ignore. The happy solution is to have the South become more like the North as soon as possible. Were that to occur, the central tenor of contemporary international relations would be altered fundamentally and reduced perhaps to squabbles over fishing rights, tourism misadventures, and minor World Trade Organization violations. International relations would become more like what European international relations have become since 1945.

Liberal arguments foresee just such a global future outcome with the gradual diffusion of economic growth to the South. Liberal economic theory sees accelerated growth in the South eventually converging on slowing growth in the North, thereby diminishing appreciatively the North–South gap in income levels. Economic growth in the South would then lead to major gains in democratization and reduced conflict within the South, and between the South and the North.[1] But is this forecast probable? We think not, as it overlooks what we see as the inherent nature of long-term economic growth.

In our view, long-term economic growth is predicated on intermittent surges of radical technological innovation originating in a central country situated in the North. We refer to this country as the system leader. The intermittent surges of innovation have far reaching implications on the innovator's economy, but they diffuse unevenly to the rest of the world economy, absorbed in the North but much less so in the South. Rather than forecasting convergence, an appreciation for uneven technological diffusion suggests the probability of further North–South divergence as the North becomes increasingly more technologically complex in ways that the South cannot hope to emulate.

We evaluate the possibility of this pessimistic prediction by examining the effects of system-leader technological innovation on Northern and Southern economic growth. We anticipate that most of the beneficial effects are monopolized by the North with little going to the South. Indeed, as system leaders and Northern economies become technologically more complex and the South does not, the effects of technological innovation should be expected to negatively impact the South. Empirically, that is precisely what we find in examining North–South growth dynamics over the past 130 years.

The remainder of this paper is organized as follows: The next section presents the problem we study. The third section presents an overview of the leadership-long cycle perspective and extends it to the North–South gap. The fourth section presents our research design, the fifth section reports empirical results, and the sixth section summarizes our key findings and discusses their broad implications.

The Problem

Bairoch's (1982) data on the geographical distribution of manufacturing provide a useful starting point for this section, capturing what we think is the crux of the North–South gap. Manufacturing, as one index of the location and innovation of higher technology, became increasingly concentrated in the global North (Western Europe, North America, and, eventually, Japan). Table 1 focuses on the chief technology pioneers of the nineteenth and twentieth centuries, Britain and the United States, and two Bairoch aggregations, the developed countries (DCs), and the less developed countries (LDCs), including China, India, and a few Latin American states. We view these two aggregations as rough approximations of the global North and South, respectively.

[1] Citations for these arguments are provided in the next section.

TABLE 1. Proportion of World Manufacturing Production

Year	*Britain*	*United States*	*Developed World*	*Third World*
1750	1.9	0.1	27.0	73.0
1800	4.3	0.8	32.2	67.8
1830	9.5	2.4	39.5	60.5
1860	19.9	7.2	63.4	36.6
1880	22.9	14.7	79.1	20.9
1900	18.5	23.6	89.0	11.0
1913	13.6	32.0	92.5	7.5
1928	9.9	39.3	92.8	7.2
1938	10.7	31.4	92.8	7.2
1953	8.4	44.7	87.0	13.0
1963	6.4	35.1	91.3	8.7
1973	4.9	33.0	90.1	9.9
1980	4.0	31.5	88.0	12.0

Source. Based on data reported in Bairoch (1982).

TABLE 2. Estimated Shares of New Technology in Manufacturing Output

	1830	*1860*	*1880*	*1900*	*1913*
Britain	32–40	60–70	62–74	68–78	72–80
Other Developed	6–10	18–24	30–38	49–57	55–65
Third World	0–1	0–1	1–3	4–9	10–19

Source. Kozul-Wright (2006, 118).

Table 1 shows world manufacturing residing largely in the South through the first third of the 19th century but moving increasingly to the North by mid-century.[2] The two individual leaders in this shift are, first, Britain, peaking around 1880 (with 22.9%), and, second, the United States, peaking in the early 1950s (44.7%). For much of the 20th century, Bairoch's data suggest that most of the world outside the most affluent zone produced from 7% to 12% of world manufacturing output. After 1980, the global South continued to make gains, but the global North continued to monopolize manufacturing.

Table 2, also relying on Bairoch data, suggests another important dimension of this process. The innovators specialize in new or the latest technology, which gradually diffuses to other DCs but much less so to the LDCs. From 1830 to 1913, Britain controlled some 9.5–22.9% of the world's manufacturing output (Table 1). Yet much of this output, especially between the years 1860 and 1913, focused heavily on new technology. Other DCs gradually closed the gap. In 1830, the ratio of new technology foci in Britain compared with other DCs was on the order of about 5–1 (32–40% in Britain versus 6–10% in other DCs). By 1913, the ratio was about 1.27–1. In marked contrast, new technology was very slow to emerge in the Third World, and by 1913 the new technology specialization ratio remained heavily biased towards Britain (5:1) and other DCs (4:1). Clearly, new technology diffuses highly unevenly.

The South complains that LDCs cannot be expected to make much economic improvement in a world economy already heavily biased in favor of the North. The Northern response tends to rely on the liberal prediction that the poor will eventually become more affluent if they emulate the states that have already become rich. Other things being equal, the fast growth of the rich

[2] Keep in mind that 18th century manufacturing was not as complex an enterprise as manufacturing became in the 19th and 20th centuries.

should slow and the slow growth of the poor should accelerate as it takes advantage of the technology already created by the rich, ultimately leveling the playing field as the growth rates and development levels of the rich and poor converge. Yet other things are rarely equal. The global North gained its development lead in an earlier time and that context is not likely to be duplicated in exactly the same way in the 21st century.[3] One might well ask, for that matter, whether we should want the South to repeat the intense conflicts of the late 19th and the first half of the 20th centuries that the North endured. But such a question would be somewhat rhetorical because Southern states lack the technological infrastructure and development that provided both an economic foundation and substantial motivation for the world wars of 1914–1918 and 1939–1945.

In terms of motivation what we mean is that world wars are fought in part because of ascent and decline patterns in relative technological gains, with late developers challenging early developers. By development, moreover, we do not simply mean production gains. Long-term modern economic growth is propelled by cumulative waves of technological expansion and production frontier discontinuities, including successive waves of early industrialization in iron and textile production, steam engines, chemistry, steel, electrification, gasoline engines, and, today, information technology. Each wave is led by a pioneer economy that develops the new technology and reaps the benefits of pioneering activity. Other economies adapt these technologies as best they can. Some improve on the initial innovations; others simply copy. But there is no guarantee that all economies will be able to adapt to the newly established production frontiers. On the contrary, those economies that have been most successful at adapting remain restricted to a small set of advanced economies—the North. The rest of the economies make up the South. Movement out of the South into the North is not impossible, but so far it has been accomplished by few Southern states such as late-19th century Japan or post-1970s South Korea and Taiwan.

Why might that be the case? The two most prominent types of arguments—herein labeled ''liberal optimism'' and ''Northern vampirism''—do not appear to be very helpful. Neither one is totally invalid, but neither one fully explains the central gap phenomenon—that is, that the gap appears to be widening. The liberal optimism approach predicts that the gap should narrow. The Northern vampirism view predicts that no Southern states should be able to bridge the gap. Instead, the gap widens even though a few LDCs have moved into the North and a few others may follow.

The case for liberal optimism is predicated on the notion that economic growth is a generic activity in which everyone can participate but that, in some cases, various obstacles prevent full participation (Barro 1997; Lucas 2003; Singer and Wildavsky 1996). If poor countries can rid themselves of obstacles such as government intervention, corruption, land inequalities, low literacy, and excessive population growth—or, in other words, become more like the affluent societies (Dowrick and DeLong 2003, 204–5)—they too can enjoy faster growth rates. Eventually, the faster growth rates of the later developers should catch up or converge with the de-accelerating growth rates of the early developers, and income levels converge. As one economics Nobelist puts it:

> Sooner or later everyone will join the industrial revolution…all economies will grow at the rate common to the wealthiest economies…percentage differences in income levels will disappear…Ideas can be imitated and resources can and do flow to places where they earn the highest return (Lucas 2000, 166).

[3] For insight into the domestic nature of the earlier context, see Chang (2002).

To be sure, there is empirical evidence for this convergence process, but it is almost exclusively restricted to the Northern group. Later developers within the North have been able to absorb or adapt the technological innovations generated by the British (primarily 19th century) and American (primarily 20th century) pioneers. Their income per capita levels, as a consequence, have tended to converge on those of the Northern leaders. The same statement applies only to a few Southern states, and even here the convergence is often far from including the majority of the population.

The ''Northern vampirism'' argument emphasizes that the North has exploited the South for hundreds of years and that the wealth of the North is only possible because of this exploitation. The North reserves for itself high-profit manufacturing, which can be purchased by the South while restricting the South to providing food and raw materials to the North. Since the North is highly unlikely to abandon its own path to success voluntarily, it is up to the South to break its structural dependency on the North somehow and to proceed to develop its own industry as autonomously as possible (Frank 1978; Wallerstein 1974, 1980, 1989).

Even though we are hard pressed to deny the evidence for exploitation, there are several problems with this view. One notable problem, already mentioned, is that some Southern states have beaten the odds and moved up the technological gradient. Presumably, they should not have been able to do this unless either they were simply anomalies or there are significant weak points in the nature of Northern dominance. Either way, upward mobility is not ruled out and therefore must be explained. A second problem is that it is not at all clear that Northern prosperity has consistently depended on access to Southern goods or markets. Northern trade, investment, and prosperity are largely Northern-centric. If we are right in according technology a strong driving force, developments in technology have reduced the dependence on Southern raw materials—not intensified them. In many respects, the greater Southern problem these days is how to claim more attention from the North rather than less. Thus, if exploitation was once blatant and prominent, neglect seems more problematic these days.

As noted, we do not rule out the possibilities of liberal catch-up or Northern exploitation. What is missing from these interpretations, however, is the vital role technology plays in driving economic development. Building in part on Kondratieff (1984) and Freeman and Louca (2001), we argue that technological progress is the main carrier of long-term growth. In our view, progress comes in successive waves that at least partially supplant earlier waves via Schumpeter's (1939) creative destruction, emanates primarily from a single source, and then diffuses unevenly to other economies. If we are correct, the Southern problem is more one of avoiding falling further behind than it is of catching up or evading exploitation. If the South is generally unable to adopt or adapt to successive technological breakthroughs, it will likely fall farther behind a frontier that is intermittently advanced in the North. Some Southern catch-up may be feasible in terms of earlier technological waves, but it is likely to remain too many waves behind to make much progress vis-à-vis convergence.[4]

This argument seems eminently testable. Reuveny and Thompson (2001, 2004b) have demonstrated that U.S. technological change has driven U.S. aggregate economic growth and that both U.S. technological change and aggregate

[4] Prebisch (1950) and Myrdal (1957) offer similar views, but without technological waves pioneered by a single source, assuming the innovations remain the monopoly of DCs. Neoclassical growth theory (e.g., Solow 1956) also stresses technological change but does not explain its source. New growth theory (e.g., Romer 1986) reserves a key place for progress but focuses on generic knowledge. Both theories assume that technology and human capital are fully mobile, though empirical economists observe that they are not (Abramowitz and David 1996; Baumol 1986), attributing innovation failures to something missing in the receiving side (e.g., savings, good government, education).

economic growth have driven world economic growth. We can reframe this in terms of the North–South divide. Do system-leader technological change and aggregate growth contribute equally to Northern and Southern economic growth? Or, is it more likely, as we argue here, that these forces primarily diffuse to the North and much less so to the South? We think the leadership-long cycle perspective is a useful tool in approaching these questions.

The Leadership-Long Cycle View and North/South Economic Growth

The leadership-long cycle perspective observes that, historically, systemic leadership and world economic growth have consistently followed a twin-peaked wave pattern, each wave lasting roughly 50 years.[5] During the first wave (ascent), one country rises to leadership in the world system. During the second wave (catch-up), the leader is established but then begins a relative decline as competitors emerge. In *upswing* phases of each wave, leadership and growth are expanding. In *downswing* phases of each wave, they are contracting. In the ascent wave, political relationships among the most powerful states are destabilized by uneven growth. In the downswing phase of this wave, a global competition follows the destabilization, which historically (between 1494 and 1945 in any event) involved global combat between coalitions led by the leader and by a challenger. One state emerges as the principal winner or systemic leader thanks in large part to its lead in technological innovation. A catch-up wave follows in which a new competition builds. The leader gradually loses its economic and political edge, and a new ascent wave is initiated with the next system leader emerging.

A number of generalizations related to this interpretation have been developed and tested elsewhere.[6] For instance, the key to global ascent is the successful monopolization of radical innovations in leading sectors of commerce and industry, such as mechanized textile looms, steam engines, electrification, automobiles, jet engines, and computers. The introduction of leading sectors leads to the growth of the pioneering lead economy and, in turn, the growth of the lead economy stimulates world growth. The monopoly profits finance the buildup of the leader's military capabilities of global reach, which are critical for maintaining its global concerns. At its peak, the system leader maintains a commanding lead in global reach power. Then, as the leader's economic centrality dissipates, so too does its lead in global reach power, albeit subject to some lag. World economic growth and shifting concentrations in radical innovation eventually reduce the economic lead of the pioneer. Even so, only some economies converge on the leader's position of affluence and technological sophistication.

One primary feature of this process is its discontinuous nature. Economic growth and radical innovations have been manifested as long waves that decay when the innovational novelties lose their ability to accelerate growth. As old innovations become routine components of the world economy, new spurts in economic growth hinge on the advent of the next cluster of radical technological change. A second strong feature, therefore, involves alternating periods of fast growth (stimulated by new technology) and slow growth (brought on by the routinization or decline of now old technology). As Freeman and Louca (2001) and Perez (2002) observe, to the extent that new technology is slow to emerge or encounters infrastructure inadequacies or political obstacles, slow or negative economic growth (economic depression) is likely to persist until at least some of these barriers are overcome. Several extensions of the leadership-long cycle

[5] Given its scope, we cannot fully review the leadership-long cycle literature. For expositions (without attention to the South), see Modelski and Thompson (1996) and Thompson (2000).

[6] See, Modelski (1987, 1996), Thompson (1988, 2000), Rasler and Thompson (1994), Modelski and Thompson (1988, 1996), and Reuveny and Thompson (2004b).

perspective to deal with North–South-related phenomena have been pursued recently in the literature, centering on issues such as North–South income inequality, Southern debt crises, Southern democracy, and North–South violent conflict (Reuveny and Thompson 2002, 2003, 2004a, 2005, 2006, 2007, 2008). For each of these phenomena, a theoretical and empirical case has been made that they are strongly influenced by global processes predicated ultimately on the nature of technological change and the consequent political-economic hierarchy outlined above.

Having presented the perspective, we can combine its principles with some selected observations on structural problems related to technology transfer. We retain the assertion of the leadership-long cycle perspective that systemic leadership and the long waves of discontinuous economic growth, for which system leaders are primarily responsible, drive long-term fluctuations in world economic activity. Economic innovation in the lead economy creates technological spurts that drive long waves of economic growth and fund systemic leadership capabilities. Yet economic growth never operates on a level playing field. Some parts of the world economy are favored over other parts, and we need to build this fact of life into our growth models.

From our perspective, economic growth especially depends on intermittent surges in technological change introduced by the lead economy. As a consequence, new products and industries emerge in discontinuous fashion. So too do new ways of making communication and the transport of goods faster and cheaper, thereby reducing transaction costs.[7] These innovations do not simply fall from the sky; they are introduced and developed primarily by system leaders. In the 17th century, it was the Dutch. The 18th and 19th centuries were dominated by British technological change. In the 20th and perhaps the 21st centuries, the United States has been the principal pioneer in the way people produce, consume, exchange, and transport goods.

Surges in economic growth in other countries, therefore, are fueled by waves of long-term growth stimuli emanating primarily from the system leader's innovative economy, which promotes the world economy in two interrelated channels: The leader's radical innovation drives growth at home and abroad, and the growth of the leader's economy itself stimulates the world economy. In order to obtain the new products, some reductions in barriers to trade will ensue. Technological diffusion will enhance the ability of some other economies to produce the new products and these expanded competencies may encourage lowered trade barriers.[8] In the process, the system leader increasingly has come to serve as a principal source of investment and finance, thereby providing further encouragement for positive growth spirals.

Order in long distance commerce is another contribution traceable to system leaders. Technological growth and predominance in leading sectors of commerce and industry give the system leader an added incentive to develop specialized capabilities of global reach. Trade routes must be kept open and secure from interference and piracy. For this reason a concentration in technological innovation tends to be accompanied by a concentration in global reach capabilities. Historically, global reach capabilities have been predominately naval given the maritime medium favored by long-distance trade throughout much of the past five centuries. Not only does the leader have an incentive to develop such

[7] We do not suggest that the leader's economic growth always reduces all types of transaction costs. Our emphasis here is placed on reducing the costs of globally transporting products and information.

[8] Diffusion processes may include knowledge transfer that often accompanies trade or foreign direct investments, relocation of entrepreneurs, government policies that attract foreign business, knowledge transfer from studying in foreign countries, migrant contacts with the home country, and government-to-government transfers. We think these complex processes are better studied in a separate paper.

powers, it also has the wherewithal—thanks to the rents from technological leadership—to fund it.

Economic growth is thus stimulated fundamentally by a package of technological change, lowered transaction costs (including costs pertaining to security), lowered trade barriers, expanded investment, and economic growth diffusion, all of which are attributable to some extent to the actions of system leaders. If the source of these changes is highly concentrated, the impacts of the changes are apt to be less than universal. Some parts of the world are likely to benefit more while others benefit less, depending on factors such as resource endowment, location, and receptivity to technological diffusion.

We know that the historical pattern has been one of certain regions being favored—Western Europe, North America, Australia/New Zealand—by 19th and 20th century investment, migration, trade, and technological diffusion. What about other countries? Lall (2003) provides one good handle, summarized selectively in Table 3, on the imperfections of the spread of technology. His main point is that economic theory makes assumptions about this process that are not manifested empirically. In theory, technology is freely available to whoever needs it. It can be pulled off the shelf and applied wherever its development seems efficient and appropriate. But in reality, there are a number of reasons why technology is unlikely to spread widely and easily. Actors may be less aware of what technology might be available than is often assumed. Path dependencies shape trajectories that are often difficult to alter. While technological backwardness can lead to rapid growth as late developers close the gap with pioneers, underdevelopment often means that acquiring technology and learning how to use it is all the more difficult. Critical skills are likely to be lacking. So, too, are supportive linkages to external information and resources. Some technologies are difficult to learn. Moreover, simply learning how an existing technology works may not be sufficient if the capability for innovating new technology remains out of reach.

Yet even if these adaptation problems are somehow overcome, innovation and technological information have been increasingly controlled by transnational corporations. Economies of scale and vertical and horizontal organizational networks encourage the concentration of production sites. Some states may benefit but many more will be marginalized. From Lall's vantage point, the diffusion of Northern technology to the South is therefore a highly uneven process in which only a few states have overcome the structural problems in successfully acquiring technology (Lall 2003). The outcome is summarized by the array in Table 4 of the distribution of manufacturing in the developing world towards the end of the 20th century. Three observations seem most pertinent. Different parts of the global South have done better than other parts. East Asia has done best, followed distantly by Latin America and the Middle East. The positions of the non-Asian regions deteriorated in the period between 1985 and 1998. Only East Asia has had much success in producing high technology, which we take to be an indicator of what Lall refers to as ''technology learning'' of greater depth than is manifested elsewhere.

Table 5 offers a quick look at the additional contention that transnational corporations are overwhelmingly Northern. In 1995, six of the 500 (1.2%) largest corporations in the world (based on revenues) were Southern (Table 7 in the next section classifies countries as Southern or Northern). By 2005, the proportion had expanded to 34 of 500 (6.8%). Table 5, however, suggests two qualifications to this growth. In 2005, 16 of the 34 are Chinese, and China, presumably, is on course to leave the South at some point in the 21st century. The other 18 are headquartered in Venezuela, Mexico, Thailand, Brazil, Malaysia, Saudi Arabia, Turkey, and India. The exceptions to the predominance of Northern firms then, are highly concentrated. They also tend to focus on national

TABLE 3. Theory and Reality in Technology Development

Theoretical Assumptions in Economics	*Reality*
Actors have full knowledge of technology, which can be readily transferred. Production functions are universal. National endowments may vary.	Information on technology is difficult to locate and evaluate. Knowledge about technology is imperfect and hazy.
Once technology is perceived to be appropriate, its application is immediate in all circumstances.	The successful transfer of technology is a prolonged process that depends on local learning.
All actors use technology with the same efficiency. If there is any learning involved, it is uniform, predictable, and costless.	Each actor has a unique learning path depending on initial situation and subsequent efforts. Learning is more costly, riskier, and more uncertain at lower levels of development.
Actors maximize well-defined objectives that are easily switched as appropriate.	Actors satisfice and develop organizational routines that are adapted over time based on experience and imitation. The cumulative nature of learning and path dependence make it difficult to change technological trajectories.
Learning how to use technology is a generic process. Technology is technology.	Different technologies involve different learning costs, risks, skills, and linkages. Some are much more difficult than others.
Technology transfer is an autonomous process.	Different technologies have different degrees of interaction with, and dependence on, outside sources of knowledge, resources, and markets.
Technological development is a generic process. All technology acquired is beneficial to economic development.	Technology development takes place at different depths. One can use imported technology without being able to adapt or reproduce it, leaving the developer dependent on external actors.
Appropriately skilled labor, as well as research and development capabilities, will be available for any technological development.	Advanced technologies and research and development capabilities increasingly require higher levels of knowledge, numeracy, and industrial skills that may be absent, or in short supply due to illiteracy, restricted educational infrastructure, and lack of industrial experience.
Foreign direct investment (FDI) is readily available as a way to acquire technology.	FDI is highly concentrated. In 1998, 10 states received 76% of total FDI in the LDCs.
Corporate enterprises can be created as appropriate and potentially anywhere in order to engage in economic competition.	Large firms in industrial countries dominate the world corporate scene, their respective industries, trade, and innovation.

Source. Based on the discussion in Lall (2003, 282–286).

monopolies dealing with petroleum and telecommunications in large countries, owing their size to something other than global competition and technological innovation. Even the Chinese exceptions have so far not represented the Chinese economy as a whole, large parts of which still remain highly underdeveloped.

Putting it all together, the North–South arena is not necessarily static, but there seem to be limitations in diffusing technology. The international political economic structure seems stacked against a substantial or near-future diminishment of the North–South gap. We argue that the system's lead economy periodically extends the technological frontier by introducing radical innovations. Pioneering revolutionary industries help to bestow a substantial production edge

TABLE 4. Regional Shares of Developing Countries' Manufactured Exports

Sector	*Year*	*East Asia*	*South Asia*	*Middle East*	*Latin America*	*Sub-Saharan Africa*
All Manufactures	1985	56.9	4.5	12.9	16.9	2.6
	1998	69.0	3.8	6.0	8.9	0.8
High Technology	1985	81.0	1.1	1.8	6.6	1.3
	1998	85.5	0.6	0.7	2.1	0.0

Notes. The numbers in the cells represent percentages of developing countries' total manufactured exports. The Middle East includes North Africa. Latin America excludes Mexico. Sub-Saharan Africa excludes South Africa.
Source: Based on Lall (2003, 281).

TABLE 5. Southern Firms in the Fortune Global 500 Largest Corporations

1995	*2000*	*2005*
Pemex (Mexico)	PDVSA (Venezuela)	Sinopec (China)
Bank of China	Sinopec (China)	State Grid (China)
Indian Oil	State Power (China)	PDVSA (Venezuela)
Cofco (China)	Pemex (Mexico)	China National Petroleum
Itausa-Investimentos (Brazil)	China National Petroleum	Pemex (Mexico)
Telebras (Brazil)	Indian Oil	Petrobras (Brazil)
	Industrial and Commercial Bank of China	Petronas (Malaysia)
	China Telecommunications	China Mobile Communications
	Bank of China	China Life Insurance
	Petronas (Malaysia)	Bank of China
	Sinochem (China)	Hutchison Whampoa (China)
	China Mobile Communications	PTT (Thailand)
	Carso Global Telecommunications (Mexico)	China Southern Power Grid
	Banco do Brazil	Banco Bradesco (Brazil)
	Agricultural Bank of China	China Telecommunications
		Baosted Group (China)
		Sinochem (China)
		Sabic (Saudi Arabia)
		Reliance (India)
		Koc Holding (Turkey)
		Bharat Petroleum (India)
		Hindustan Petroleum (India)
		America Telecommunications (Mexico)
		Oil and Natural Gas (India)
		Itausa-Investimentos (Brazil)
		China Railway Engineering
		Carso Global Telecommunications (Mexico)
		Cemex (Mexico)
		Cofco (China)
		China First Automotive Works
		Shanghai Automotive (China)
		China Railway Construction
		China State Construction
		State Bank of India

Notes. The national identity of the firm is stated in parentheses unless the national identity is found in the firm's name.
Source: The information has been extracted from Fortune (1996, 2001, 2006).

on the entire economy that takes the lead.[9] Some other economies are able to absorb the innovations and growth emanating from the leading economy relatively quickly; others do not have the demand, infrastructure, access to investment, or required know-how. As a result, other things being equal, the gap between the system leader and the North vis-à-vis the South does not close.

The process is not solely economic. Political factors play a role in the diffusion of technology. Lall (1992, 1996, 2003, 2004a), for example, argues that successful adoption of technological diffusion and buildup of industrial capability requires government policies that provide institutional, infrastructural, financial, educational, and coordinative supports to the private sector, ameliorates market failures, and promotes saving and investments. The East Asian miracle, he argues, demonstrates the importance of an activist approach to industrial and technological development.

While these national policies can have some impact, they do not operate in a political economic vacuum. As Lall (2004b) generally writes, changes in the global economic environment and international ''rules of the game'' can constrain governments. In our perspective, systemic leadership provides the required international orders for the world economy, including public goods such as institutions that promote freer trade, global financial institutions, stable currency markets, lending of last resort, and political pressures and outright interventions to stabilize crucial regions. While these international orders may not profit everyone equally, they are expected to be beneficial for both North and South, as long as the system leader is in a reasonably strong position to provide them.

Empirical Research Design

Having stated our theoretical argument, our question is whether it can be further substantiated empirically. To that effect, we examine the following two models:

$$\begin{aligned}\text{NORTHERN ECONOMIC GROWTH} = {} & \alpha_0 + \alpha_1 \text{LEADING SECTOR GROWTH} \\ & + \alpha_2 \text{LEADING SECTOR SHARE} \\ & + \alpha_3 \text{SYSTEMIC LEADERSHIP} \\ & + \alpha_4 \text{LEADER GROWTH RATE} \\ & + \alpha_5 \text{NORTHERN GROWTH INERTIA} \\ & + \alpha_6 1914\ \text{DUMMY} \\ & + \alpha_7 \text{SOUTHERN ECONOMIC GROWTH} \\ & + u\end{aligned}$$

$$\begin{aligned}\text{SOUTHERN ECONOMIC GROWTH} = {} & \beta_0 + \beta_1 \text{LEADING SECTOR GROWTH} \\ & + \beta_2 \text{LEADING SECTOR SHARE} \\ & + \beta_3 \text{SYSTEMIC LEADERSHIP} \\ & + \beta_4 \text{LEADER GROWTH RATE} \\ & + \beta_5 \text{SOUTHERN GROWTH INERTIA} \\ & + \beta_6 1914\ \text{DUMMY} \\ & + \beta_7 \text{NORTHERN ECONOMIC GROWTH} \\ & + v.\end{aligned}$$

[9] For example, Ford's assembly line changed the automobile industry and diffused to other industries.

In these models, Greek letters are coefficients, and u and v are error terms. The dependent variables, NORTHERN ECONOMIC GROWTH and SOUTHERN ECONOMIC GROWTH, are economic growth rates attained by the North and South. SYSTEMIC LEADERSHIP is the leader's share of global reach capabilities held by major powers. LEADING SECTOR GROWTH RATE is the growth rate of the leading sector in the leading economy. LEADING SECTOR SHARE is the leader's share of global leading-sector output produced by major countries. LEADER GROWTH RATE is the growth rate of the leader's economy. NORTHERN GROWTH INERTIA and SOUTHERN GROWTH INERTIA are the lagged values of each dependent variable, and 1914 DUMMY is set to one after 1914, and to zero otherwise. Next, we describe these variables in detail, and link them to our theory.

Dependent Variables

NORTHERN ECONOMIC GROWTH is the growth rate of the Northern economy, where the North excludes the leading economy, identified as the U.K. before 1914 and the United States after 1914. SOUTHERN ECONOMIC GROWTH is the growth rate of the Southern economy. Data for the North and South units of analyses must be computed from national data, which requires assigning countries to North and South.

Since the processes discussed here are relatively slow, we need long time series. However, the most common index of output—real Gross Domestic Product (GDP)—is a relatively recent concept. GDP data typically date to about 1950. To be sure, some DCs have longer series, but this is of limited help if one wishes to collectively compare DCs and LDCs. There is one major exception to this empirical lacuna. Maddison (1995, 2003) provides historical real GDP data on a number of states, expressed in constant dollars, purchasing power parity-adjusted terms. These data are not without limitations. In particular, as one goes further back in time before 1945, they are based on estimates, not economic measurement in the usual sense. However, we currently see no alternatives. Until better information becomes available, Maddison's work remains the only effort to generate the comparable wealth data we need.[10]

When we began the long-term research project of which this paper is a part, Maddison (1995) offered time series of various lengths on 56 states from 1870 to 1992, which we employed in seven papers (Reuveny and Thompson 2002, 2003, 2004a, 2005, 2006, 2007, 2008). These 56 countries account for more than 90% of the output of the world economy and population (Maddison 1995). Recently, Maddison (2003) has extended the 56 time series to the year 2000, added a number of Southern estimates after 1950, and extended a few Northern series with estimates dating back to 1820. We use Maddison's (2003) estimates to extend the series of our 56 states from 1992 to 2000. We do not use the pre-1870 estimates, since only a few time series are affected and the estimates are quite controversial, and we do not use the post-1950 estimates, since we seek to keep our sampling approach as consistent as possible. The new Southern estimates would only accentuate the estimation of the North–South gap, making it easier for us to support our theory empirically, and, in any case, the added estimates account for a very small part of the world economy and population.[11]

[10] For contrasting views on the pluses and minuses of Maddison's economic data, see Hanson (1997), Verspagen (1998), and Holz (2006).

[11] Most of the new Southern information made available by Maddison encompasses African and Middle Eastern states that are among the poorest states in the world system.

Maddison's data have some missing points. We fill in the data gaps between any two given points in Maddison's data by using linear interpolation.[12] Of course, the interpolated portions may not be accurate. However, the reader may recall that we aggregate the data to create indices for North and South. Some distortion is naturally acceptable at this level of aggregation. Moreover, the most complete series account for most of the world economy. Thus, we think that our interpolations do not distort the big picture at which we are looking.

Having generated the national data, we proceed to aggregate them in North and South groups. We are aware that the conventional approach to economic growth focuses on national changes. Some readers, therefore, may rebel against this aggregation. The North–South aggregation, however, is warranted for our systemic argument. We focus on differences between the two groups, and assume that the differences within each of the groups are not sufficient to undermine the rationale for our comparison. Threats to validity posed by this approach are discussed toward the end of this section.

There is no convention for North–South classification. Some studies base their identifications of countries as Northern and Southern on the timing and extent of industrialization, but leave the criteria implicit (e.g., Freeman and Perez 1988; McCormick 1988; Rostow 1978). Other studies classify countries as Northern or Southern on the basis of shorter periods of time, often mixing economic and military capabilities (Arrighi and Drangel 1986; Kentor 2000; Kick 1987).

We classify countries as Northern or Southern based on level of economic development, but with a systemic twist. A country is classified as Southern if its GDP per capita is equal to or less than 25% of the highest real GDP per capita in the system; otherwise, it is classified as Northern (Reuveny and Thompson 2002, 2003, 2004a, 2005, 2006, 2007, 2008). Economic development, in this view, is a process of catching up with the technological frontier established by the system leader. As Dowrick and DeLong (2003) note, development is not the categorical attainment of some threshold. Rather, it is movement toward a level established by the best institutions, technologies, and productivity levels introduced by the development leader(s). ''What you are converging to is thus a moving target'' (Dowrick and DeLong 2003, 195). Our use of GDP per capita does not mean that development is simply a matter of attaining some income. We use it because it is simple and comes close to working without intervention. Constructing indices measuring modernity of national technology would be an ambitious project in its own right. While our method is not perfect, we need a dynamic threshold. Using a single absolute threshold, as in Kuznets (1972) or Passe-Smith (1998), will not work for long periods. Our experimentation with

[12] Overall, 19% of the series are interpolated, assuming each missing year experienced its average share of the change between points supplied by Maddison (1995). Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Netherlands, New Zealand, Norway, Sweden, Britain, and the United States have complete series. Chile and Venezuela have complete series from 1900. Ivory Coast, Ethiopia, Kenya, Morocco, Nigeria, Tanzania, and Zaire have complete series from 1950. Data for the other 41 states either begin after 1870, have gaps, or both. We interpolate data for the following countries/years: Japan (1871–1884); Switzerland (1871–1898); Spain (1871–1889, 1891–1899); Argentina (1871–1889, 1891–1899); Brazil (1871–1889, 1891–1899); Mexico (1871–1889, 1891–1899); China (1871–1889, 1891–1899, 1901–1912, 1914–1928, 1939–1949); India (1871–1899, 1891–1899); Indonesia (1871–1889, 1891–1899); Ireland (1871–1889, 1891–1899, 1901–1912, 1914–1925, 1927–1928, 1930, 1932, 1934–1935, 1939–1946); Portugal (1871–1889, 1891–1899, 1901–1912, 1914–1928, 1930–1937, 1939–1946); Hungary (1871–1899, 1901–1913, 1914–1919, 1921–1923, 1943–1945); Czechoslovakia (1871–1889, 1891–1899, 1901–1912, 1914–1919, 1938–1947); Russia/USSR (1871–1889, 1891–1899, 1901–1912, 1914–1927, 1941–1946); Egypt (1901–1912, 1914–1949); Ghana (1901–1912, 1914–1949); Greece (1914–1928, 1940–1941, 1943–1944); Turkey (1914–1922); Bulgaria (1914–1923, 1946–1949); Poland (1939–1949); Romania (1939–1948, 1949, 1951–1954, 1956–1959); Yugoslavia (1914–1919, 1940–1947); Colombia (1901–1912, 1914–1924); Peru (1901–1912); Bangladesh (1901–1912, 1914–1928, 1930–1931, 1933–1937, 1939–1947); Burma (1902–1905, 1907–1910, 1912, 1914–1915, 1917–1920, 1922–1925, 1927–1930, 1932–1935, 1937, 1939–1949); Pakistan (1901–1912, 1914–1928, 1930–1931, 1933–1937, 1939–1947); Philippines (1901–1912, 1914–1928, 1930–1937, 1939–1949); South Korea (1901–1912); Taiwan (1901–1902); Thailand (1871–1889, 1891–1999, 1901–1912, 1914–1928, 1930–1937, 1939–1949); and South Africa (1914–1949).

TABLE 6. Northern–Southern Countries Classification

North		*South*	
United Kingdom	Japan (after 1894)	Argentina	South Korea (to 1982)
United States	Finland (after 1919)	Brazil	Philippines
Belgium	Poland (after 1929)	Chile	Taiwan (to 1976)
Netherlands	Russia (after 1931)	Colombia	Thailand
Switzerland	Greece (after 1956)	Mexico	China
Denmark	Portugal (after 1957)	Peru	India
Austria	Taiwan (after 1977)	Venezuela	Burma
France	South Korea (after 1983)	Turkey	Indonesia
Sweden		Japan (to 1893)	Pakistan
Canada		Finland (to 1918)	Bangladesh
Australia		Poland (to 1928)	Ethiopia
New Zealand		Russia (to 1930)	Egypt
Ireland		Bulgaria	Morocco
Czechoslovakia		Yugoslavia	Nigeria
Hungary		Rumania	Zaire
Norway		Greece (to 1955)	Ivory Coast
Spain		Portugal (to 1956)	Kenya
Italy			Tanzania

Notes. Maddison provides economic data for some states prior to their independence. Thus, these states are considered as Northern or Southern from 1870 on unless their series begins later than 1870 due to missing data, or as otherwise indicated due to movement from the South to the North.

higher thresholds (e.g., 33% and 50%) restricted the North to a few Western European states and their offshoots. The 25% threshold permits more non-Western European/non-North American states to join the North beginning in the 1920s. If forced to choose between a limiting and liberal North–South threshold, we prefer to err on the liberal side. Table 6 presents the resulting coding.

Table 6 conforms to clues provided in the economic history literature. The order of leaving the South and joining the North seems intuitively satisfying. For example, in 1870 we start with a bloc of European and North American states. Our South includes many of the overtly LDCs, such as China and India. Only eight states in our sample transition from South to North: Japan (in 1894), Finland (1919), Poland (1929), the Soviet Union (1931), Greece (1956), Portugal (1957), Taiwan (1977), and South Korea (1983). A change in status for Japan in the 1890s is not controversial. Japan is followed by a few European states which are, in turn, followed by Taiwan and South Korea. Had the East Asian states or the Soviet Union not made the transition to Northern status several generations after 1870, we might question the reliability of Table 6. That they did transition at reasonable times gives Table 6 face validity.[13]

Independent and Control Variables

Since our goal is to evaluate the effects of leadership long-cycle variables in the North and in the South, we employ the same core independent variables in both cases. Our first two variables represent technological change in the leading economy. LEADING SECTOR GROWTH measures the yearly growth rate of leading-sector production in the leading economy. LEADING SECTOR SHARE measures

[13] In evaluating our list, we also checked if moving Southern states that improved their status to the North guarantees that the North stays ahead. We specified the North in 1870 and forbade moves between blocs, ignoring for the moment Dowrick and Delong's (2003) ''moving target.'' We find that it does not matter empirically which method is used, as only a few states have moved to the North (Reuveny and Thompson 2003).

the yearly share of the global leading-sector production held by the system's lead economy. For our period, we identify the U.K. as the leading economy in 1870–1914, and the United States after 1914.

Any economy is characterized by activities in various sectors. Some sectors are relatively stagnant, others grow slowly, and a few not only grow rapidly but also accelerate the growth of the economy. This last type of sector is linked directly to the idea that long-term growth comes in spurts and is carried by specific and radical innovations in commerce and production in certain sectors (Modelski 1982; Modelski and Thompson 1996; Rostow 1978; Thompson 1988). We refer to these sectors as ''leading sectors.'' Some authors (e.g., Freeman and Perez 1988) refer to them as ''technological regimes or trajectories.'' Others (e.g., Helpman 1998) call them ''general purpose technologies.'' Whatever the terminology, the underlying assumption is that new technology comes in clusters in some sectors, diffuses throughout the pioneering economy, and then diffuses to receptive areas in the rest of the world.

To best measure leading sectors, one must select indicators that simplify the complex changes under way while not attempting to measure all possible facets of new technological regimes. However, it is essential to select sectors that made a difference in their respective time periods. Table 7 lists our leading sectors, which have been consistently highlighted by all the leadership-long-cycle analyses cited above as applicable since the mid-19th century. The ''high growth'' dates identify the periods during which the particular sectors gained the lead. The ''start-up'' dates indicate periods during which sectors were in a phase of preliminary development.

Once the leading sectors and their periods are identified, the next problem is one of developing a schedule of sector entry and exit. Yet, Table 7 does not suggest how to develop continuous series, and data are often not available for leading-sector production in their early periods. The primary operational question, therefore, is not so much when to begin counting a leading sector but, rather, whether one should abruptly discontinue sectors after their high-growth periods are concluded.

For the pre-1973 period, we use the leading sector entries and exits from Rostow (1978) and Modelski and Thompson (1996). Since the early leading sectors are predicated on the British leadership phase, we maintain the late-19th century indicators of innovation for the United States through the following high-growth periods, assuming some lag in the transmission of British innovations to the American economy. Beginning with electricity consumption, however, we continue to employ a leading-sector indicator through only the following start-up phase. This procedure yields the following indicator schedule: iron/steel production (1800–1945), railroad expansion in terms of absolute line

TABLE 7. Lead Industries, Indicators, and Timing

Industry	*Indicator*	*Start-up*	*High Growth*
Railroads	Railway track open Railroad track density	1792–1815	1815–1850
Steel	Steel production	1850–1873	1873–1914
Chemicals	Sulfuric acid production		
Electrics	Electricity consumption		
Motor Vehicles	Motor vehicle production	1914–1945	1945–1973
Electronics	Semiconductor industry sales		
Information technology	Information industry production (ISIC group 3825, 2832 and division 385)	1973–2000	2000–2030?*

* The ''?'' denotes the uncertainty associated with forcasting two decades into the future.

laid and line laid/total area (1830–1914—with both indices given equal weight), acid production (1868–1945), electricity consumption (1903–1945), motor vehicle production (1914–2000), and semiconductor production (1954–2000). For the post-1973 period, we follow Hall and Preston (1988) in aggregating data on three United Nations International Standard Industrial Classification categories: 3,825 (office, computing, and accounting machinery), 3,832 (radio, television, and communication equipment), and 385 (scientific, controlling, measuring, and photographic/optical equipment). This indicator captures the ongoing development of the information age's leading sectors without the benefit of any hindsight.

With the leading sectors' entry and exit times at hand, we calculate the yearly growth rates of output produced by the leader's economy in each sector, and the yearly shares of the outputs produced in each sector by the leader out of the aggregated output produced in that sector by the principal global economic powers of Britain, France, Germany, U.S., and Japan. The growth rates and production shares of each sector are aggregated across their overlapping years, and the sums are divided by the number of indicators aggregated per year, respectively, creating our LEADING SECTOR GROWTH and LEADING SECTOR SHARE measures.

SYSTEMIC LEADERSHIP is measured by the leader's share of global reach capabilities, as approximated by naval data. The post-1960 data reported in Modelski and Thompson (1988) have been updated and extended to 2000 with new information.[14] Naval power and the power to project coercion over long distances were largely synonymous in much of the post-1494 era. For our time period, this variable is computed based on naval expenditures, first-class battleships, dreadnought-class battleships, aircraft carriers, nuclear attack submarines, and nuclear ballistic missiles. For the years between 1870 and 1945, the measure is based on data for Britain, France, Germany, Japan, Russia/USSR, and the United States. In the post-1945 era, it is restricted to the United States and the Soviet Union/Russia.

More recently, other dimensions of global reach have been developed, particularly strategic air-power, satellites, and cruise missiles, but these dimensions too often require naval support. While it remains an empirical question, we believe that information on the global distribution of aerospace capabilities would generally follow the profile established by our naval data.[15] It should also be noted that we do not attempt to measure national military capability per se but rather the ability to police the global system by moving armed forces over long distances relatively quickly. Sea powers have always been much better at this task than land powers, as the recent events in the Persian Gulf have demonstrated; sea powers have also taken the lead in developing aerospace power (Hugill 2005).[16]

In the period between 1870 and 1914, the system-leader role was played by Britain, although it was in relative decline from at least 1870 on. From 1914 to 2000, the leader role was played by the United States, although it was quite reluctant to take the lead between the world wars. Our time series for SYSTEMIC LEADERSHIP is thus generated by splicing the global reach capability share data of Britain with that of the United States in 1914.

Our last core independent variable, LEADER GROWTH RATE, does not measure technological change, but rather captures the overall effect of the leading

[14] This measure has been used by both leadership long-cycle studies and others (e.g., Boswell and Sweat 1991; McKeown 1991; Rasler and Thompson 1994; Reuveny and Thompson 2004b; Thompson 1988).

[15] Aerospace data that are currently being collected will permit testing this assumption in the future.

[16] Other forms of leadership also exist (e.g., in trade). Rasler and Thompson (1994) and Reuveny and Thompson (2004b) show that economic leaderships of various types and global reach power are closely associated.

economy's vitality on the Northern and Southern economic growth rates. Like the Northern and Southern economic growth rates, this variable is also computed based on the real GDP data of Maddison (1995, 2003). Before 1914, it is computed based on the data for Britain, and after 1914 it is computed based on the data for the United States.

Turning to the control variables, recent studies argue that using too many controls is inappropriate for statistical inferences (e.g., Ray 2003). While we do not discount these views, we include controls based on substantive grounds. NORTHERN GROWTH INERTIA and SOUTHERN GROWTH INERTIA are the past values of NORTHERN ECONOMIC GROWTH and SOUTHERN ECONOMIC GROWTH, respectively. Economic variables may change slowly over time, exhibiting inertia as effects filter throughout the economy. This is customarily modeled empirically by incorporating the lag of the dependent variable as a control variable. The variable 1914 DUMMY is set to zero before 1914, and to one after 1914. It is included since SYSTEMIC LEADERSHIP employs British data before 1914 and American data after 1914, which may generate a relatively abrupt change in this year. SOUTHERN ECONOMIC GROWTH in the Northern model and NORTHERN ECONOMIC GROWTH in the Southern model account for their possible effects on each other.

Expected Effects and Design Issues

So far, we have presented our models, data, and measures. This subsection states expected effects for our variables and discusses design issues. A rise in LEADING SECTOR GROWTH is expected to promote Northern and Southern growth, but more so in the North, the main beneficiary of technological diffusion. A rise in LEADING SECTOR SHARE is expected to reduce Northern and Southern growth, but more so in the South, which is more likely to fall behind when the leader monopolizes leading goods. A rise in SYSTEMIC LEADERSHIP is expected to promote Northern and the Southern growth, as the leader provides international public goods that are good for business. A rise in LEADER GROWTH RATE will promote both Northern and Southern growth, but more so in the North.

For the controls, increases in NORTHERN GROWTH INERTIA and SOUTHERN GROWTH INERTIA are expected to increase Northern and Southern growth rates, respectively, reflecting greater path dependence. In general, this force may be larger when series are measured in terms of levels, as opposed to growth rates. Since our series are growth rates, which may be erratic over time, their inertia may not be that strong. The inertia may also be stronger in the North than in the South, since the Southern economy, by virtue of being dependent on agriculture and resources, may fluctuate more over time. Finally, we do not have strong expectations regarding the respective effects of rises in NORTHERN ECONOMIC GROWTH in the Southern model, SOUTHERN ECONOMIC GROWTH in the Northern model, and 1914 DUMMY in both models; our primary concern is to control for their possible effects.

Next, we need to consider several design issues. Our growth series generally are noisy, fluctuating over time. To improve our ability to read them prior to statistical analysis, we average them across decades and plot them in four figures. Each of the figures will include the Northern and Southern economic growth rates and one of the leadership platform variables. The goal is not to make conclusive inferences based on plots, but rather to learn about tendencies before a statistical analysis. In general, we view visual inspections of the data and statistical analysis as complements, rather than as substitutes.

A number of variables that may affect economic growth in the North and the South (e.g., institutional qualities and demography) are absent from our model.

These sorts of variables typically change slowly and their effects are manifested by inertia, which is modeled, as noted, by the lagged-dependent variable. Hence, in addition to the notion of inertia, the lagged-dependent variable may capture effects of potentially missing variables (if they affect the dependent variable, they probably also affect its lag).[17] As Burkhart and Lewis-Beck (1994), Li and Reuveny (2003), and others note, this method makes it more difficult for spurious effects to be reported, but it also makes it harder to find statistically significant results. In the spirit of choosing a more liberal income threshold for the North–South classification, we prefer to err on the side of making it relatively harder for us to support our theory.

We also need to consider the possibility of serial correlation. In this case, standard errors are biased even though the coefficients are not. While the inclusion of the lagged-dependent variable in the model alleviates this problem (Beck and Katz 1995), we employ robust standard errors, as suggested by Newey and West (1987). We also need to consider the possibility of nonstationary dependent variables. In our case this is not a concern, as our dependent variables are not trending aimlessly. This is to be expected since they are based on first differences, which typically do not include unit roots. Next, in concordance with Morrow, Siverson, and Tabares (1998), Oneal and Russett (1999), and many others, we use a one-tailed *t*-test for all of our coefficients with theoretically anticipated signs.[18]

Finally, while we use the North and South units of analyses, one may question our approach because economic growth studies typically use national units of analyses. We think this potential criticism is not very strong. One may argue that aggregating the GDPs of, say, California and Maine, suffers from this problem since the distance between them resembles the distance between many nations and their economies. Still, all scholars employ the total U.S. GDP. More broadly, the possibility that Northern and Southern growth rates are traced primarily to national factors is captured by our model's error terms and should work against us in the test. If our theory finds empirical support, the threat is probably not too large, or our common stimuli are large enough to be able to show themselves despite this threat.

Empirical Results

This section presents our results. Beginning with plots, the Northern, Southern, and leader growth series are multiplied by 10 for better visualization. Figure 1 presents decade averages of Northern and Southern economic growth and systemic leadership. We discern waves in systemic leadership—first the decline of the British, then the absence of prominent peaks between the wars, and then the United States peak in the 1950s. These outcomes are anticipated by the leadership-long cycle perspective. Observing a longer period than in Figure 1, Thompson (1988) and Modelski and Thompson (1996) find that the main peak in British systemic leadership occurred shortly after the Napoleonic Wars, similar in timing to the United States case after World War II. Thanks to the victory in war, the exhaustion of opponents, a war-induced military edge, and the platform provided by the leading economy, systemic leadership is strongest shortly after the global war that essentially installs leaders in a trial-by-combat.

[17] That said, it should also be noted that these types of variables are generally more appropriate for discriminating among nations, which is not what we seek to do in this study.

[18] Hence, for leading-sector growth, leading-sector share, systemic leadership, leader growth rate, Northern growth inertia, and Southern growth inertia, we use one-tailed tests, and for the 1914 dummy, Northern economic growth, and Southern economic growth, we use two-tailed tests.

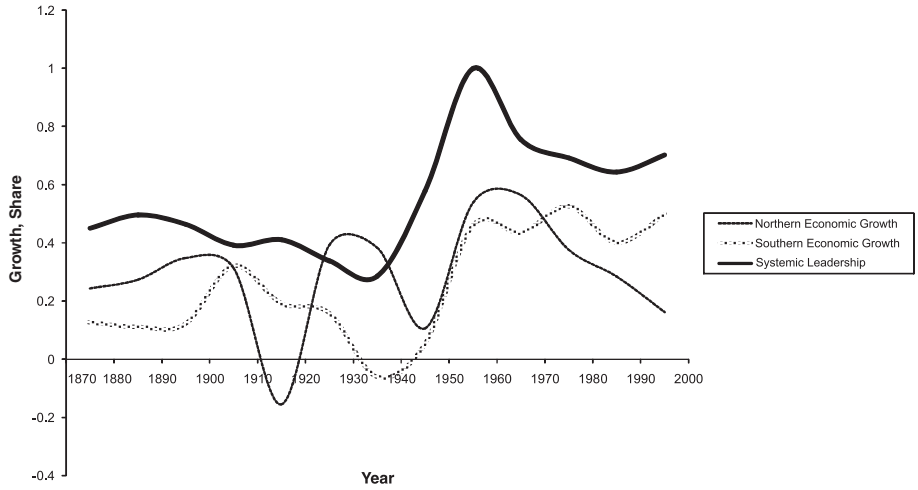

FIG. 1. Decade Average North and South Economic Growth and Systemic Leadership

''Long waves'' are discernible in the Northern economic growth series. Their length is about 40–50 years. The first wave could be said to peak in the 1890s, and the second, really an extension of the first (they are separated by the World War I interruption), and a postwar spurt, peaks in the late 1920s. Another wave begins in the 1940s, and peaks in the 1960s. The Southern economic growth waves, in contrast, are relatively less pronounced. The first wave peaks in the 1900s, the second in the 1950s, after which the series hovers without much change. The timing of the waves of the Northern series generally correspond to the long wave-chronology discussed in the leadership-long cycle studies, while the Southern wave is shown here for the first time. The Northern and Southern average economic growth rates are relatively lower before World War II than after 1945, but during most of the years shown, the Southern average economic growth rate is lower than the Northern average growth rate.

The systemic leadership series declines from the 1870s through the 1930s, and again since the 1960s, and rises modestly after the collapse of the Soviet Union in the early 1990s. The Northern economic growth series corresponds relatively well with the leadership series since the 1940s, and before the 1920s. After WWII, the series rises, reflecting a small rise in leadership in the 1910s, with some lag. The Southern economic growth series most closely resembles the naval series before the 1890s and after around 1910. Both series seem positively associated with systemic leadership, as expected theoretically.

Figure 2 presents the Northern and Southern growth rates together with the share of leading-sector production held by the leader. The share series, arguably, suggests one evident peak. As shown in Thompson (1988) and Modelski and Thompson (1996), an earlier peak in the 1840s through 1850s, which is not included in Figure 2, led to the decline shown in Figure 2 through the first decade of the 1900s. The buildup to the peak in the 1950s is checked temporarily by the depression of the 1930s. Oscillations in Northern growth correspond roughly to the shape of the U.S. leading-sector share monopoly if we factor in the World War II interruption. Periods with a high leading-sector share seem associated with low or declining Southern growth rates, suggesting a negative association between the two series.

Figure 3 shows the two growth series with the leader's leading-sector growth. The late-19th-century decline in leading-sector growth is somewhat arrested towards 1900. There is moderate improvement in technological growth prior to

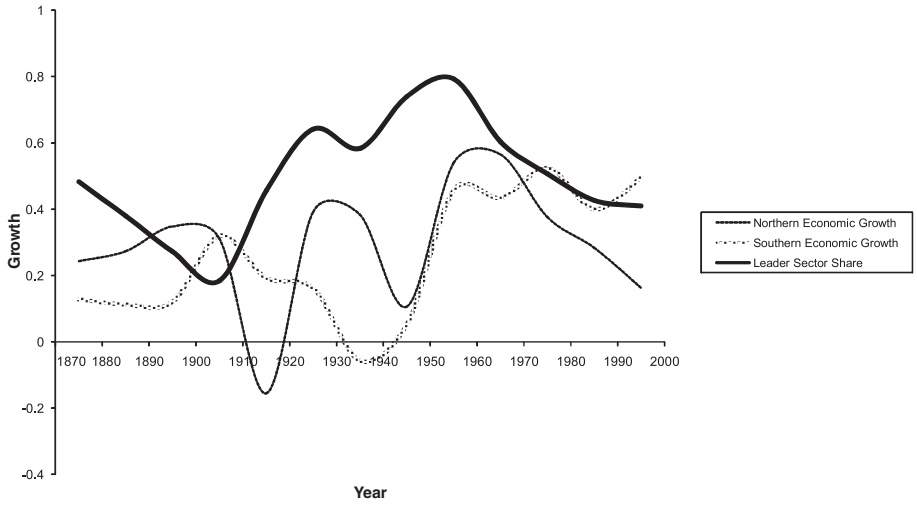

FIG. 2. Decade Average North and South Economic Growth and Leading-Sector Share

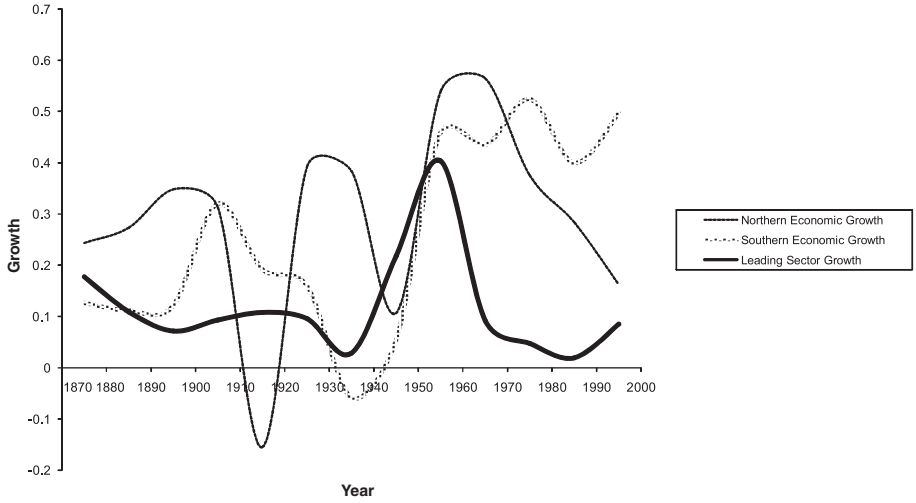

FIG. 3. Decade Average North and South Economic Growth and Leader-Sector Growth

the onset of world depression in the 1930s, while the leading-sector growth peak of the 1950s is hard to miss. The series also tracks up in the 1990s. In all, this behavior is in line with the leadership-long cycle argument for a ''twin peaks'' phenomenon in which system leaders enjoy spurts of technological growth before and after global wars. Figure 3 also suggests that the Northern growth is roughly in sync with the leading-sector growth series, subject to a lag. That is, the leading-sector growth peaks first and then is followed by a rise in Northern growth. The Southern growth series seems less in sync with these dynamics, although one could argue that the Southern improvement since about 1960 is linked to the spike in system-leader innovation of the 1950s. The early 20th century and post-mid 1960s economic growth in the South is much less supportive of this linkage.

Finally, Figure 4 shows the leader's aggregated economic growth rate together with the Northern and Southern economic growth series. The leader's growth series is very much like the Northern growth series, with the Northern behavior

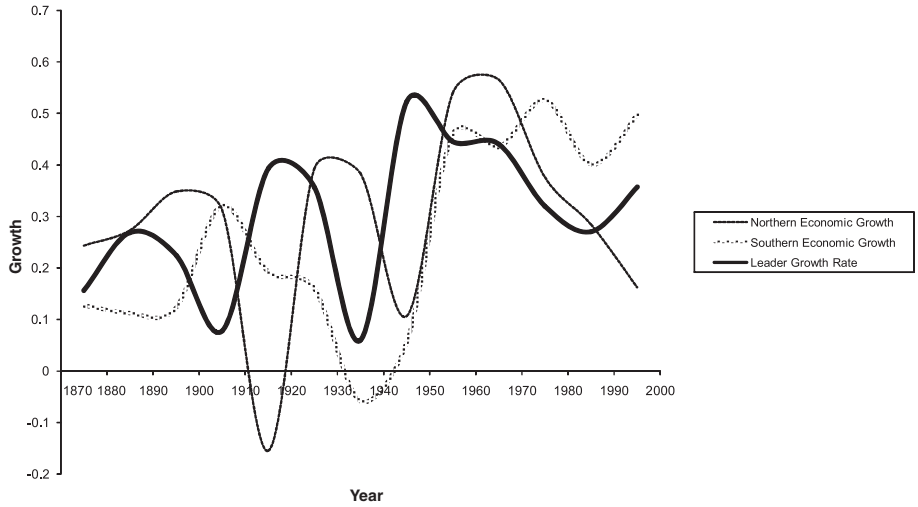

FIG. 4. Decade Average North and South Economic Growth and Leader's Growth

TABLE 8. Estimation Results

Variable	*Northern Economic Growth Model*	*Southern Economic Growth Model*
Constant	0.009 (0.0072)	0.006 (0.0080)
Northern growth inertia	0.080 (0.0723)	
Southern growth inertia		0.085 (0.0897)
Leading-sector growth	0.019* (0.0120)	0.006 (0.0134)
Leading-sector share	−0.016 (0.0208)	−0.047** (0.0220)
Leader growth rate	0.078* (0.0525)	0.098 (0.0799)
Systemic leadership	0.052*** (.0176)	0.079*** (.0234)
Southern economic growth	−0.201 (.1985)	
Northern economic growth		−0.187 (.2293)
1914 dummy	−0.394*** (.0611)	−0.179 (.1431)
R^2	.50	.26
Sample size	131	131

Notes. Robust standard errors in parentheses. *denotes significance at the 10% level; **denotes significance at the 5% level; and *** denotes significant at the 1% level. One-tailed tests are used for all the variables, except for Southern Economic Growth, Northern Economic Growth, and 1914 Dummy.

lagging the leader fluctuations with regularity. This regularity and visual pattern is considerably less evident in the Southern series.

Figures 1–4 support our theoretical interpretation, which expects different Northern and Southern growth dynamics, and North–South relationships to the system leader. However, figures based on decade averages cannot be the last word on how or whether our variables relate to each other. To examine these effects, we turn to linear regressions conducted using the raw, nonaverage data.

Table 8 presents the results. Column 2 presents results for the Northern economic growth model, and Column 3 presents results for the Southern economic growth model. The goodness of fit in the Northern model, as measured by R^2 = .5, but only .26 in the Southern model. This suggests that in general the leadership platform is less able to explain the Southern economic growth over time than the Northern economic growth, as expected theoretically.

Beginning with the variables of primary interest, the coefficient of LEADING SECTOR GROWTH in the Northern model is positive and statistically significant. An increase in the growth rate of the system leader's leading sector increases

Northern economic growth, as anticipated. The coefficient of this variable in the Southern economic growth model is also positive, but it is not statistically significant, suggesting that an increase in the growth rate of the leader's leading sector has little or no effect on Southern economic growth.

The coefficient obtained for LEADING SECTOR SHARE is negative in both the Northern and Southern economic growth models, but is statistically significant only for the South, as anticipated. Hence, as expected theoretically, when the leader's global monopoly edge in leading-sector production rises, the South falls behind more than the North. Put differently, as the leader's global edge in producing the leading sector rises, the North and the South are affected negatively, but the North is relatively less affected than the South, as it is relatively better positioned and more able to absorb the new waves of radical innovations, compared with the South.

The coefficients obtained for LEADER GROWTH RATE are positive in both the Northern and Southern growth models. However, this coefficient is statistically significant only in the Northern model. The *p*-value obtained for the coefficient of LEADER GROWTH RATE in the Southern model is .110, suggesting a weaker effect than in the North. Thus, an increase in the overall or aggregate economic growth rate of the leading economy promotes economic growth in the North, and less so in the South, as expected theoretically.

The coefficient of SYSTEMIC LEADERSHIP is positive and statistically significant in both models. As expected, a world system with stronger leadership is, by and large, more politically stable and economically orderly, as the leaders, at least in the previous two centuries, provided political and economic public goods that benefited the economy (mainly, of course, because they benefited their own economies and global connections). With declining systemic leadership, one should expect a decline in trade openness and financial stability, and ultimately, once every 100 years or so, a slide into political chaos that, historically, involved global war from which a new system leader emerged.

Moving to the controls, the effects of rises in NORTHERN GROWTH INERTIA and SOUTHERN GROWTH INERTIA on the Northern and Southern economic growth, respectively, are positive, but insignificant, reflecting the variability in the growth series. However, the *p*-value for the Northern inertia is .134, while that for the Southern inertia is larger, suggesting a greater role for inertia in the North than in the South, as expected. The effect of a change from 0 to 1 in 1914 DUMMY, indicating a new system leader, is statistically significant only for the North. In the Southern model, the *p*-value is .105. The leadership change affects the Northern economy more than the Southern economy. This is intuitive, recalling the relatively tighter links between the leading and the Northern economies. The effects of rises in NORTHERN ECONOMIC GROWTH and SOUTHERN ECONOMIC GROWTH on each other are statistically insignificant, or the two blocs generally operate as two separate units. This is also suggested by Figures 1–4, where many Northern rises and falls have no Southern parallels.

Conclusion

This paper extends a leadership-long cycle interpretation of the North–South gap. We hypothesized that the Northern economies are the primary beneficiaries of the radical innovation emanating from the system's lead economy, while much less trickles down to the South. We tested this argument of uneven technological diffusion with time series data dating back to 1870.

Our results support a view emphasizing the leader's stronger economic ties with the North vis-à-vis the South. The diffusion of ideas, technologies, and know-how associated with the leading economy are likely to fare better in the North than in the South. System-leader demand for Northern products is also

likely to be important. Stylized observations suggest that, unlike the North, the leader's growth affects the South by way of stimulating labor-intensive, resource-oriented, or low-level manufacturing production. This type of stimulation is likely to have a lesser effect on growth than the Northern absorption of sectors more associated with the leader's radical innovations. The effects of systemic leadership are essentially identical and positive in both the North and the South, indicating that while the technological and economic dimensions of leadership are restricted primarily to the North, the ordering benefits are enjoyed by both the North and the South. Given the marked persistence of the South's membership, we can only infer that the economic benefits of world order are not as enriching as the diffusion of new technology and system-leader economic growth.

Taking a broader view, the basic nature of contemporary international relations would change if the North–South gap evaporated. Much of the present-day turmoil is concentrated in the South. Wars, economic collapses, humanitarian crises, new diseases—the traditional four horsemen of the apocalypse—now take place, for the most part, in the South. While many Northerners might like to turn their backs on the problems of the global Southern ghetto, they cannot ignore the impacts. Population growth puts stress on the global environment and food supply. Many Southerners are drawn to Northern affluence, if they can find ways to penetrate Northern barriers to Southern migration. New diseases emerge in places where people have considerable contact with animals or where once inaccessible jungles are penetrated by the outside world; these new diseases then tend to spread around the planet. Northern targets are prime foci for Southern terrorism seeking the withdrawal of Northern troops and support for client states in the South. Southern humanitarian crises, involving famine, refugees, genocide, and natural disasters, no longer seem as remote as they once did. All in all, the North cannot ignore the South.

The world would no doubt be a nicer place if the North–South gap disappeared. But it appears unlikely to go away anytime soon. The evidence suggests that whatever the case for global trickle-down, catching-up, and exploitation, there is a structural problem with the imperfections of technological diffusion. The liberal theory naiveté assuming that technology is freely available to whoever might need it does not seem to hold. New technology developed by the lead economy diffuses mainly to the North. The Northern economies benefit, while the Southern economies benefit much less or stagnate.

Barring basic changes in foreign assistance and development approaches, the inherent duality of the contemporary international relations predicated on uneven and unequal development propensities will probably be with us through much of the twenty-first century. The implied Southern focus on the technological paradigm of yesterday suggests three possible futures. The resulting North–South income gap may not vary that much over time, as the South works harder and harder, but is only able to grow its income in a rate similar to that obtained by the North. In a second scenario, the income gap grows over time, as the current Northern gains lay the foundations needed to share disproportionately the gains from the next radical technological wave. But the gap may also fluctuate over time. Things may get better for a while, seemingly vindicating the development policy approach of the day, but the structural Southern problems will eventually and inevitably resurface with the advent of the next wave of radical innovation.

The expected persistence of a North–South income gap in these scenarios does not preclude some states from escaping the South and joining the North. A few states have managed to do this. If China eventually moves up the world's technology gradient, the Northern population will expand considerably. India or Brazil might also move up. These states, however, are characterized by very high internal income inequality, and it may be more accurate to say that only seg-

ments of their populations and economies have the potential to move into the North. In any case, even if these nations somehow beat the structural odds against them, large portions of Asia, the Middle East, sub-Saharan Africa, and Latin America are likely to be left behind.

Does the persistence of the gap mean that all the Southern problems will continue to escalate? The answer is, ''not necessarily.'' The number of civil wars expanded in the post-World War II era in part because there were a number of new states created (Hironaka 2005). New states are more prone to civil war than old states, but this does not mean that newer states must experience constant internal warfare. Ways of dealing with diseases are being developed, and some success has been achieved in coping with problems such as HIV and AIDS. New (and old) approaches to controlling terrorism and migration pressures are being tried, including relying on the most ancient technique in the play book, building walls to keep the ''barbarians'' out. Democratization has managed to expand to places one might not expect to be very receptive to such arcane political practices as being able to vote the incumbent rascals out of office. Of course, it also remains to be seen whether these new ways of doing things will stick and/or whether they will ameliorate problems or make them worse.

Our message is neither that the sky is falling nor that things will only get worse. Rather, our message is that there appears to be good reasons for not expecting Southern problems to go away in the near, and quite possibly the distant, future. Liberal optimism about the future is well and good, but it remains just that—more an optimistic attitude than an empirically and theoretically sound forecast of the future of international relations. It seems highly unlikely that Lucas's (2000, 116) forecast that sooner or later all states will join the industrial revolution will be realized in this century. For that matter, it seems unlikely that all states will join the industrial revolution at any point in time.

It follows, then, that we should look for alternative solutions to what are likely to be enduring North–South policy problems. Waiting for economic convergence is a bad bet. Holding out for a massive Marshall Plan for the global South seems equally unlikely. Foreign aid and humanitarian relief may ameliorate short-term problems but cannot be expected to resolve fundamental structural problems in planetary economic growth patterns. Acknowledging the existence of a major problem would be a step in the right direction. Only then might we expect the development of new ideas for old policy problems. Only then might we expect to come to terms with the realities of a dualistic globe and its implications for future economic growth, conflict, and living standards.

One example of a possible step in the right direction was suggested by Pritchett (1997). Given the major divergences in economic growth experiences, why should we be searching for a universal theory of economic growth? Moreover, it seems even more dubious to base any such exercise on the early developers. A one-size-fits-all theory is not likely to be all that useful if it fails to explain why there has been so little movement between North and South over the past 137 some years. In the interim, we might do better to develop different theories and policies that apply specifically to economies that already have substantial industry, as opposed to those that are attempting to climb out of poverty traps or are caught somewhere in between.[19] We also need to think more creatively about what should be/can be done with states that are unlikely to move up the technological gradient at any point in the future.

To the extent that the North–South axis becomes the premiere context for international relations in the 21st century, we may also need to adjust appropriately our non-economic theorizing. During the Cold War, polarity reigned as one of the most critical variables in our analytical repertoire. In a world increas-

[19] Something similar is advocated by Sachs (2005) who calls for clinical economics and differential diagnoses.

ingly divided between North and South, polarization may become more significant. The widely embraced democratic peace may be expected to remain far less than universal for some time to come. International institutions and norms may also be expected to function on less than universal principles and probably even less well than perhaps they once did. Varieties of asymmetrical warfare (e.g., insurgency, terrorism, and Northern interventions into perceived Southern problem areas) may not just be a passing fancy of the past few decades but the new norm—in contrast to the classical fixation on more symmetrical, interstate warfare. To mangle an old French saying, the more things remain the same, the more things we study as students of international relations may have to change.

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