



#### ABSTRACT

This paper shows how Japanese firms and the Japanese state constructed a development model based on the steel industry as a generative sector that drove Japan's economic ascent in the world-historical context of U.S. hegemony. We make three arguments in this paper. First, there is a new model of capital accumulation that does create new forms of social inequality by redistributing costs and benefits in very different ways than earlier models. Second, Japanese firms and the Japanese state created this new model of capital accumulation and social inequality via mechanisms including joint ventures, long term contracts, and other forms of international trade and investment, not U.S.-based transnational corporations, as is usually assumed. Third, world-systems theory reconstructed through the lens of the new historical materialism explains this restructuring of the capitalist world-economy as the outcome of Japan's economic ascent over the last fifty years. Further, we argue that this new model of capital accumulation has had similar impacts on redistributing the costs and benefits of development between core and peripheral regions of the capitalist world-economy in a wide range of global industries.

These strategies created a tightly linked set of technological and organizational innovations to overcome the natural and social obstacles

to Japanese development, dramatically increase Japan's international economic competitiveness by lowering production costs in all sectors of the economy, turn Japan into the world's largest exporter of manufactured products, restructure a range of global industries, and recreate the world-system hierarchy in support of Japanese development. In particular, organizational innovations in the use of long term contracts and joint ventures in raw materials industries to foster global excess capacity and lower rents to resource extracting firms and states reallocated the costs of providing the material building blocks of Japanese development to the states and firms of its new raw materials periphery. This competitive advantage drove Japanese capital accumulation and economic ascent, and simultaneously drove underdevelopment in Japan's periphery.

These Japanese innovations became key elements of globalization as U.S. and European transnational corporations and states sought to compete with Japan. Joint ventures, long-term contracts, and other forms of interfirm cooperation have replaced vertically integrated foreign direct investment, the earlier U.S. model of capital accumulation and international economic linkage, as the model for global industries.

## INTERNATIONAL INEQUALITY IN THE AGE OF GLOBALIZATION: JAPANESE ECONOMIC ASCENT AND THE RESTRUCTURING OF THE CAPITALIST WORLD-ECONOMY

Paul S. Ciccantell  
Stephen G. Bunker

### I. INTRODUCTION

At the end of the twentieth century, many analysts argue that development theory is in crisis and unable to explain the functioning and consequences of the "new world economy" (see, e.g., Evans 1999; Hamilton 1999; McMichael 1999). Contentious debates focus on the benefits and costs of globalization, on whether there is anything truly "new" about the world economy, and on whether the national state has been superseded (Amin 1996; Arrighi 1998; Biersteker 1998; Boxill 1994; Dunning 1998; Garrett 1998; Harvey 1995, 1996; Holm and Sorenson 1995; Kiely 1998; Robertson and Khondker 1998; Shaw 1997; Sklair 1998; Tussie 1998; Yaghmaian 1998; see Ciccantell 2000 for an analysis of these debates).

Materially, a fundamental new characteristic of the world economy over the last fifty years is the tremendous increase in both the volume of raw materials traded internationally and the distances these raw materials travel. In 1960, sea-borne petroleum, coal, iron ore and bauxite trade totaled 2,093 billion ton-miles (a measure that combines both the volume of trade and the distance each ton moves from the point of extraction to the point of industrial processing). Twenty years later, in 1980, these four raw materials accounted for 11,015 billion ton-miles of sea-borne trade, an increase of 426%, as these industries became global.

Paul S. Ciccantell  
Department of Sociology  
Western Michigan University  
Sangren Hall  
Kalamazoo, MI 49008  
[paul.ciccantell@wmich.edu](mailto:paul.ciccantell@wmich.edu)  
<http://www.wmich.edu/sociology/>

Stephen G. Bunker  
Department of Sociology  
University of Wisconsin-Madison  
1180 Observatory Drive  
Madison, WI 53708  
[bunker@ssc.wisc.edu](mailto:bunker@ssc.wisc.edu)  
<http://www.ssc.wisc.edu/soc/>

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Coal, historically one of the most localized industries in the world, experienced the most dramatic globalization, with seaborne trade increasing from 145 billion ton-miles in 1960 to 1,849 billion ton-miles in 1990. At the same time, prices fell in real (inflation-adjusted) terms from US\$86.65 in 1959 (in 1992 dollars) to US\$43.63 in 1998 for coal imported into Japan. Surprisingly, the existing hegemon, the U.S., had little to do with either the expansion of trade or the drop in prices. Instead, the strategies of Japanese firms and the Japanese state to resolve the fundamental obstacles to economic ascent in the face of U.S. hegemony drove both of these changes. Contrary to claims that globalization supercedes the national state, we find that the actions of the Japanese state were crucial in developing and applying these strategies. We also find clear interactions between Japanese firms and the state and the firms and states of nations in the periphery that Japanese strategies restructure.

We make three arguments in this paper. First, there is a new model of capital accumulation that does create new forms of social inequality by redistributing costs and benefits in very different ways than earlier models. Second, Japanese firms and the Japanese state created this new model of capital accumulation and social inequality via mechanisms including joint ventures, long-term contracts, and other forms of international trade and investment, not U.S.-based transnational corporations, as is usually assumed. Third, world-systems theory reconstructed through the lens of the new historical materialism explains this restructuring of the capitalist world-economy as the outcome of Japan's economic ascent over the last fifty years.

The following section will outline our theoretical model, which we term the new historical materialism. Section three outlines the key issues in the development of the Japanese steel industry, the central generative sector that drove Japanese economic ascent from the 1950s through the 1980s. Section four examines key factors in Japan's construction of its periphery in the post-World War II era in support of its economic ascent. Section five highlights the key impacts of Japan's restructuring of the capitalist world economy over the past fifty years, and the conclusion outlines how the new historical materialism provides a model for understanding the causes and consequences of international inequality.

## II. NEW HISTORICAL MATERIALISM

In *The Long Twentieth Century*, Giovanni Arrighi invites us to follow him beneath the hidden abode of production into the realms of politics, finance, and war (1994:25), where Braudel has claimed that the capitalist stratum has the flexibility to keep its investments in lines of business that do not face the problem of diminishing returns (1994:8). Arrighi takes the revealed preference of capitalists

for ever-more rapid turnover times on investment and for liquidity to indicate a deeper goal of using money to make more money without passing it through the production of commodities. By focusing his arguments on highly abstract monetary relations as the goal and ultimate end of all systemic cycles of accumulation, Arrighi has constructed a powerful model of the stages from maturity to decadence of different hegemons, the contradictions of hegemonic overaccumulation being partially resolved by investment in other rising economies.

Part of this model's power lies in Arrighi's use of McMichael's (1990, 1992) strategy of incorporated comparisons to account for what we call the cumulatively sequential increase in size, scope, volume, and density of productive, financial, political, and commercial relations across ever broader spaces. In achieving a coherent model of how these cumulatively sequential increases simultaneously create the conditions of subsequent hegemonic ascent and structure the relations between mature or declining hegemon and new centers of accumulation (*i.e.* Amsterdam to Britain, Britain to the U.S., the U.S. to Japan and East Asia), Arrighi overcomes the stasis imposed by Wallerstein's (1974, 1982) dependence on tripartite categories whose relations remain fundamentally unchanged. In this paper, we attempt to incorporate an analysis of the very material processes that Arrighi sees the capitalist stratum as bent on avoiding into an expanded model of cumulatively sequential increase.

We will do this by focusing on the emergence of hegemonic potential rather than on its maturity and decline. We posit that the beginnings of hegemonic ascent require successful coordination of internal or domestic technological advances, particularly in heavy industry and transport, with the external solution of access to cheap and steady sources of the raw materials used for heavy industry. We believe that the raw materials used in greatest volume present the greatest challenge and best opportunity for economies of scale. These economies of scale, however, drive a contradictory increase in transport cost, as the closest reserves of raw materials are depleted more rapidly as the scale of their industrial transformation increases. The tension of this contradiction between the economies of scale and the cost of space foments technological innovation a) in transport—vessels, loaders, ports, rails, *etc.*, and b) in chemical and mechanical means of reducing component inputs per unit of output (*e.g.* coal and iron in steel), and c) improvements in control of heat, pressure and the mix of chemicals that make the unit material inputs stronger and thus enable smaller, lighter amounts to perform the same work. All of these technological fixes drive each other, and all of them tend to generate increases of scale, thus exacerbating over the long-term the very contradiction between scale and space that they are designed to solve. The national economies that have most successfully initiated technological and organizational solutions—internal and external—of this contradiction have simul-

taneously (a) generated their own rise to economic dominance, (b) restructured the mechanisms and dynamics of systemic and hierarchic accumulation, and (c) expanded and intensified the commercial arena of raw materials trade and transport. We call these sectors generative (see also Bunker and Ciccantell 2000, Ciccantell and Bunker 1999). The linkages from these generative sectors spread throughout the ascendant economy, including, for example, supplying direct inputs such as wood in Holland, Great Britain and the U.S. and steel in Japan for shipbuilding, and iron and then steel for producing textile machinery in Great Britain. The myriad direct and indirect linkages from the generative sector lower raw materials costs, increase labor productivity, and improve international competitiveness in many sectors of the ascendant economy.

This exacerbated tension between the contradictions of scale and space is sequentially cumulative, so each systemic cycle of accumulation has confronted more complex tasks, requiring greater and more efficacious state participation, promotion, and protection, together with more and greater coordination of firms and sharing of both the costs and the benefits of technological innovation within and across sectors (even if they continue to compete for market share). These internal dynamics must also achieve reduction in the costs of the raw materials and of the transport infrastructure in the external zones from which they are exported. The cumulatively sequential increases in scale of raw material transformation and in the size and capacity of transport vessels and infrastructure corresponds to and makes economically viable the expansion of the practical commercial space in each systemic cycle of accumulation.

We will show how the technological developments generated in response to the contradiction between scale and space for the most voluminously used raw materials provide part of the impulses that create, expand, and restructure the world system as a series of punctuated cumulative sequences. Commerce in the most voluminously traded raw materials—from wood and grain to iron ore and coal—has proceeded from river-based to lake-based to ocean-based transport through the Dutch, British, and American systemic cycles of accumulation and Japan's successful restructuring of these trades into truly global sourcing. Each step of this expansion allows and employs huge increases of scale in transport technologies. We will then show how the introduction of new scales of transport and of industrial transformation, by broadening the sources of raw materials from river basin to lake system to global networks, systematically reduce ground rents (see Ricardo 1983, Marx 1967, Coronil 1997) available to the resource-rich economies which export them. The interaction between scale, scope, technological innovation, denser political and material relations between firms, sectors and state increase the productivity, the profitability, and the financial and political power in the national economies that initiate, regulate, and structure each sys-

temic cycle of accumulation. Simultaneously, the same set of skills and interactions lowers the rents to and increases the infrastructural investments of raw materials exporting economies.

Thus, we believe that each hegemonic cycle has simultaneously increased the commercially integrated space, the movement of raw materials in this space, and global inequalities between raw materials exporters and raw materials importers (see Bunker and Ciccantell 1999). In this paper, we illustrate these patterns through an analysis of the most recent sustained national economic ascent. We will examine the mechanisms underlying enhanced inequality in an expanded commercial space in an examination of (a) the Japanese steel industry, and in particular of the technological advances in the scale of blast furnaces and in the scale and precision of the basic oxygen furnace whose use and integration the Japanese pioneered and dominated, (b) the Japanese shipbuilding and shipping industries, especially as these generated economies of scale, and (c) the political, financial, and material synergies between these industries. We emphasize particularly (a) the development of Maritime Industrial Development Areas (MIDAs) that reduced Japanese raw materials landed costs, increased Japanese productivity and economic competitiveness across all sectors of the economy, and linked the internal and external sectors of the Japanese model of capital accumulation, and (b) the dependence of steel and shipping in Japan on and their long-term impoverishment of rents to their key suppliers of coal and iron.

Our concept of generative sector extends and refines Rostow's (1960) notion of leading sector. Generative sectors drive technological, financial, organizational, and political relations, stimulating cooperation across firms, sectors, and states in strategies and actions both domestic and international. The technological advances fomented within the generative sectors follow both forward and backward linkages (cf. Hirschman 1958), most importantly by providing templates (cf. Chandler 1977) for direct application to other sectors which directly or indirectly constitute clusters or linked nodes in chains of production (Marx 1967, Schumpeter 1934). The spread of innovation through such clusters constitutes a consistent theme in economic history. For example, Landes (1969) follows Marx in identifying the complex mutual stimulus that coal mining fomented between (a) advances in the technologies of generating heat and pressure from steam and of transforming heat into mechanical energy in order to lower water tables in the deepening mine shafts, (b) advances in metallurgy required to contain pressures in the boilers, (c) advances in metal working required to sustain vacuums and pressures in moving pistons and their cylinders, (d) standardization of components used in these boilers, pumps and machines, and (e) advances in the fuel efficiency of all of these processes. The chemical advances in technology, particularly in metallurgy, and the control over the pressures generated, required

collaboration between firms and surveillance and support by the state. All of these technological advances fed into other sectors, including into rail and ship transport needed to move the raw materials whose consumption each technical advance cheapened and thereby accelerated.

The generative quality of the innovations in these clustered nodes contrasts with the position of cotton within the economy (Landes 1969, Hobsbawm 1968). Where coal, iron and steam fed and cheapened production in multiple other sectors, cotton as a product was primarily aimed at an end use. Lazonick's list of the multiple other industries for which cotton served as a leading sector all provided inputs to cotton, so all of the linkages were backward from cotton. Because the technical advances in spinning and weaving were specific to textiles, they could not be extended to other sectors.

Historically, those sectors with the densest forward and backward linkages to other sectors are those involving the most voluminously used raw materials, especially when we include the chemical transformations and improvements of these raw materials and the ways in which they are transported. Historically as empirical process and chemically or logistically as material process, technical advances in the fuel efficiency and the strength of these materials and in their transport have consistently created cumulative sequences toward ever-greater scale. Heat and pressure both become more economical in larger containers, and higher heats and pressures create chemical transformations and mechanical energy more efficiently (Landes, 1969). The basic oxygen furnace, for example, is cheaper and faster to operate, more amenable to automatic controls, allows for more precise alloys at higher temperatures, and is capable of a larger capacity than either the basic Bessemer or the open hearth furnaces. We have shown similar processes at work in maritime transport and bulk-breaking or handling (Bunker and Ciccantell 1995a, 1995b).

A historical materialism focused on the mechanisms underlying generative sectors facilitates comparative methods appropriate to the cumulatively sequential processes of a spatially expanding and intensifying world-system. McMichael's (1990, 1992) incorporating comparisons, Tilly's (1995a, 1995b) encompassing comparisons, and Tomich's (1994) commodity circuits all assume larger, and potentially global, systemic unities within which comparable instances, differences, or simply cases may occur. All three authors confront the problem of how to compare phenomena which may be linked to each other through various complex causalities of relations; none, however, (a) problematize the explanatory status of the larger systemic unities, (b) acknowledge or offer a means to account for different degrees of intensity or significance of the relationship between the instance or cases and the larger processes of which they are instances or cases, or (c) address the explanatory status of the mechanisms that constitute the complex

causalities that link instances and cases to the larger systemic unities.

We propose that matter and space, as naturally given aspects of physical reality, manifest themselves socially and economically in built or manipulated environments as cost, scale, and distance. In these and related manifestations, matter and space pose regular, specifiable conditions of production and exchange. The conditions, once specified, may reveal their explanatory status and the intensity of their links both to the local and temporal particularities of instances and to temporally evolving global systems in which they participate and which they partially form.

In other words, we propose that comparison based in highly specified, physically and spatially grounded material analysis resolves some of the problems in recent comparisons of cases or instances that participate in complex systems of highly dense interaction, especially when the system itself evolves over time, driven by and driving changes in its component parts. We will work this out by explaining why and how the generative sectors in the most rapidly rising national economies have consistently been sectors that have been most driven to develop technologies that resolve the contradictions between economies of scale and costs of space, and why these sectors are defined by their dependence on procuring, transporting, and transforming those raw materials that are used most voluminously (a) in building the environment, (b) in fixing capital in plant, and (c) in the infrastructure and vehicles of bulk transport.

Since the second industrial revolution, or since the growth of economies that build machines to make machines, steel is the most voluminously used raw material, and its major inputs have included coal, iron, and oil. One of the major sites for the social incorporation of these materials has been in the means of integrating space and matter, that is, in the means and infrastructure of transport which themselves serve most significantly to cheapen the spaces across which these voluminously used materials are transported.

The social processes of production depend fundamentally on matter; production-enhancing technologies entwine comprehensively with the historically accumulating social knowledge of and capacity to manipulate ever-more precise differentiations between the chemical and physical properties and attributes of different material forms (in their pure instances, their transformation into energy, and their reaction to and incorporation of each other) under different conditions and combinations, including particularly temperature and pressure. Space defines and organizes the world economy as a system because of the ways that matter is distributed in and across space.

Different kinds of matter are located in different places. As technology advances, material forms used for particular production processes or for particular products become progressively more specific. The locations of specific kinds

of materials correspondingly become more rare, so that the total distance, *i.e.* the space, between the locus of production and the locus of extraction increases. Thus, space and matter are integrally entwined in both production and extraction. Expanded production consumes more matter across broader spaces, and thus the expanding interaction of scale and distance of matter and space drive the expansion and the intensification of the world system.

Space is simultaneously a means of production, a condition of production, a barrier or cost of production, and an obstacle to circulation of commodities. Space impinges on extraction even more directly than on production, as the space in which the resource extracted occurs is naturally, or geologically and hydrologically, determined. The attributes of this space include not simply location on a two-dimensional plane, but (a) the topographic characteristics of the site and of the entire space between the site of extraction and the site of transformation, and (b) the amount of space across and within which a given amount of the resource occurs (in minerals, space is reduced to a percentage of pure ore and a measure of overburden, that is, to the amount of other matter in whatever space must be excavated to extract a given amount of the mineral in question). The composition—hardness, friability, moisture, *etc.*—of the surrounding matter combines with this space to determine cost of extraction and processing, as well as environmental impacts of the extraction. Thus, the relevant space of matter (or the space that matters) in extraction includes depth and extent of one form of matter within other forms of matter (*i.e.* the ground) as well as the naturally determined distances between the sites of natural occurrence and of social transformation.

In reducing the cost of this space, expanded production generates large and complex technological innovations in material and energetic forms, innovations that permit increased economies of scale in transport vehicles, loaders, and infrastructure. Marx (1967), Mandel (1975), Innis (1956), Landes (1969), Chandler (1965, 1977), and Harvey (1982) have in different ways explained the multiple and complex links between expanded production, technological advance in material use and in energy capture and containment, and new means of transport. Marx (1967), Innis (1956), and Harvey (1982) have all noted the high-cost of building the environment required for rail and shipping, and the role of the state and of high finance in overcoming the inadequacies of individual capitals or of private ownership of land. Though the role of raw materials procurement and transport and the technical or physically determined economies of scale in heavy industry are consistently undertheorized by all of these authors, the cases or instances in which they have discovered and then present these relationships of capital and innovation consistently involve the movement of matter across space, and the questions of property in both matter and space.

This confluence of space and matter in the formation, expansion, and intensification of the world-system demands a specific focus on the strategies to procure and transport raw materials as these have structured cumulatively sequential systemic cycles of accumulation. The resolution of the contradictions between scale of transformation and cost of space has created generative sectors in all of the economies that have become serious candidates for hegemonic status. The material processes and physical attributes of the raw materials and their extraction and transport can be specified in precise, regular and commensurable, and thus in comparable, terms theoretically independent of any of the social processes that constitute a relational analysis of the world economy or comparison of its component parts. We can explain their links to the generative sectors that drive the expansion and reorganization of the world system. Their explanatory status can thus be quite high, as the synopsis of our research on the development and consequences of the Japanese model of capital accumulation in the following sections will show.

### III. STEEL, SHIPS AND MIDAS IN JAPAN: THE CENTRAL GENERATIVE SECTORS

After Japan's defeat in World War II, the U.S. initially sought to prevent Japanese re-militarization and the reconstruction of its key industrial suppliers, steel and shipbuilding. The geopolitics of the Cold War forced the U.S. to "Reverse Course" and support economically and diplomatically Japanese re-industrialization. This joint U.S.-Japanese effort, however, confronted a myriad of obstacles, most notably the exhaustion of domestic raw materials, capital shortage, long ocean voyages from potential supply sources, and bitter resentment among potential Asian raw materials suppliers, particularly Australia, to trade and investment relations with Japan as a result of Japan's actions in World War II. Japanese firms and the Japanese state, supported by U.S. and World Bank financial assistance, created a new model of domestic development based in the steel, shipbuilding, and shipping industries. In the external sector, without which these industries could not develop, U.S. financial and diplomatic assistance helped create a new model of raw materials supply via long-term contracts and minority joint venture partnerships in Australia that Japanese steel firms and the Japanese state, led by the Ministry of International Trade and Industry (MITI) refined and expanded into a highly coordinated global model of raw materials supply and capital accumulation that drove Japanese economic ascent.

MITI was assigned regulatory duties for the steel industry by its establishment law of 1952 of "promotion, improvement, and coordination of production, distribution, and consumption of mineral products; guidance, assistance, and fostering necessary for promotion of rationalization of the mineral industry;

furtherance and coordination of development and utilization of coal and other mineral resources" (cited in Wang 1962:33–34). MITI in the early 1950s actively opposed the targeting of the steel industry by the government because of concerns over the industry's ability to be internationally competitive. The economic boom that began in 1955 led to a reevaluation of the potential of the steel industry as a leading economic sector. MITI became involved as a coordinating agent for the steel sector in a number of areas, including control over capacity expansion in an effort to keep steel plants operating at full capacity without severe price competition (Yonekura 1994:212–237; O'Brien 1992).

This new model of state-firm-sector coordination only developed out of a protracted series of conflicts between these groups. MITI confronted the vested interests of the old steel companies and their still highly influential leaders, but the industry was highly dependent on MITI and the ExIm Bank of Japan for access to raw materials, negotiations with the U.S. government, and capital. MITI was able to parlay this leverage into regulatory powers over the entire industry, which it used to promote new technologies of unprecedented scale and efficiency.

The Japanese government focused its resources on promoting economic development through heavy industrialization in steel and shipbuilding during 1950s and 1960s. In addition to financing and export promotion, the Japanese government also

set out to establish huge industrial parks. The first was on land reclaimed from Tokyo Bay. Kawasaki Steel, a new company, was given three million square meters of land on which it built the most modern integrated steel facility in the world. Located close to a new, modern harbor, a continuous production line was established covering all stages of production from raw materials to finished products on the same site and using the most modern technology in the world. With labor still relatively cheap, Kawasaki steel became the cheapest in the world. Here the results of dividing up the old zaibatsu came into play. Neither Yawata Steel nor Fuji Steel was prepared to allow a newcomer, Kawasaki Steel, to steal a march on them. Both launched similar developments, creating a large and modern Japanese steel industry in the world-beating class (Reading 1992:70–71).

The Maritime Industrial Development Area (MIDA) program begun in the 1950s coordinated firm and state investment in new greenfield ports and steel plants utilizing the latest technological advances developed in Japan and imported from other nations to reduce costs and increase Japanese economic competitiveness in steel, shipbuilding, and all other sectors that used steel and the steel-based transport infrastructure.

Beginning in the 1950s, Japanese steel firms undertook a long series of efforts to increase the scale of blast furnaces used to produce pig iron, the first stage of

processing iron ore and metallurgical coal. Led by Japanese technological innovations, blast furnaces increased in capacity from 1,500 tons per day in 1950 to 4,000 tons per day by the late 1960s (Manners 1971:27;34) and to 22,000 tons per day by the early 1990s (McGraw-Hill 1992:425–426). The Japanese adopted, perfected and diffused a second significant improvement in blast furnace operation, the improvement in the quality of the burden (the charge of raw materials into the furnace) through the sizing, agglomeration, and beneficiation of iron ore (Manners 1971:160). Limiting the variation in the size of iron ore, sinter and pellet feed increases the efficiency of the furnace, reducing the volume of coal required and increasing the productivity of the furnace and lowering production costs (Manners 1971:36–37). Japan's global sourcing of iron and coal facilitated blending and allowed the Japanese significant raw materials cost savings.

A similar process of blending varieties of metallurgical coal has had similar impacts on the costs of blast furnace operations. The premium prices commanded by metallurgical coals because of their useful properties for metallurgical use have been reduced by Pulverized Coal Injection (PCI). PCI allows metallurgical coal to be partially replaced by a wider variety of grades of coal which are injected into steel direct reduction furnaces rather than being processed into coke before being added to a blast furnace. PCI allows both the use of lower cost coal and eliminates the need for coking batteries, the most environmentally destructive aspect of steel making (Phelps 1992:54–61). Japanese steel firms thus reduced production costs by escaping the "tyranny of metallurgical coal" by substituting less expensive steam coal.

Japanese steel firms also reduced the amount of coke (processed metallurgical coal) needed to produce each ton of pig iron in the blast furnace. The average amount of metallurgical coal required to produce coke declined from 1.1 tons per ton of pig iron in 1950 to 0.83 tons per ton of pig iron in 1965 (Manners 1971:35) and to 0.4 tons per ton of pig iron in the early 1990s (McGraw-Hill 1992:425). This dramatically cuts raw materials cost for a blast furnace, since only about 36% as much coal must be acquired and transported to the blast furnace. For the Japanese steel industry, faced with a lack of domestic metallurgical coal and the need to import this essential input thousands of miles, increasing efficiency of coal consumption was a critical need. Increasing the scale of blast furnaces also contributed to lowering energy costs, as has computer control of the process of blast furnace operation (McGraw-Hill 1992:425–426), another technology pioneered by the Japanese steel firms.

As Manners concludes, "all iron- and steel-producing countries benefited from the improvements of blast-furnace technology, but none perhaps quite so rapidly as Japan" (Manners 1971:38). This rapidity resulted in large measure from the role of MITI and other agencies in providing both capital and raw materials

access support and imposing critical regulations. By combining increasing scale of the blast furnace with careful control of blending multiple ores and controlling the size of feed, Japanese steel mills became the largest and most efficient in the world by the mid-1960s. These efficiencies and reduced transport costs, by diminishing the amounts of iron ore and coking coal required to produce each ton of pig iron in Japan, were critical components of Japan's competitive advantage in steel production since the late 1950s.

The major fuel economies in steel production were driven by the size of the blast furnace that produces pig iron, but the scale of the second steel making stage limited the potential for scale increase, and therefore fuel economy, as the blast furnace and the second stage had to be made compatible. Fuel economy depends on scale of processing, and the scale of processing advances through myriad technical discoveries that progressively cheapen steel making, but does it through scale increases that progressively accelerate the consumption of raw materials. This increases the cost of space across which raw materials must be transported, and within which there is an ever-smaller number of deposits large enough to support the consumption of ever-larger integrated smelters.

The Japanese steel firms led the way in adopting a new technology, the basic oxygen furnace, that had significant advantages over the open hearth furnace that dominated U.S. steel production and adapting this technology to increase scale and efficiency. The basic oxygen furnace reduces the time required to produce one batch of steel to half an hour from the four to five hours per heat required in an open hearth furnace by injecting pure oxygen under high pressure (Ohashi 1992:542). Japan was by far the most rapid adopter of the basic oxygen furnace (Whitman 1965:853–855). This innovation dramatically increased the scale of production, since a basic oxygen furnace in Japan could produce eight to ten times as much steel in a given length of time relative to a U.S. open hearth furnace.

The economies of scale of integrated steel works have grown rapidly since World War II. In the early 1950s, scale economies were thought to exist up to 1 million tons per year of capacity, while by 1965 economies of scale were recognized up to 5 million tons per year and potential economies of scale were identified up to 10 million tons per year (Manners 1971:59). Planned plants in Japan in the late 1960s called for total capacities of 12 million ingot tons (Manners 1971:70). This created a tremendous incentive to increase the scale of blast furnaces in Japan to match the speed and output of the basic oxygen furnace. The capital barriers to establishing this scale of smelting and the potential for crippling overcapacity in the still underdeveloped Japanese and Asian markets set the stage for state-sector-firm cooperation, regulation, and resolution of disputes. On this stage, various agencies of the Japanese state, most notably MITI and the

ExIm Bank, took the lead in the creation of the most tightly coupled relationship between capital and the state in history. MITI learned technical and political skills that made it essential to the steel, shipbuilding and shipping industries. MITI's competence and power allowed it to combat and restrain the self-interests of particular steel companies in the interests of the sector and those of the national economy as a whole. Much of what MITI essentially became originated in its critical role in the adoption and improvement of the Basic Oxygen Furnace.

Rapid growth in the Japanese steel industry necessarily meant construction of greenfield projects, which do not suffer the innovation-retarding drag of capital vested in obsolete plants, depleted sources, and restrictive distribution networks. As a result, Manners argues, "there is a good deal of evidence...to suggest that, on average, Japanese steelmaking costs in 1965 were substantially below those of the United States iron and steel industry, and that Western European costs by and large lay somewhere between the two" (Manners 1971:116). Savings in raw materials and transport costs, combined with technological innovations and adoptions, had in less than twenty years transformed the Japanese steel industry into the world's lowest cost, fastest growing steel industry. As a consequence:

today, for a wide variety of steel products, a Japanese manufacturer of steel products can buy Japanese steel at prices ranging from 15 to 30 percent lower, depending on the gauge, than his American counterpart can buy it in the United States. This handily gives the Japanese manufacturer a cost advantage of 5 to 8 percent less over his U.S. competitor for products such as forklift trucks, construction equipment, automobiles, and ball bearings (Abegglen and Stalk 1985:77–78).

This cost advantage for domestic steel consumers in Japan also translated into international competitiveness in steel exports. As a result, Japanese steel firms have dominated world steel trade since the early 1960s. Japanese steel exports rose from 8.8% of total world exports in 1960 to a peak of 40.8% in 1976; in volume terms, the increase was from 2.3 million tons to 36 million tons over the same period. Japanese steel exports have ranged from 19 million to 33 million tons per year over the last 25 years, constituting 20–30% of total world steel exports during this period (data calculated from OECD 1985 and USBM/USGS Various Years).

In short, as the U.S. government and Japanese development planners foresaw in the late 1940s, the steel industry has become the linchpin of a number of linked industries which have complemented one another in a "virtuous cycle" of economic development. With the steel industry as a generative sector providing the raw materials foundation for reducing production costs for many sectors of the

Japanese economy, Japan transformed into the world's second largest economy and the United States' most formidable economic competitor.

All of these innovations have led to larger scale and increased distance across the needed spaces. The cost of distance offsets the savings of processing steel. This contradiction generates state-firm-sector collaboration to design and implement more efficient transport technologies, more effective transport infrastructures, and the incorporation of ever-broader spaces as potential sources. These transport technologies have required and promoted larger transport scale.

The technical achievements and scale increases in steel production and their development over time have both required and provided the means for increased fuel efficiency of transport. For different but complementary physical causes (relating to inertia, momentum, and hydraulics), size of ship, or scale of transport, is directly associated with fuel economy. The advances in steel quality that are associated with scale-dependent fuel economies in smelting contribute to the tensile strength requirements of the hulls of larger ships and to the capacity of the boilers and engines to withstand the temperatures and the pressures that are directly associated with efficiency of transfer from heat energy to mechanical energy.

The transport strategy developed via the coordinated efforts of MITI, the ExIm Bank, and the Japanese shipping, shipbuilding, and steel firms allowed Japanese steel firms to take advantage of the tremendous economies of scale available in bulk shipping to dramatically reduce production costs of steel in Japan and to capture all of these benefits for themselves, rather than sharing them with coal and iron ore producing firms and exporting regions.

One of the key elements of transport as a Japanese raw materials access strategy was large government subsidies to shipbuilding and shipping firms via the Programmed Shipbuilding Scheme (first introduced in 1947) that carefully controlled the number and types of ships built to suit the importing and exporting needs of the nation (Chida and Davies 1990:66–90). The Japanese government also arranged an innovative lease of a former naval shipyard to a U.S. shipbuilding firm, in return for allowing unlimited access to Japanese engineers, managers and workers. This provided the foundation for research and development on the construction of larger petroleum tankers and bulk carriers and the construction of large shipyards capable of building such large ships, as well as a variety of other innovations that reduced the cost and labor requirements of shipbuilding (Chida and Davies 1990:98–112; Todd 1999:13). For example, during the 1980s, Japanese labor requirements for building a 62,000 dwt bulk carrier fell from 380,000 hours in 1981 to 170,000 hours in 1991 (UNCTAD 1992:39).

Labor saving was of critical importance in Japan because of the high wages of shipyard workers. During most of the post-World War II era, shipyard workers

were the highest paid workers in Japan (Chida and Davies 1990). Just as was the case in the steel industry, heavy industrialization based on raw materials was a major component of domestic consumption in Japan both directly and indirectly through workers' wages, providing a market for the industrial products that utilized steel and other processed raw materials.

Technological and organizational improvements in Japanese shipyards during the 1950s and especially the 1960s gave Japanese "shipbuilders sufficient economies of scale that they could lead the world in the new technology" of building larger and larger ships (Chida and Davies 1990:98–99). A Japanese shipyard built the first large oil tanker in 1962, at 130,000 dwt, and continued to lead the way in increasing scale with a 210,000 dwt ship in 1966, a 370,000 dwt ship in 1971, and a 480,000 dwt ship in the early 1970s (Sasaki 1976:8). Japanese shipyards pioneered similar innovations in bulk carriers, launching the world's then largest ore carrier at 224,666 dwt in 1983 with a fuel consumption of 6 kilograms per ton of cargo, versus 10 to 11 kilograms for conventional 130,000 dwt bulk carriers (Zosen May 1983:28). In order to build these large ships, Japanese shipbuilding firms constructed fifteen shipyards between 1964 and 1976 with the ability to build ships between 300,000 and one million dwt (Nagatsuka 1991:14–15).

This government direction and subsidization reflects the importance of transport as a strategic component of both raw materials access and economic development efforts on the part of the Japanese government. This tightly coordinated system of state-firm relations explicitly sought to balance the interests of shipbuilding, shipping and steel firms and broader industrial and societal interest in low-cost raw materials imports and industrial export transport, with the state as arbiter. This system allocated scarce Japanese capital resources to supply low-cost transport without wasting resources on the notoriously cyclical shipbuilding industry, a delicate balancing act of restricting capacity and output in pursuit of broader state developmental goals.

Although the Japanese steel firms initially intended to build their own fleets of ore carriers, the Japanese government's control over concessionary financing and refusal to supply financing to firms other than the major shipping lines forced the Japanese steel firms to invest in shipping firms in order to secure partial ownership of bulk shipping (Chida and Davies 1990:119). State-firm coordination served to control potential competition in a capital intensive and cyclical industry, balancing the interests of steel, shipbuilding and shipping firms with broader societal interests in conserving scarce capital and ensuring low-cost supplies of raw materials.

The Japanese government also provided financing on concessionary terms for the export of Japanese-built ships through the Export-Import Bank of Japan. Additionally, the government during the 1950s provided funding for the modern-

Table 1—Operating Cost Per DWT (dollars per year)

Ship DWT	Annual operating cost per DWT (dollars)
40,000	80
65,000	59
120,000	40
170,000	35

Source: Stopford 1988:103 (based on Drewry Shipping Consultants data)

ization of the Japanese steel industry, with one important result being the reduction in the cost of steel plate used in shipbuilding, making Japanese ship exports much more cost competitive (Chida and Davies 1990:108–109).

With this support from the Japanese government, the Japanese shipbuilding industry increased from only 15.6 % of world production (829,000 tons) to 43.9% in 1965 (5.4 million tons) and peaking at 18 million tons in 1975, 50.1% of world production. The Japanese shipbuilding industry became the largest in the world in 1965 and produced about half of total world output from the mid-1960s through the mid-1980s (Nagatsuka 1989:17). Shipbuilding was also Japan's most important export industry between 1956 and 1960 (when the steel industry surpassed it in exports) and has remained one of Japan's three major export industries until recently (Chida and Davies 1990:106).

Economies of scale in building costs and operating costs of bulk raw materials ships are quite significant. Larger ships cost far less to operate on a per ton basis than smaller ships, and economies of scale increase with ship size and distance of voyage (see Tables 1 and 2).

Japanese industrial groups control ocean shipping of raw materials on an FOB raw materials exporting port basis so that any reductions in transport costs caused by technological improvements or changes in world shipping market conditions are captured by Japanese importers. The shipping of Japanese raw materials imports is typically arranged by the firms that consume the raw materials:

because Japanese industry needs to control the transport of raw materials very closely, long-term stable freight arrangements are generally preferred. The retaining of a vessel by guaranteeing cargoes for much or all of the vessel's working life is probably the most favored (particularly for Japanese flag newbuildings for which the obtaining of a cargo guarantee would almost certainly have been a pre-requisite for obtaining Japan Development Bank loans), although Japanese interest are responsible for the employment of a large number of vessels operating under privately concluded long-term timecharters and contracts of affreightment (Drewry 1978:58).

Table 2 – Relative Economies of Scale by Ship Size and Voyage Length

		Ship Size (dwt)		
		15,170	65,500	120,380
Voyage Miles	1,000	100	47	37
	6,000	56	27	20
	22,000	52	24	17

Source: Stopford 1988:277

This is an innovative alternative to the U.S. model of raw materials firms' vertical integration into shipping, a model the Japanese steel firms initially sought to replicate. Long-term contracts for the majority of coal and iron ore transport are supplemented by short-term arrangements, allowing Japanese steel firms to take advantage of cyclical downturns in freight rates to charter additional required capacity at even lower cost as shipping firms operate bulk carriers at operating cost or less in order to earn revenues to try to survive until the next boom market.

A new element in the Japanese iron ore access strategy during the 1980s was the construction and employment of ore/bulk/oil carriers and 300,000+ dwt bulk carriers to allow Japanese steel firms to expand their iron ore supply relationship with Brazil with the opening of the Carajas mine, the world's lowest cost iron ore producer, 12,000 miles from Japan. This new strategic element was based on learning from experiences in the coal and iron ore trade with Australia, Canada, Brazil and South Africa and from experiences in managing long distance shipping of oil. This learning led to the expansion of Japanese transport networks beyond the relatively short 3,600 mile haul from Australia to 12,000 mile coal and oil shipments. The key to lowering costs on these even longer hauls is another dramatic increase in scale from 100,000–200,000 dwt ships to 300,000+ dwt ships. Oil tankers had reached this scale by the early 1970s, but iron ore, with a stowage factor of 0.5 cubic meters per ton, more than twice as dense as crude oil (1.2 cubic meters per ton) and almost three times as dense as coal (1.4 cubic meters per ton) (Stopford 1988:255), presented a tremendous technical challenge. The technological advances in ship construction and in the quality, weight, and size of steel plate and beams—most notably the mass production of high tensile steel due to this demand from shipbuilding—were combined by Japanese shipbuilding firms first to build larger oil tankers but then for

the much more difficult task of ore/bulk/oil and dedicated bulk iron ore carriers.

Shipbuilding was thus a key generative sector in the Japanese government's post-World War II development plans. The industry consumed huge quantities of Japanese steel and other inputs, was one of the most important export industries in Japan for many years, served as a model for the import, adaptation and improvement of industrial and organizational technologies, and provided the increasing scale of ships needed by Japanese shipping firms to import huge volumes of raw materials for the Japanese steel mills. The only way to link massive exporting and importing systems in the steel industry with their rapidly increasing scales of operation was to develop shipbuilding and shipping technologies and organizations that could supply bulk carriers of similarly increasing scales. Just as had been the case in earlier periods in Holland, England, and the U.S., shipbuilding created a tremendous range of material, economic, organizational, and technological linkages to other industries.

The construction of large-scale port and railroad infrastructures in raw materials exporting regions paid for by extractive region governments and/or raw materials transnational corporations is based on long-term contracts for raw materials supply with Japanese importing firms to allow the efficient use of these large ships. The impact of these costs on raw materials exporting firms and states will be discussed below.

These Japanese transport strategies for raw materials access have been strikingly successful at guaranteeing long-term access at low-cost to huge volumes of imported raw materials. Just during the 1960s, Sasaki (1976) estimated that Japanese government efforts to reduce the 20–30% share of freight charges in the total cost of imported raw materials through transport subsidies bore the following results: “during the ten years beginning in 1961, the freight costs for both crude oil and iron ore were reduced by 40 per cent....The effects of this reduction were significant and the consequent reductions in the price of electricity, petrol, iron and steel and many other products have made an immeasurable contribution to the national economy” (Sasaki 1976:7). Ocean transport closes the “virtuous circle” of generative sectors in steel, shipbuilding and shipping. Japanese strategies have restructured these global industries and turned remote ecosystems in western Australia, the Brazilian Amazon and western Canada into raw materials peripheries that have provided the material ingredients for Japan's economic ascent. Equally important, the processes of technological, organizational and institutional innovation and learning inseparably linked these international relations with Japanese internal development. Economic ascent was the product of complex coordination between firms and nature, between firms in Japan and in its emerging raw materials peripheries, between the Japanese state

and states in these raw materials peripheries and the U.S., and between the Japanese state, firm and sectors. In overcoming complex challenges presented by material, economic and political processes across multiple ecosystems and multiple political boundaries in the shadow of a powerful existing hegemon, the Japanese state and Japanese firms learned and innovated repeatedly to make Japan the global competitive leader in a wide range of industries.

The Japanese model of capital accumulation that emerged out of the conflictual efforts to promote coordination between the Japanese steel firms, MITI, and the ExIm Bank and directly linked to state-firm-sector coordination in shipbuilding and shipping (involving the parent firms of these steel firms and the same state agencies) assumed the physical manifestation of the MIDAs. The MIDAs simultaneously served as ports to unload ever-larger ships carrying raw materials from around the world at the new steel mills using the latest technology. The steel mills, in turn, supplied shipyards, automobile factories, and other major steel consumers located in the very same industrial parks built with state subsidies on land reclaimed from the ocean. MIDAs are in effect a human-produced change in topography involving the reclamation of land, the digging of new ocean and river channels, and other modifications in port areas to provide both location and transport facilities for industrial plants. MIDAs represent a very high degree of manipulation of nature.

These two mechanisms of scale-dependent fuel economy, *i.e.* in transport and in smelting, support and reinforce each other. If we consider them within an adequately spatialized understanding of the world economy, we note (1) that scale increase of transformative processes leads to (a) increased heavy industrial consumption of raw materials, (b) accelerated depletion of the most accessible sources, and thus (c) cost-increasing distance to raw material sources and (2) that economies of scale in transport are required to resolve the contradiction between savings in processing driven by economies of scale and the increased cost of transport across ever-greater spaces.

The resolution of this contradiction has led to an ever-greater volume of increasingly cheap steel in the world economy and to an ever-expanding space in which coal and iron are mined and transported. In the sequence from wrought iron to Bessemer steel to open hearth to basic oxygen, the sourcing of raw materials has progressed from river basin to lake drainage to global ocean. This has been made possible by and required the huge increase in the size of ships, ports, docks, and loading equipment.

This increase in the space in which iron and coal are provisioned and transported, however, have also eliminated the “natural tariffs of distance” (compare Innis 1956, Mandel 1975, Harvey 1982). This consequence of cheaper transport has usually been addressed in terms of the increased competitiveness of

imports against locally manufactured goods, but extractive industries suffer similar impacts. As the technology of transport globalizes raw materials sources, the importing countries are no longer constrained to more proximate sources. As the cost of transport is diminished, all mines or sources compete in the establishment of rent, which tends to lower prices. Additionally, in a situation where there are relatively few deposits of the size required to realize economies of scale, this kind of global competition reduces any element of monopoly rents.

The Japanese state and firms have enhanced this technological assault on rent and thus on the prices they pay to exporting countries by using joint ventures, long-term contracts, and various kinds of aid to create excess capacity in both coal and iron. The Japanese have been extremely aggressive in their strategies to play off North American, South American, Asian, and African sources of raw materials against each other, and their success has involved considerable learning and manipulation of information, institutional relations, and contract arrangements, but the effects of these social and political strategies would be far less without the globalization of raw materials sources that the Japanese-led revolution in maritime transport technology made possible. The revolution in transport technology would not have occurred without the massive increase of scale and fuel efficiency that the Japanese achieved with the basic oxygen furnace. By setting in motion multiple mechanisms to reduce raw materials rents, the intersection of two different mechanisms of scale-dependent fuel saving and precision enhancing technologies, one in smelting, the other in transport, directly accelerates the globalization of raw materials markets and exacerbates inequalities between the exporters and the importers of raw materials.

#### IV. JAPAN'S CONSTRUCTION OF ITS PERIPHERY SINCE WORLD WAR II

The characteristics of the U.S.-led systems of capital accumulation and global inequality are well-known and well-understood. U.S. economic and political hegemony from the late 1940s through the late 1960s was manifested internationally by transnational firms based in the U.S. These TNCs' major strategies during this period included: expanding globally to sell U.S.-made products in other countries; investing in local production facilities to supply local markets when necessary and repatriating profits to U.S. headquarters; exporting products from these facilities to U.S. markets; and exporting raw materials to the U.S. (Barnet and Muller 1974; Hymer 1979; Jenkins 1987; Chase-Dunn 1989). Transnational raw materials firms and other neocolonial apparatuses that exported profits from the periphery and semiperiphery to the core (Jalee 1968; Mandel 1975; Said and Simmons 1975; Amin 1976; Sunkel 1995) replaced impe-

rialism as the central mechanisms of global inequality (see Ciccantell 2000 for a fuller discussion).

In contrast, the Japan-driven model of capital accumulation and global inequality that emerged over the last fifty years is widely misinterpreted and misunderstood. One hallmark of globalization—the rapidly growing share of world trade taking the form of transfers between joint ventures, partnerships in long-term contracts, and other mechanisms that link firms (Harvey 1995), rather than trade as transfers from wholly-owned subsidiaries to parent companies—was most fully developed first by the Japanese steel firms to overcome the problems of capital shortage and obstacles to Japanese foreign direct investment outlined earlier. Japanese firms have used long-term contracts, joint ventures, and other forms of interfirm cooperation as competitive strategies to reduce costs in the increasingly integrated and competitive world market (Ciccantell 2000).

The first major step in creating the raw materials supply system to sustain Japan's economic ascent was obtaining access to Australian coal in the late 1940s and early 1950s. The U.S. State Department, U.S. Military Occupation Forces in Japan, the Japanese steel firms, and the Japanese state worked together to initially buy Australian coal indirectly, via U.S. military procurement channels, and then to establish direct short-term and then long-term supply agreements with Australian coal producers.

A series of long-term contracts beginning in the early 1960s, sometimes linked to minority Japanese participation in joint venture investments, and increases in ocean transport scale via Japanese shipbuilding innovations transformed Australia into the world's largest metallurgical coal exporter and Japan's most important source of metallurgical coal. Australian coal saved the Japanese steel firms money in comparison with more expensive U.S. coal; the average CIF savings per ton ranged between US\$3.85 and US\$14.25 between 1960 and 1972, a savings range of 22% to 53%. These contracts with Australia did not seek to minimize costs during the 1960s and 1970s, but instead included escalation clauses that provided an incentive and guarantee to mining firms in Australia to undertake these capital intensive investments that allowed Japan to diversify away from its huge dependence on the U.S.

The Japanese steel firms coordinated their negotiating efforts with the coal-producing firms in Australia (some Australian-owned, but many owned by British and U.S. mining firms), giving the Japanese steel firms a high degree of bargaining power in the price negotiations and allowing them to play the coal-producing firms against one another, and the two competing coal-producing states in Australia, New South Wales and Queensland, off against one another as well. The majority of coal production in New South Wales came from higher-

cost underground mines, while most coal production in Queensland came from much lower cost surface mines (Fisher 1987). New South Wales also charged a much higher per ton royalty than did Queensland; during the 1960s, New South Wales charged up to A25 cents per ton royalty on metallurgical coal for export, while Queensland charged royalties of only A5 cents per ton (McKern 1976:72). Coal producers in the two states competed for Japanese coal export contracts, often leading to severe price competition that benefited the Japanese steel mills (Koerner 1993; Fisher 1987:186). This outcome, first recognized in the early 1970s, led to lower prices for Australian coal than for U.S. coal even after adjustment for quality differentials (McKern 1976:184), a problem that continues today.

The Queensland surface mining firms and the state of Queensland effectively sacrificed an important share of the differential rent from their more favorable natural mining conditions and resulting higher labor productivity and lower costs in an ongoing effort to gain market share and earn a higher total volume of profit via expanded production, rather than maximizing rent. This strategy benefits Japanese steel mills and helps ensure the maintenance of long-term excess capacity in the metallurgical coal industry. The microeconomic logic is clear: lower-cost producers expand production because their marginal costs are lower than competitors. This strategy ignores the consequences for industry structure of this seemingly rational behavior in the face of a strategically acting cartel of buyers, the Japanese steel mills. The Japanese steel mills are willing to sign long-term contracts and make small equity investments with low profit potential to ensure steady, long-term supplies of low-cost coal that is simultaneously a lever to drive down market prices (e.g. the 50% real reduction in metallurgical coal import costs in Japan) and secure more favorable contract terms with other producers. This diversification strategy is in turn a lever to secure more favorable terms with the Australian producers who continue to follow a standard but badly flawed microeconomic strategy of expanding production in the vain hope of forcing higher-cost producers out of the industry.

Changing technological and economic conditions in a resource-rich nation, Australia, helped to pave the way for the establishment of a long-term metallurgical coal supply relationship between Japan and Australia. This relationship created a long-term growth period for the Australian coal industry from 1961 through 1982 (Fisher 1987:180). The Japanese steel firms exploited these opportunities by identifying firms and state governments most favorably disposed to promoting coal exports. As these individual actors became more invested in exports, they and their competitors increased political pressure and capital commitment to natural resource exports to Japan.

During this same period, the Japanese steel mills began efforts to further diversify their sources of supply using the Australian model. The Soviet Union

supplied between 5% and 10% of Japanese metallurgical coal imports between 1958 and 1973, and Poland, China, South Africa, Taiwan and West Germany also exported small amounts to Japan during this era. The most important diversification effort, however, focused on western Canada, increasing Canada's share in Japanese imports from 0.1% in 1958 to 19% by 1973. Other suppliers were brought onstream in the late 1980s and 1990s under similar long-term contractual arrangements, most importantly in Indonesia.

The Japanese strategies reduced the real cost per ton of metallurgical coal imported into Japan from US\$86.65 (in 1992 dollars) in 1959 to US\$43.63 in 1998. The Japanese steel mills, with the assistance first of the U.S. government and later of the Japanese state, had thus devised a model of long-term contracts to guarantee secure access to metallurgical coal from Australia that could be transferred to other regions. This new model accommodated the resource nationalism of host nations. It fundamentally altered the nature and composition of the world metallurgical coal industry, transforming metallurgical coal flows from domestic movement from captive mines to their steel mill owners to transoceanic trade flows governed by long-term contracts. Domestic and transnational firms assumed the capital cost and risks of opening up previously unexploited metallurgical coal deposits. Deposits that had not even been identified earlier because of the tremendous distances between these deposits and potential markets suddenly became highly attractive. The Japanese steel mills used the market opportunities in Japan, long-term contracts, and small equity investments as tools to induce mining firms in Australia to invest repeatedly in creating excess capacity in the world industry, driving down prices and the production prices of the Japanese steel mills. Typically, the coal was transported by state-owned railroads to state-owned ports, although one Canadian railroad and port and some Australian ports were privately owned. The Australian, Canadian and foreign mining firms assumed the capital risk for mining, and local and national governments assumed most of the risks and costs in transport. At the ports, the coal was loaded on Japanese ships for the trip to Japan and shipped FOB, meaning that the Japanese buyers paid for and controlled ocean transport and captured the benefits of transport cost reductions.

The strategies of the Japanese steel firms created excess capacity in the coal industry by bringing large new mines in several nations, most importantly in Australia, into production and pitted fragmented coal sellers against a tightly integrated coal buying cartel made up of all the major Japanese steel firms (Bunker and Ciccantell 1995a and 1995b; Koerner 1993; Anderson 1987). The result of this Japanese-driven process of globalization, based on an analysis of global and Australia-Japan coal trade flows, has been "world coking coal prices and trade (that) are lower than under perfect competition" and the creation of "an

oligopsonistic structure (under which) welfare gains from productivity increases in Australian coal mines might largely accrue to coal buyers" (Graham, Thorpe and Hogan 1999:210).

The consumer market power held by the Japanese steel firms was temporarily disrupted in the mid-1990s by a period of relatively high coking coal prices, a phenomenon that may have been due to cooperative efforts by Canada's largest coal exporter, Fording Coal, and Australia's largest coal exporter, BHP, to strike better bargains with the Japanese steel firms. The response of the Japanese steel firms to a sharp price increase in 1995 was swift: a new pricing mechanism called the "fair treatment system" was imposed by the Japanese steel firms during contract negotiations for the 1996 fiscal year. The fair treatment system called for prices to be linked to the coal quality requirements of individual Japanese steel mills and for the details of the contract negotiations to remain confidential. The Japanese firms argued "that prices could be negotiated to better reflect the value-in-use for specific quality specifications and hence improve the efficiency of price formation" (Swan, Thorpe and Hogan 1999:17). However, the outcome has been that "given coal prices and other contract details remain confidential both during and after the price negotiations, it is unlikely that the efficiency of the market has been enhanced with the introduction of the fair treatment system" (Swan, Thorpe and Hogan 1999:17); these researchers found in their econometric modeling of the relationship between coal quality and prices that the fair treatment system has actually weakened the relationship between coal quality and price in these contract negotiations. In other words, by tying prices more closely to coal quality the fair treatment system accomplished the opposite of what the Japanese steel firms said it was intended to do. The fair treatment system has instead reduced the ability of coal sellers to gather market information and especially to have any opportunity to work cooperatively because of negotiating secretly and individually with the still-coordinated Japanese coal buyers.

The results have been dramatic. Canadian coal export prices, for example, have fallen from C\$52.80 in 1997 to C\$50.50 (US\$33.09) in 1998 (*Coal Age* Feb. 1, 1998:11) and to C\$41.45 (US\$27.19) for Fording Coal's exports in 1999 (*Coal Age* Feb. 1, 1999:13), a price cut described by the president of the Coal Association of Canada as "a reduction of historical proportions....We haven't seen a price cut of this magnitude before" (*Coal Age* Feb. 1, 1999:13). New mines have been delayed, hundreds of employees laid off, and some mines have simply closed (*Coal Age* April 1, 1999:11; *Coal Age* June 1, 1999:7).

The increasing capital intensity of coal mines and transport systems have led to less employment per ton of coal produced and eventually to a decline in total employment in coal production, despite increasing overall production. In British Columbia, for example, coal production increased from 22.6 million

tons in 1985 to 27.7 million tons in 1997 (Price Waterhouse 1998:6), despite a decline in employment from 5,821 to 3,835, reflecting a productivity increase due to restructuring and increased mechanization from 3,883 tons per employee in 1985 to 7,223 tons per employee in 1997.

Moreover, the intense global competition and excess capacity fomented by Japanese long-term contracts lowers raw materials prices and reduces or eliminates rents (as demonstrated by the halving of real costs of importing coal into Japan between 1959 and 1998 mentioned earlier), putting intense pressure on exporting firms to reduce costs or face bankruptcy. The resulting ongoing restructuring of the last twenty years has bankrupted firms, closed mines, and devastated communities. One excellent example of these processes is the Balmer mine in southeastern British Columbia which experienced a long boom, followed by bankruptcy, closure, and now ongoing restructuring in an effort to remain competitive. At the same time that joint ventures between the Japanese steel firms and their Canadian partners have faced repeated crises, the Japanese steel firms have been busy signing new long-term contracts in Australia, South Africa and Indonesia to support the opening of new mines, creating even more global excess capacity.

The iron ore trade relationship between Australia and Japan developed along similar lines. In the early 1960s, Australian iron ore producers focused on exporting iron ore to Europe, but the long distance and resulting high transport costs made this trade extremely expensive and largely uncompetitive. Mining firms in Australia that had begun selling coal to Japan in the 1950s began exploring for iron ore in Western Australia and lobbying the Australian government to end its ban on iron ore exports in the late 1950s. By offering long-term contracts and credit needed for opening new, and much larger, mines and transport systems, the Japanese contrived to orient most of the greenfield iron ore projects toward the Japanese market after the Australian government permitted iron ore exports in 1960. In the mid-1960s, Australian iron ore exporting firms began to focus on the Japanese market because of relatively proximity. The Japanese steel mills signed long-term contracts with several major Australian iron ore mines, with some of these contracts including financial and engineering assistance from Japan to develop these projects (Manners 1971:167-168).

The first two mines built in Western Australia as joint ventures to supply Japan were required to build their own rail and port infrastructure (Skillings 1969; McKern 1976:206-216), an important departure from the metallurgical coal mine model in eastern Australia. The next four iron ore mines developed in Australia (three in Western Australia and one in Tasmania) included the Japanese steel firms or Japanese trading companies as partners and also built their own infrastructure (McKern 1976:206-216). Most critically for the Japanese

steel industry, this exploration and investment by Australian and foreign mining firms revealed the huge iron ore reserves of remote regions of Australia. In 1950, Australia's known reserves were only 126 million tons of contained iron ore, a mere 0.5% of world reserves (Manners 1971:228); by the early 1990s, Australian reserves were 10.2 billion tons of contained iron ore, 16% of world reserves (USBM 1992) and eighty times as large as known reserves forty years earlier, after hundreds of millions of tons had already been extracted, mainly for export to Japan.

The Japanese steel firms were coordinated as a sector and articulated with the Japanese state and with the general trading companies that typically handled the logistics of these large-scale flows of coal and iron ore. With iron ore deposits located less than 400 kilometers from the west coast of Australia and separated by few intervening hills on the gradual downhill railroad journeys, and the coasts of Western Australia and Tasmania also amenable to the development of large-scale ports, as eastern Australia had been for coal exports, the Japanese steel firms utilized their large-scale MIDA ports in Japan for both coal and iron ore imports.

The massive scale of these iron ore mines and the dedication of transport infrastructure designed specifically for exporting iron ore had major implications for the turnaround time of the massive capital investments in these facilities. In 1969, 100,000 tons of iron ore represented 2% of the Goldsworthy mine's five million tons of annual output. This week's worth of iron production could be loaded onto railcars and shipped to the port within the same seven to eight day period over the three hour railway journey, loaded onto a ship in just over two days' time, and shipped 3,600 miles to Japan in a few days' sailing time (Skillings 1969:8) and converted into pig iron, smelted into steel, and cast into semifinished products within another three to four weeks. This tightly integrated, large-scale extraction, transport and processing system made very efficient use of the hundreds of millions of dollars of capital invested in the system by utilizing the latest technologies of mining, rail transport, port facilities, bulk shipping, and steel production in a well-organized system governed by long-term contracts linking the mining company to Japanese steel companies, trading companies, and shipping companies.

The efficiencies and synergies that made Japanese steel and shipping crucial generative sectors came at the cost to Australia and other raw material exporters of rent reduction because of excess capacity in over-supplied world markets and state and/or firm commitment of huge capitals or debt rigidly sunk in mining and transport infrastructure. These long-term contracts and later annually negotiated price and quantity terms were not ideal instruments from the perspective of raw materials exporting firms and states. Even before the Western Australian

iron ore mines came into production, mine development costs had exceeded estimates by 15% to 30%, while contract prices with the Japanese steel mills were as much as 15% below world market prices. One analysis argued that the reason was that the mining company operators "had one disadvantage in dealing with the Japanese: they competed against one another on price. The result: Japan sewed up one of the best iron-ore import deals in history" (*Business Week* August 13, 1966:99). Japan's iron ore prices from other sources at the time ranged from 20.5 to 26 cents per pound of contained iron, while the Australian contract prices were 14.5 to 21 cents and an average of 18 cents per unit of contained ore. Efforts to renegotiate the contracts were undertaken with only limited success as other iron ore exporting countries, most notably India, filed formal protests with the Australian government and the national government investigated the terms of the contracts (*Business Week* August 13, 1966:98–100). This disadvantage of uncoordinated negotiations on the exporting end confronting tightly coupled firm-sector-state coordination at the importing end would become a hallmark of iron ore-exporting nations' relations with the Japanese steel firms.

Australian iron ore exports to Japan increased from nothing in 1963 to 13.8 million tons in 1968; Australia became Japan's largest iron ore supplier in only five years. By 1973, exports reached 64 million tons, more than three times greater than Japan's second largest supplier and 56% of Japan's total iron ore imports. Australia has remained Japan's largest iron ore supplier throughout the past thirty years, and this same model of long-term contracts was utilized in Brazil and other iron ore-exporting nations during this period.

Our focus on evolving material process as cumulatively sequential in space and over time allows us to ground comparisons between systemic regimes of accumulation as historical transition and to incorporate within that comparisons of different instances of subordination within a restructured periphery at particular moments in time. Thus we see Canada bound into the formation of new global markets with the same general mechanisms that the Japanese firms and state learned and adapted in Australia, but we can also see how the Japanese adjusted their strategies to the different material and spatial characteristics of the Canadian resources, most notably their far greater distance from Canadian ports, the far rougher terrain between the mine and the port, and then the far greater distance to Japan. These differences enter into both the contractual relations that Japan established with Canadian firms and provincial states, and with their treatment of these coal exporters once the mines and transport infrastructure were established.

Similar comparisons are possible with iron exporters. The basic strategies employed in Brazil were those learned and perfected in Australia, but their actual implementation was adapted to the spatial, material, and political realities of

Brazil. The major Brazilian supplier of iron to Japanese firms is the Carajas mine in the Southeastern Amazon, the largest iron mine in the world. Owned by CVRD, which was a mixed public and private but very much national firm until its privatization in 1996, Carajas was financed through a complex mix of Japanese, American, European, and Korean public loans coordinated by the World Bank under policies that had originated under U.S. concerns in the 1970s to ensure adequate raw materials supplies (see Bunker and O'Hearn 1992). In this case, Japan played a far less central role in financing and in contracts, using instead U.S. and European Union interests in the mine to stimulate finance, and working instead to influence the Brazilian national state and CVRD to develop the mine in such a way that it fed into Japanese global sourcing strategies at local cost. Thus the costs of a 690-mile-long railroad to a port capable of handling 385,000 dwt ships were left to World Bank coordination of a trans-core loan to CVRD for the mine and a joint venture with Docenave, a CVRD subsidiary, to build the huge ships that would allow economic shipments of iron ore all the way to Japan. The promise of Japanese long-term contracts led CVRD to choose the far longer rail lines, the far bigger port, and the huge investment in ships that could only dock in Japan and in Rotterdam over the much cheaper infrastructure that its original partnership with U.S. Steel had envisioned. The initial arrangement with U.S. Steel had entailed barging the ore downriver to the existing port of Belem and then on to the U.S. in the smaller ships appropriate to regional, rather than global, trade in cheap bulk raw materials.

Comparison with Australia shows that Japanese strategies in Brazil responded to (a) the topographies and locational characteristics of the Amazon, (b) the far more centrally controlled structure of the Brazilian federal system, (c) the political power of CVRD relative to both the national state and the much weaker Amazonian states, and (d) the greater distance from Brazil to Japan. In order to achieve its own incorporation into Japanese globalizing strategies, CVRD used the national congress and national ministries to undermine local state control over land and taxes. CVRD pushed the establishment of new federal agencies that controlled land use on a military model and promoted national state initiatives that preempted land formerly under local state control. At the same time, it collaborated with Japanese development agencies to promote fiscal incentives that would support the infrastructure required for access to the Japanese market, while manipulating federal decrees that reduced its tax and rent debt to the local state. In these ways, the Amazon's incorporation into Japan's resource-supplying periphery led to huge capital costs, rent reduction, and impoverishment of local administration.

The fundamental problem of how to move huge volumes of bulky raw materials, iron ore and metallurgical coal, thousands of miles to Japan at costs low

enough to allow the Japanese steel industry to be competitive in the world economy was resolved through a combination of technological, organizational and institutional innovations at the firm, industry, and state levels. One analyst had already noted by the late 1960s the tremendous influence that Japan's rapidly growing demand for iron ore imports had on the world iron ore market between the early 1950s and late 1960s:

the importance of the Japanese market far exceeded the volume of imports moving into that country. Partly because of the rapid rate of growth of demand for iron ore, but also because of the highly aggressive purchasing policies adopted by their iron and steel industry, the Japanese tended to set the pace and the style of change in the ore markets of the world. Faced with exceptionally high raw-material costs at the beginning of the period, the Japanese steel industry systematically set about to ensure a reduction of its raw-material transport costs. By accepting the responsibility and the economies of long-term and large-scale ore purchases, and by skillful bargaining with its suppliers, Japan by 1965 had established for itself a much admired and an almost enviable position (Manners 1971:253).

Technological and organizational innovations in extracting, transporting, and processing iron ore and coal made Japan the world's lowest cost steel producer by the 1960s, driving Japanese economic ascent by lowering costs throughout the Japanese economy and increasing its global competitiveness.

## V. JAPAN'S RECONSTRUCTION OF THE WORLD ECONOMY AND ITS CONSEQUENCES

The experience gained from accessing coal and iron ore in Australia via long-term contracts with minimal Japanese capital investment laid the foundation for the tremendously successful program for diversifying sources whose capital expenses were largely met by exporting states and firms: the "ABC policy (Australia, Brazil, and Canada)...a term applied to describe this approach, and to recognize the need for vigilant management of security of supply, quality, and delivery...the strategy has been clear: supply basic intermediate feedstock materials to downstream assembling and processing manufacturing industries at the lowest possible cost" (McMillan 1985:79–80).

This model, in various forms and combinations (Ozawa 1986), has since the late 1940s provided the material foundations for Japan's economic ascent. The challenge of gaining access to Australia's metallurgical coal began a learning process for the Japanese state on how to create the raw materials supply relations Japan would need to support industrialization. Australia became the first major raw materials supplier directly dependent on Japanese markets; Brazil and Canada became during the 1960s the other two major pillars of Japan's raw materials supply chains. Locationally, topographically, and politically, these countries

presented very different sets of problems and opportunities for Japanese raw materials access strategies. In learning how to respond to and exploit these differences, the Japanese state and Japanese firms developed highly useful flexibility and agility that later served them well in other countries.

The Japanese steel firms and the Japanese government, with initial support by the existing hegemon, the United States, successfully restructured the world coal and iron ore industries to supply low-cost coal and iron ore to Japan, while transferring the vast bulk of costs and risk to mining firms and state and national governments in Australia and, later, in Canada, Brazil, South Africa, Indonesia, and even the U.S. itself. The new combination of large-scale mines and large-scale transport facilities, while reducing the cost per ton of production and transport, have greatly restricted the markets available for these mines' production, since these low costs are dependent on the utilization of large ships that can only berth in a very small number of ports outside Japan. The coordination of Japanese steel firms in negotiating prices for coal and iron ore, the high capital costs of these mines that make sales even at a loss essential in order to service high debt loads, and the construction of dedicated infrastructure by extractive states and firms all combine to give Japanese steel firms tremendous advantages in bargaining over purchase terms with coal producers. This restructuring of the world coal and iron ore industries was a fundamental material and economic pillar of Japan's rise as an industrial power and challenger to U.S. economic hegemony.

MIDAs, the linchpin and physical manifestation of the Japanese model of capital accumulation, restructure nature, the Japanese economy, and the world economy through state policies and investment in combination with private firms in order to manipulate nature, space, topography, and existing economic and social structures in search of private profits. The MIDAs represent a clear case of state-firm-sector organization of unprecedented scope and cost in response to the increasing scale, geographical scope of sources and markets, and technical complexity of the bulk raw materials industry as the result of the cumulatively sequential punctuated evolution of the world economy.

Japan could only compete against the regionally based comparative advantages of a U.S. dominated world market by using the ocean to become global. This inevitable next step for the system of global sourcing was only possible by creating new institutions for the tight coupling of firms, sectors, and states. The Japanese government and MITI's successful response to this challenge restructured both domestic and global social and economic organization. MIDAs are the central element and the epitome of tightly coupled internal and external restructuring and reorganization to support Japan's industrial transformation. MIDAs were located and constructed in order to efficiently articulate with a

network of far-flung sources of precisely distinguished types of coal and iron that were economically viable to transport only with the scale of transport the MIDAs made possible. The MIDAs also were critical to the tightly coupled internal system of very large-scale, very efficient downstream distribution, and the quality control that the continuous casting basic oxygen furnace operating at full capacity required. In other ways, MIDAs looked inward to the domestic economy, sustaining economies of scale and distribution and outward to global sources, making possible very large cargoes and also providing the capacity for efficient storage and movement needed for precise blending of coal and iron ores.

The MIDA is one of the clearest examples of how Japanese strategy and organization have linked the domestic and the international. The strategy for raw materials access is so tightly coupled with the organization of production in Japan that the internal and the external are continuous in their organized relationship of the flows of raw materials, while at the same time strong incentives for state-firm-sector collaboration within Japan draw the internal-external distinction very clearly in terms of how the cost savings and profits are distributed. The tightly-coupled flow of raw materials from mine to market is so closely organized, and the various phases so interact, that the internal-external line is obliterated. At the same time, the shared interest of the firm-sector-state alliance in promoting national economic growth, pooling information, and socializing risk heighten the internal-external division by systematically favoring Japanese domestic interests at the level of the firm, the sector, the national economy, the society, and the world economy.

At the same time that this model of capital accumulation has had such salutary effects in Japan, the consequences for raw materials exporting regions have been equally dramatic and, on balance, often very negative. Perhaps the most striking example of both the positive and negative impacts of becoming part of Japan's raw materials periphery can be found in the coal mining country of southeastern British Columbia. The Elk Valley region began producing coal a century ago for railroads and local coke ovens. Dieselization of railroads in the 1950s brought the industry in the area into what appeared to be its final decline. Coal reserves were and still are extremely large (measuring several hundred million tons of proven reserves today), but the largest customer had disappeared and the small coal-dependent towns in the area appeared headed for oblivion.

In the early 1960s, however, one coal firm began selling metallurgical coal to the Japanese steel mills from the Balmer mine. The Balmer mine was a joint venture of a subsidiary of U.S.-based Kaiser Steel Corporation and minority partners Mitsubishi Corporation and a consortium involving all of the major Japanese steel firms (by 1991, Balmer was the largest open pit coal mine in the

world) (MEMPR 1992:33). By the late 1960s, long-term contracts for millions of tons per year of exports to the Japanese steel mills from Balmer and other new mines transformed the region from a fading, localized coal industry into a major global center of coal production for export. During the 1970s, a period of generally high and rising coal and other energy prices, this joint venture earned an average profit rate of 16% per year (*Canadian Mines Handbook 1980-81* 1980:137), or as one former executive put it, “Kaiser was printing money” because coal production was so profitable.

By any measure, the impacts of coal exports to Japan have been profound. Canadian metallurgical coal exports increased from 600,000 tons in 1963 to 39 million tons by 1991, with the vast majority coming from southeastern British Columbia and going to Japan. Coal was Canada’s most important export to Japan by the early 1990s (*The Elk Valley Miner* May 21, 1991:20). In British Columbia, the coal industry employed over 3,500 people and paid C\$180 million in wages in the mid-1990s (SEEDA 1995:5). The coal and linked industries account for approximately 1% of Canada’s GDP and a much larger share of British Columbia’s GDP and export revenues. Employment in the British Columbia coal industry overall increased from only 457 in 1967, the low point in the historical decline of the industry, to a peak of 5,821 in 1985, and the local population grew rapidly. Obviously, coal is of major significance nationally and locally and developed from a dying industry in the early 1960s into a major economic force by the mid-1980s.

However, intense global competition because of excess capacity developed to fulfill long-term contracts with the Japanese steel firms provoked restructuring over the last fifteen years that lowered total employment in the province’s coal industry to only 3,835, with 2,360 of those jobs in the Elk Valley. All of the mines in the area have laid off workers, experienced temporary shutdowns, and declined dramatically in profitability. Moreover, local populations today are smaller than they were in 1981, reflecting declining employment due to restructuring.

Exports to Japan thus brought a boom to the region during the 1970s and early 1980s, but restructuring since the early 1990s has dramatically altered the earlier boom conditions and presented a series of profound challenges for the region. Similar stories can be told about other Japanese raw materials peripheries in Australia, Brazil, Venezuela, Indonesia, and other nations.

## VI. CONCLUSION: NEW HISTORICAL MATERIALISM AND INTERNATIONAL INEQUALITY

This paper showed how Japanese firms and the Japanese state constructed a development model based on the steel industry as a generative sector that drove

Japan’s economic ascent in the world-historical context of U.S. hegemony. These strategies created a tightly linked set of technological and organizational innovations to overcome the natural and social obstacles to Japanese development, dramatically increase Japan’s international economic competitiveness by lowering production costs in all sectors of the economy, turn Japan into the world’s largest exporter of manufactured products, restructure a range of global industries, and recreate the world-system hierarchy in support of Japanese development. In particular, organizational innovations in the use of long-term contracts and joint ventures in raw materials industries to foster global excess capacity and lower rents to resource extracting firms and states reallocated the costs of providing the material building blocks of Japanese development to the states and firms of its new raw materials periphery. This competitive advantage drove Japanese capital accumulation and economic ascent, and simultaneously drove underdevelopment in Japan’s periphery.

These Japanese innovations became key elements of globalization as U.S. and European transnational corporations and states sought to compete with Japan. Joint ventures, long-term contracts, and other forms of interfirm cooperation have replaced vertically integrated foreign direct investment—the earlier U.S. model of capital accumulation and international economic linkage—as the model for global industries. This new model of capital accumulation has had similar impacts on redistributing the costs and benefits of development between core and peripheral regions of the capitalist world-economy in a wide range of global industries.

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