

UNIT SIX: INDUSTRIALIZATION AND ECONOMIC DEVELOPMENT

Since humans first began to farm about 10,000 years ago, the earth's landscape has constantly changed as economic activities have evolved. For thousands of years, agricultural practices were most responsible for the transformation of land areas. Then in the late 18th century, less than 300 years ago, another economic development – industrialization – began to reconfigure the landscape in dramatic ways, creating a vast panorama of farmlands punctuated by growing cities. The growth of cities is one consequence of industrialization, an economic change so recent in earth's history that we cannot possibly understand how far-reaching its influence will be in the future.

Industrialization is a topic of great interest to **economic geography**, a discipline that studies the impact of economic activities on the landscape and investigates reasons behind the locations of economic activities. Geographers are also interested in the changes that industrialization has brought to the cultural and social landscapes as well, especially in the different patterns of wealth that it has created. Largely as the consequence of industrialization, not only has the gap between rich and poor people of many nations grown, the divide between rich and poor nations has become much more pronounced.

KEY CONCEPTS IN INDUSTRIALIZATION AND DEVELOPMENT

Industrialization is the process by which economic activities on the earth's surface evolved from producing basic, primary goods (such as food products) to using factories for mass-producing goods for consumption. Whereas agriculture is a **primary economic activity** that directly extracts products from the earth, industry is composed of **secondary economic activities** that transform raw materials into usable products. Industrialization involves the production of goods using advanced sources of energy to drive large machinery and specialized labor to produce standardized goods. Secondary activities also pose different locational problems than those for primary activities. They often involve the assembly and the processing of inputs (raw materials) and the distribution of outputs (finished products) to other points, so location of industry usually requires more spatial levels of consideration than primary activities require.

The **Industrial Revolution** began this process in England during the late 18th century. **Economic development**, the process of improving the material conditions of people through diffusion of knowledge and technology, has occurred as a result of industrialization. Economic development may be traced by examining three types of economic activities as they have developed through time:

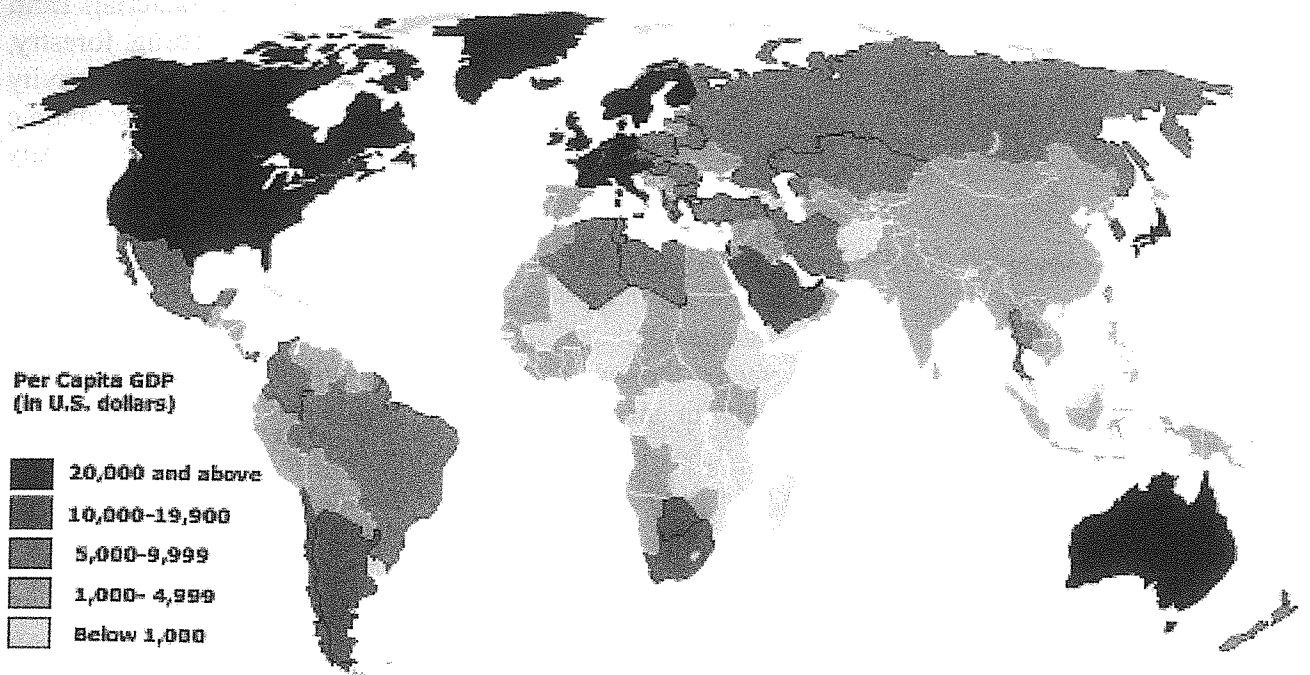
- **The primary sector (agriculture)** is the part of the economy that draws raw materials from the natural environment. The primary sector – agriculture, raising animals, fishing, forestry, and mining – is largest in low-income, pre-industrial nations. This type of economic activity first appeared about 10,000 years ago, and continued to be the main type of human economic activity on earth until the 20th century. Even today farming is the major occupation in many countries of the world.
- **The secondary sector (industry)** is the part of the economy that transforms raw materials into manufactured goods. This sector grows quickly as societies industrialize, and includes such operations as refining petroleum into gasoline and turning metals into tools and automobiles. Historically this sector was first created in the late 18th century by the Industrial Revolution, which replaced human and animal muscle with energy generated by machines. As industrialization spread to other areas of the world, it has transformed societies beyond economic activities, dramatically changing lifestyles, values, beliefs, and customs.
- **The tertiary sector (services)** is the part of the economy that involves services rather than goods. The tertiary sector grows with industrialization and comes to dominate **post-industrial societies**, or countries where most people are no longer employed in industry. Whereas production in industrial societies centers on factories and machinery generating material goods, post-industrial production is based on computers and other electronic devices that create, process, store, and apply information. With post-industrialism, a society's occupational structure changes significantly. Examples of tertiary jobs include construction, trade, finance, real estate, private services, government, and transportation. **The quaternary sector** is often seen as a subset of the tertiary sector. It includes service jobs concerned with research and development, management and administration, and processing and disseminating information.

Countries of the world may be categorized by the evolution of economic activities. Those that have experienced industrialization may be called **more developed countries (MDCs)**, and those that have not may be categorized as **less developed countries (LDCs)**. More countries in today's world belong to the latter category, but some may be subcategorized as **newly-industrializing countries**. During the last few decades, some countries, mostly in Asia and parts of Latin America, have experienced economic growth, so that they appear to be somewhere in between MDC and LDC status. An example is South Korea, a country that only fifty years ago was a relatively poor agricultural country. During the late 20th and early 21st century, South Korea has developed into one of the world's largest economies and also has experimented with democratic institutions. The process that it has experienced is sometimes called **compressed modernity** – rapid economic and political change that transformed the country into a stable nation with democratizing political institutions, a growing economy, and an expanding web of nongovernmental institutions. Mexico is often cited as newly-industrializing, with its dramatic economic growth that began in the 1980s based on its abundance of oil.

ECONOMIC INDICATORS OF DEVELOPMENT

Economic development may be measured in several ways, including the following:

- **Gross Domestic Product Per Capita** – **The Gross Domestic Product (GDP)** is the value of the total output of goods and services produced in a country during a year. Dividing the GDP by total population creates the **Gross Domestic Product Per Capita**, a measure of the average



Annual gross domestic product (GDP) per capita. This measure exceeds \$20,000 in most MDCs, compared to less than \$5,000 in most LDCs. In between are newly industrializing or middle-income nations.

person's contribution to generating a country's wealth in a year. Annual per capita GDP exceeds \$20,000 in MDCs, compared to about \$1,000 in LDCs, with newly-industrializing countries somewhere in between. GDP Per Capita is strongly related to many social characteristics, including literacy rates and education levels, since economic development is dependent on a skilled work force.

- **Types of jobs** – More developed countries usually have the fewest workers in the primary sector, and the most in the tertiary sector. Less developed countries have a larger percentage of their workers in the primary sector, generally occupied as farmers. Middle-income nations have an in-between spread of workers in the three economic sectors.
- **Worker productivity** – Workers in more developed countries are more productive than in less developed countries, largely because they have access to more machines, tools, and equipment to perform their work. Workers in LDCs must rely more on human and animal power. Productivity can be measured by the **value added** by each worker. The value added in manufacturing may be figured by subtracting the costs of raw materials and energy from the gross value of the product. The value added in MDCs is much higher than in LDCs.
- **Access to raw materials** – Development requires access to raw materials, such as minerals and trees, which can be transformed into useful products. Energy to operate the factories is also necessary, and it takes the forms of oil, coal, water, or natural gas. One reason that the Industrial Revolution began in England was the country's abundance of coal. A motivation for European empires was control of natural resources in other areas, so even though the countries had limited resources within their boundaries, they came to control raw materials in other areas of the globe. Today countries have access to raw materials through world trade.

- **Availability of consumer goods** – MDCs not only have enough wealth for essential goods and services, they also have money for nonessentials. Whereas food, shelter, and clothing are essential for human life, other products are not. Three indicators commonly used to measure consumption of nonessential goods are cars, telephones, and televisions. These products are accessible to most people that live in MDCs, and their production and sale are vital to the functioning of the economy. Few people in LDCs have the means to buy nonessential goods, and so the growth potential of their economies is limited.

Economic development is often accompanied by **social development**, such as high rates of literacy, access to formal education, and good health care. Economic development also changes demographic characteristics, such as life expectancy, birth rates, and death rates.

THEORIES OF ECONOMIC DEVELOPMENT

What factors explain differences in levels of economic development? Two conflicting theories guided social scientists in the 20th century in answering these questions:

- **Modernization model** – According to this theory (also called the westernization model), Britain was the first country to begin to develop its industry. The Industrial Revolution was spurred by a combination of prosperity, trade connections, inventions, and natural resources. Max Weber explained that the cultural environment of Western Europe favored change. Wealth was regarded as a sign of personal virtue, and the growing importance of individualism steadily replaced the traditional emphasis on kinship and community. Once started, the British model spread to other European nations and the United States, which prospered because they built on British ingenuity and economic practices. By extension, any country that wants its economy to grow should study the paths taken by industrialized nations, and logically they too can reap the benefits of modernization, or “westernization.” Modernization theory identifies tradition as the greatest barrier to economic development. In societies with strong family systems and a reverence for the past, the culture discourages people from adopting new technologies that would raise their standards of living.
- **Dependency theory** – This analysis puts primary responsibility for global poverty on rich nations. In contrast to the modernization model, dependency theory holds that economic development of many countries in the world is blocked by the fact that industrialized nations exploit them. How can a country develop when its resources (natural and human) are controlled by a handful of prosperous industrialized countries? Inequality has its roots in the colonial era when European nations colonized and exploited the resources of other areas around the world. Although virtually all colonies gained independence by the late 20th century, political liberation has not translated into economic health. Dependency theory is an outgrowth of Marxism, which emphasizes exploitation of one social class by the other. The same dynamic is at work in assessing relationships among countries. Problems, then, cannot be solved by westernization, but must be addressed by establishing independence. In reaction to this theory, many LDCs have experimented with forms of socialism, with the intent of nationalizing industry and narrowing the gap between the rich and the poor.

Modernization Theory: Rostow's Stages

Modernization theory holds that economic prosperity is open to all countries. According to W.W. Rostow, modernization occurs in four stages:

- 1) **Traditional stage** – People in traditional societies build their lives around families, local communities, and religious beliefs. Their lives are often very similar to those of their ancestors, and they generally have very limited wealth. Most people are subsistence farmers. A century ago, most countries of the world were in this initial stage of economic development, and some still are.
- 2) **Take-off stage** – Often with the encouragement of political leaders, people start to experiment with producing goods not just for their own consumption but also for trade with others for profit. The country experiences something like an industrial revolution, and sustained growth takes hold. Urbanization increases, and technological and production breakthroughs occur. Greater individualism, a willingness to take risks, and a desire for material goods also take hold, often at the expense of family ties and traditional customs.
- 3) **Drive to technological maturity** – During this stage, economic growth is widely accepted, and people focus on attaining higher living standards. The economy diversifies as people become more prosperous and can afford some luxuries. Many miss the security of family and local community life, but poverty has been reduced greatly and material goods are much more common. Cities grow, as more people leave the farms, and modernization is evident in the core areas of the country. The rate of population growth is reduced as children require more years of schooling in order to survive in the increasingly complex society, and become more expensive to raise. International trade expands.
- 4) **High mass consumption** – Economic development steadily raises living standards as mass production encourages consumption of industrial products. Items that may have been luxuries in previous stages now become necessities as the society is structured on the expanding array of goods produced. This stage is marked by high incomes, with a majority of workers involved in the service sector of the economy.

Modernization theory claims that high-income countries can help poorer countries by encouraging them to control population growth, increase food production, and take advantage of industrial technology. They also may provide poorer countries with foreign aid. Socialist countries have criticized modernization theory as a justification for capitalist systems to continue to exploit non-capitalist countries. Critics point out that modernization simply has not occurred in many poor countries. Another criticism is that modernization theory fails to recognize that rich nations, which benefit from the status quo, often block paths to development for poor countries. Poor countries today have to develop from a position of global weakness, so they have a much more difficult task than the industrialized countries did during the 19th century. Another criticism of modernization theory is that it suggests that the causes of poverty lie almost entirely in the poor societies themselves, which is like blaming victims for their own plight.

Dependency Theory: Wallerstein's Capitalist World Economy

Immanuel Wallerstein first explained economic development in 1974 using a model of the **capitalist world economy**, a global economic system that is based in high-income nations with market economies. As a dependency theorist, Wallerstein traced economic inequality among nations to the colonial era when Europeans first took advantage of the wealth of the rest of the world. He divided today's countries into three types, according to how they fit into the global economy:

- 1) **Core countries** – These are the rich nations that fuel the world's economy by taking raw materials from around the world and channeling wealth to North America, Europe, Australia, and Japan through multinational corporations that operate worldwide.
- 2) **Countries of the periphery** – Low-income countries were drawn into the world economy by colonial exploitation, and they continue to support rich ones today by providing inexpensive labor and a large market for industrial products.
- 3) **Countries of the semiperiphery** – The remaining countries of the world are somewhere in between. They exert more power than peripheral countries, but are dominated to some degree by the core countries.

According to Wallerstein, the world economy benefits rich societies and harms other countries by making them dependent on the core countries. Their dependency is perpetuated by narrow, export-oriented products, such as oil, coffee, and fruit. They lack industrial capacity, so they are caught in a cycle of selling inexpensive raw materials and buying expensive manufactured goods, forever spending more than they take in. As a result, they often have high foreign debt that cripples their economies even further.

In contrast to modernization theory that puts most responsibility for development on individual countries, dependency theory emphasizes the idea that no country develops in isolation because the global economy shapes the destiny of all nations. Critics say that dependency theory wrongly treats wealth as a zero-sum commodity, as if no one gets richer without someone else getting poorer. They say that in reality new wealth is created through ambition, hard work, and new uses of technology, so no developed country "blocks" others from success. Another criticism of dependency theory is that it places too much blame on rich countries that have a long history of supporting economies of nations such as India, South Korea, and Japan, through foreign investments that foster economic growth. Dependency theorists are also criticized for ignoring cultural factors in poor countries that discourage economic growth, such as values that emphasize family and tradition rather than innovation. Corrupt national leaders may also contribute to the poor economic health of countries that lack a strong rule of law, since the country's wealth is squandered or monopolized by the elite.

The Self-Sufficiency Model

Whereas the Rostow development model encourages LDCs to identify and develop products that they can successfully trade in international markets, the **self-sufficiency model** encourages them to isolate fledgling businesses from competition of large international corporations. According to self-sufficiency advocates, LDCs can only escape global inequalities by shielding local businesses from trade in the

international market and encouraging internal growth. Countries promote self-sufficiency by setting barriers that limit the import of goods from other places. Some governments have set high taxes on imported goods to make them more expensive than domestic products, and others have fixed quotas on imported goods. Another approach is for a country to require international companies to purchase expensive licenses in hopes of discouraging them from selling within its borders. For example, India used all of these methods for years to encourage internal economic development. Although many Indian companies grew under the self-sufficiency model, one problem that emerged was inefficiency. With government subsidies and import protections in place, businesses had little incentive to improve quality, lower production costs, or reduce prices, and so their products were sometimes inferior to – but more expensive than – those on the international market. Another problem was the development of a highly complex bureaucracy that set and enforced government regulations that restricted the growth of businesses.

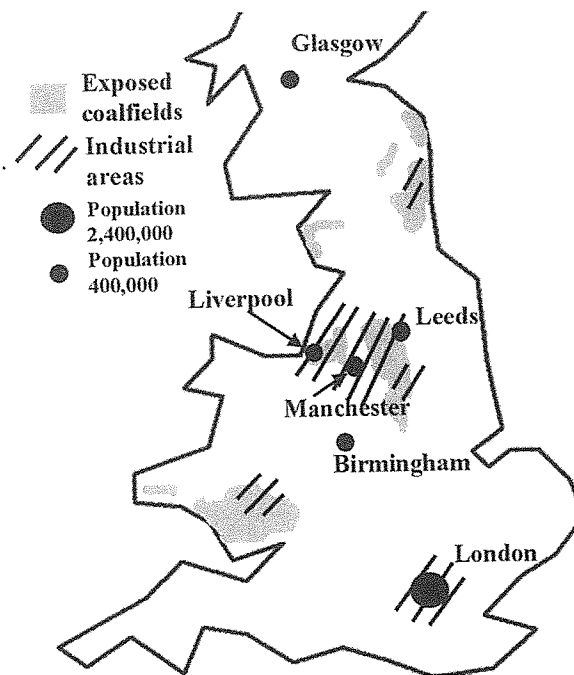
In contrast to India, the four “Asian Tigers” adopted the international trade alternative. Hong Kong, South Korea, Taiwan, and Singapore – whose economies boomed starting in the 1960s – used **export-oriented industrialization**, a strategy that seeks to directly integrate the country’s economy into the global economy by concentrating on economic production that can find a place in international markets. The countries have watched the “product life cycle” that follows stages: first an innovator country produces something new; next that country moves on to other innovations. Meanwhile, other countries think of ways to make the first product better and cheaper, and export it back to the innovator country. For example, Asian countries have prospered from this strategy with automobiles and electronics in their trade with the United States.

GROWTH AND DIFFUSION OF INDUSTRIALIZATION

Industry existed in many areas of the world before the late 18th century, but the Industrial Revolution intensified it greatly. Examples of industrial centers before the Industrial Revolution were silk factories in China and metal workshops in India. Goods in many other parts of the world were superior to those produced in Europe, although most of the work was done by hand and power was provided by water and/or wind. The early factories in 18th century Britain were run by water running downslope. The big breakthrough came with the steam engine, invented by **James Watt**, which allowed much more flexible use of energy to drive new machines. Watt’s engine could pump water much more efficiently than the watermills then in use. At the same time new methods for smelting iron were discovered that transformed coal into high-carbon coke.

THE INDUSTRIAL REVOLUTION

The textile industry was one of the first to benefit from the new steam-powered machines and smelting processes. A series of inventions meant that thread and cloth could be woven together much more quickly than before, and British factories began to demand more raw materials – such as wool, linen, and cotton – for their ever-increasing capacity to manufacture. The textile industry was transformed from a large collection of scattered home-based industries to a small number of large factories centered in a few locations. Britain’s stable government and wealth gathered from overseas ventures, as well as an abundant supply of coal, helped spread the new technologies to other industries, including transportation and communications. The first railroad in England was opened in 1825, and soon its major cities were connected by rail. Ships also benefited from steam engines, and England expanded its growing industrial power as steam-powered vessels began crossing the Atlantic.



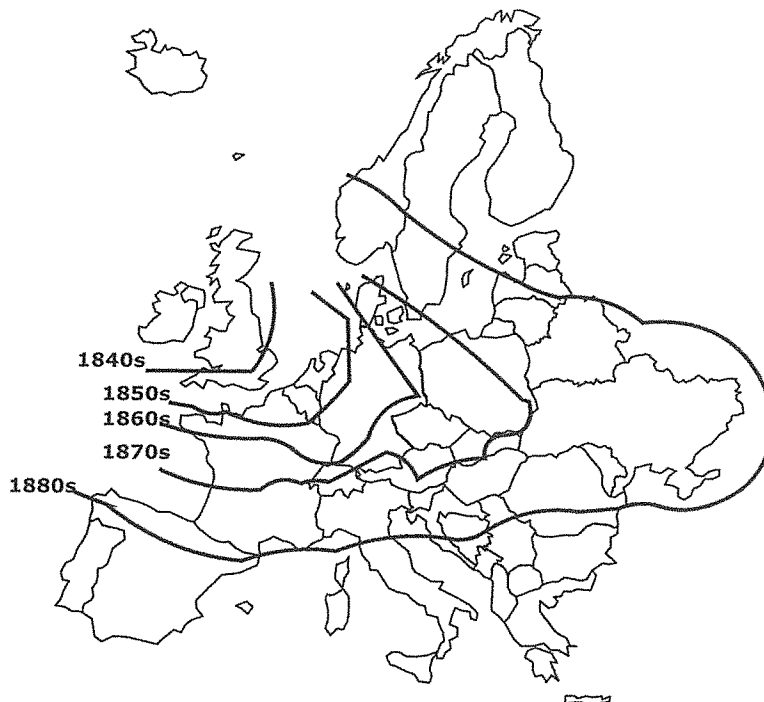
Industrial Britain by 1850. The first industries arose in northern and western England around abundant coal and iron-ore deposits. Railroads connected the major cities to one another and to the coast for shipping.

Industrialization Through the Early 20th Century

As industrialization diffused during the 19th century, Britain had an enormous comparative advantage over other areas, allowing it to expand its colonial empire to further prosperity and power spawned by its creator role in the Industrial Revolution. The new industries transformed England's landscape. Cities grew dramatically, especially in the Midlands of north-central England, where a belt of major coalfields extended from west to east. In mainland Europe, another industrial belt developed around coalfields that stretched from northern France, southern Belgium, and the Netherlands, through Germany, to Poland. Iron ore was also found in this area, and economic activity developed accordingly.

Western Europe's industrial success was not based exclusively on its abundant raw materials, but also on the ability of France, Britain, and the Low Countries to access resources around the world through their colonial empires. Europe also had comparatively skilled laborers as well as established trade routes to facilitate exchange of new products. By the turn of the 20th century, industry had diffused as far as northern Spain, southern Scandinavia, and the Ukraine.

Industrialization also diffused westward across the Atlantic to North America, where natural resources and available land space encouraged economic development. The first U.S. textile mill was built in Rhode Island in 1791 by Samuel Slater, a former worker in an English factory. Industry grew in response to the U.S. government's protection of industry through embargoes on European trade, and the industry grew accordingly. Before 1860 industry concentrated on processing North America's abundant food and lumber resources, and iron and steel industries rapidly developed during the late 19th century. Most early industry flourished in the northeastern United States, where despite a lack of abundant natural resources, the large populations from Boston in the north to Washington D.C. in the south provided a large market for consumption of industrial products. New York City became one of the world's great ports, with a huge skilled and semiskilled labor force, and a fine natural harbor for **break-of-bulk** (transfer of cargo from one type of carrier to another) from ships to trains and trucks and vice versa.



The diffusion of the Industrial Revolution. The Industrial Revolution began in England in the late 18th century, and diffused across Europe, following belts of coalfields and iron ore.

By the time that World War I began in 1914, Europe had developed a huge industrial base, and the United States was rapidly catching up. However, industrialization had not diffused to the rest of the world, except for areas settled by Europeans, such as Australia.

20th Century Industrialization After World War I

The earlier industrialization of Europe and the eastern United States gave those regions a huge economic advantage by the early 20th century, but the picture changed dramatically as key resources of the world became oil and natural gas. During the mid-20th century, the use of coal as an energy source in industry diminished, and the use of oil and natural gas greatly increased. Industrialized nations needed these products to run their power plants, machinery, cars, airplanes, and ships. Oil and natural gas also became common forms of energy for heating homes and providing household conveniences, such as hot water and cooking stoves.

This reliance on oil and natural gas meant that the United States and industrialized Europe increasingly turned to foreign countries to provide for their needs, vesting new economic power to those that had these natural resources. Today these countries include Saudi Arabia, Kuwait, Iran, Russia, China, Mexico, Venezuela, and Nigeria. While oil has enriched them, they have also played host to American and European multi-national companies that have established production centers within their border. Most oil-rich nations signed agreements with these companies that have allowed a great deal of the wealth to return to the U.S. and Europe, producing international tensions between developing countries and the established industrialized powers.

THE EVOLUTION OF ECONOMIC CORES AND PERIPHERIES

The Industrial Revolution greatly impacted the regions that it reached, but it totally bypassed other areas. Areas of industrial activity marked the earth's surface, while others remained much the same as

before. **Location theory** explains the locational pattern of economic activities by identifying factors that influence this pattern. First, **primary industry** develops around the location of natural resources, such as the industrial belt in the British Midlands. Next, as transportation improves, **secondary industry** develops, which is less dependent on resource location. Raw materials may be transported to the factories for manufacture. The location of secondary industries depends on several factors:

- **Variable costs** – Energy, labor, and transportation is less expensive in some areas than others, encouraging industries to develop.
- **Friction of distance** – Although secondary industry may transport raw materials to factories, the cost usually goes up the farther the distance of transport from source to factory. At some point, the distance is too great for practical transportation.
- **Distance decay** – Largely because of the friction of distance, industries are more likely to serve markets of nearby places than those far away. As distance increases, business activity decreases until it becomes impractical to do business.

The patterns formed by primary and secondary industries divide the world into regions based on their economic activity: core, semi-periphery, and periphery. Immanuel Wallerstein first used these terms in 1974 to promote dependency theory among nations, and many economic geographers now use the core-periphery model to describe economic spatial patterns in general. Core regions have concentrations of primary and secondary industries, peripheral regions do not, and semi-peripheral regions have some industries but not as many as core regions do. Even within “core countries” wealthy urban cores lie in contrast to depressed rural peripheries. For example, in the modern-day United States, “high-tech” concentrations, such as those that exist along the Pacific coastline, in the Northeast, and in some interior cities (such as Austin, Texas), create wealth that contrasts to rural areas or “rust belt” industrial areas that provide few job opportunities for young people. With more jobs in the service sector, people move to areas where those jobs are provided, leaving the peripheral areas with even fewer resources than they had before. Another country with distinct core/peripheral distinctions is India, where high-tech jobs (often outsourced by Western companies) are growing rapidly in urban centers, as contrasted to peripheral areas that still adhere to traditional customs and occupations.

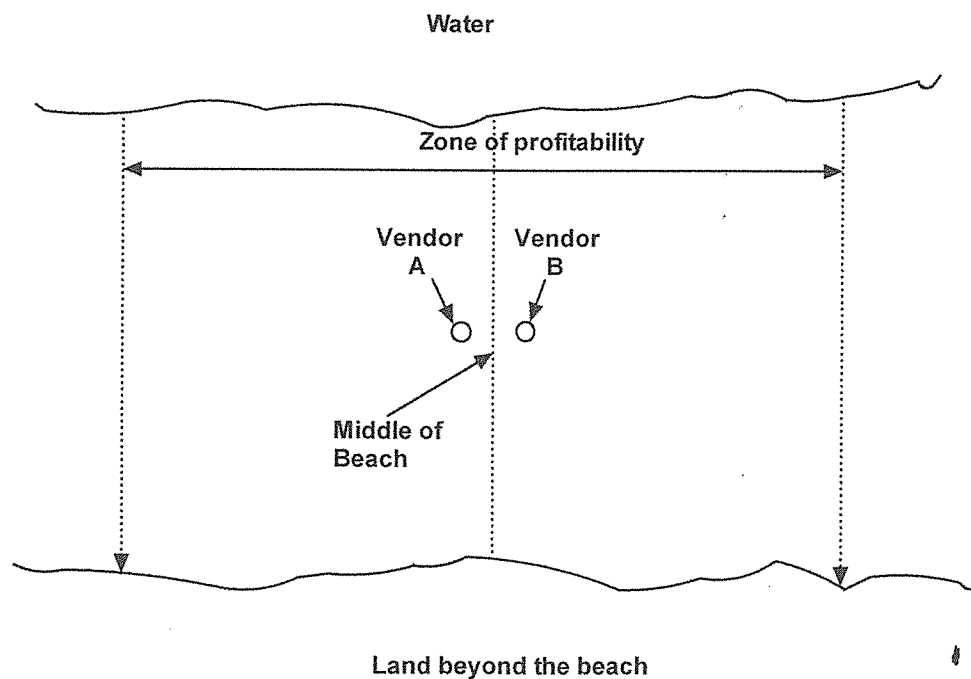
WEBER'S MODEL FOR THE LOCATION OF INDUSTRIES

In his *Theory of the Location of Industries* published in 1909, German economic geographer **Alfred Weber** developed a model for the location of secondary industries. Weber's industrial model is often compared to von Thünen's agricultural model because they both are examples of location theory that explain why economic activity is patterned as it is. Weber identified points for particular inter-related activities, such as manufacturing plants, mines, and markets. Weber's **least cost theory** explained location of industries in terms of three factors:

- **Transportation** – The site of industry is chosen based partly on the cost of moving raw materials to the factory and finished products to the market. Business owners look for the least expensive transportation costs. Today, for most goods, truck transport is cheapest over short distances; railroads are most cost efficient over medium distances; and ships are cheapest over long distances. However, transportation involves terminal costs, which vary considerably, and are least expensive for trucks and most expensive for ships.

- **Labor** – The cost of labor is also taken into consideration, and cheap labor may allow an industry to make up for higher transportation costs. For example, a factory may relocate from the United States to Mexico, where transportation costs to market increase, but are more than made up by cheaper labor costs.
- **Agglomeration** – If several industries cluster (or agglomerate) in one city, they can provide support by sharing talents, services, and facilities. A restaurant needs furniture and equipment, and the companies that provide those products have workers that bring business to the restaurant. All the workers need clothes that may be provided by a clothing store that also needs furniture and equipment and employs people that eat at the restaurant. The point of agglomeration explains location of industry, but excessive agglomeration may lead to an increase in labor and transportation costs, leading to a process called **deglomeration**, or the exodus of businesses from a crowded area.

Some economic geographers have criticized Weber's model as too inflexible, particularly in considering costs over time. The **substitution principle** suggests that business owners can juggle expenses, as long as labor, land rents, transportation, and other costs don't all go up at one time. If labor costs go up, they may be offset by a decline in transportation and rent costs, encouraging the owner to stay put. This balancing of expenses allows a business to be profitable within a larger area than Weber's model suggests.



LOCATIONAL INTERDEPENDENCE THEORY

Another approach to location theory is **locational interdependence**, or the influence on a firm's locational decision by locations chosen by its competitors. In contrast to Weber's reliance on variable costs, this model is concerned with **variable revenue analysis**, or the firm's ability to capture a market that will earn it more customers and money than its competitors. One example provided by economist Harold Hotelling is a stretch of beach with two ice cream vendors selling identical products, with a fixed demand for ice cream among its customers (those on the beach). Where should each vendor locate? Logically you might say that each should locate in the middle of her half of the beach, but in reality what generally happens is that both will cluster in the middle. That way each can have her half, but can also compete for those in the middle, maximizing the customer base. The problem is that some customers will have to walk further to get their ice cream, so they may change their minds about wanting ice cream. If that happens, the vendors might have to relocate.

CONTEMPORARY PATTERNS AND IMPACTS OF INDUSTRIALIZATION AND DEVELOPMENT

Today traditional location theories, such as Alfred Weber's model, are limited by their focus on particular points of local economic interactions. Globalization means that every country's industrial development is related to conditions in the global economy. **Space-time compression** describes the reduction in the time it takes to diffuse something to a distant place as a result of improved communications and transportation systems. Although situation and site factors are still important for understanding economic activities, globalization has altered their meaning so that position of places in the global web is also crucial. For example, the role of agglomeration in location decisions has reached new dimensions as urban areas have grown much larger and international contacts have increased. If you wish to locate a sock factory in China to benefit from low-cost labor, you would have many needs, ranging from transportation facilities to markets (both in China and overseas) to telephones, electricity, and water services. Both surface and ocean transportation has to be taken into consideration, for getting raw materials (such as cotton) to the factory and shipping the finished socks out to market. These all are examples of **infrastructure**, or services that support economic activities. Without all of these things in place, a sock factory would be difficult to operate. The growth of economic activities conducted via the internet makes express package delivery systems more important, so that consumers in one part of the world may buy goods sold by companies in far-distant areas.

MAJOR INDUSTRIAL REGIONS

Due to many factors – such as historical patterns of development and colonization, current power relations among nations, and geographical context – the distribution of industry around the world is quite uneven. For example, industrialization patterns in Europe are still based on the diffusion of industry from its origins in Britain across to France and Germany. Only a few countries have become major industrial economies through a confluence of factors, including abundant natural resources, favorable relative location, stable political circumstances, economic leadership, and high levels of educated and trained executives and workers.

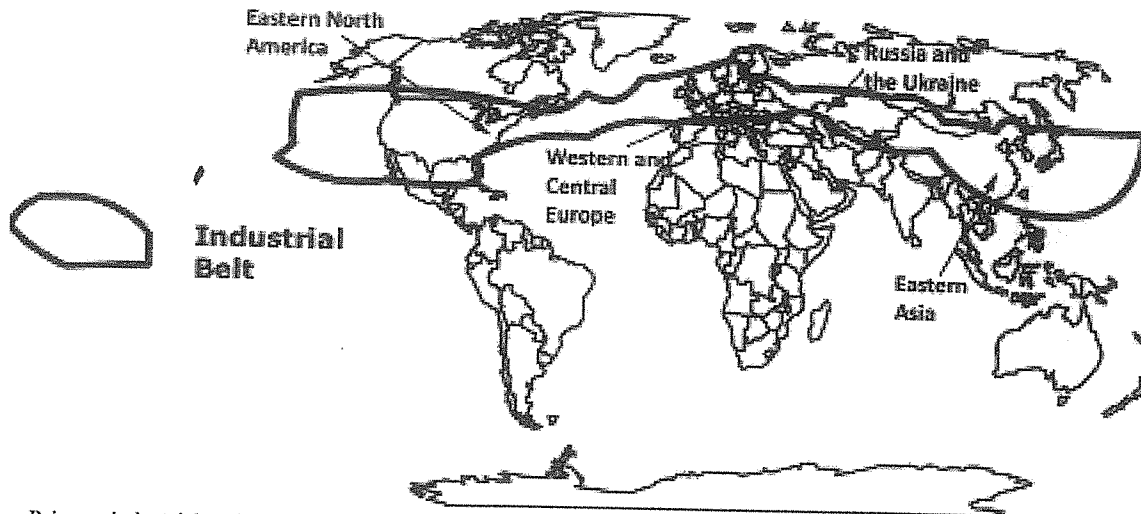
SITUATION AND SITE FACTORS

Geography provides companies with two types of production costs:

Situation factors have to do mainly with transportation – bringing raw materials or parts into a factory and shipping the finished goods to consumers or retailers. The farther something has to be carried, the higher the cost, so a manufacturer tries to locate a factory as close as possible to both buyers and sellers. If the cost of transporting the finished product is higher than the cost of shipping raw materials, then the factory should be located closer to the buyer than to the seller, and vice versa. For example, **bulk-reducing industries**, such as the North American copper industry, usually locate factories close to raw materials because the raw materials are heavier and bulkier than the finished products. The U.S. steel industry has located factories around iron and coal deposits and has repositioned its locations as sources have changed. More recently, with more iron ore coming from Canada and Venezuela, steel factories have moved to the East and West coasts, away from previous plants in the Midwest. For **bulk-gaining industries**, such as most canned food and beverage products, factory locations are usually determined by accessibility to the market. Cans, bottles, and ingredients are brought to the factory, and emerge packaged for consumers. Weight is gained, especially with products (such as soda) that have a significant amount of water added. Also, cars are much more difficult to ship out of factories than the parts coming into the factory are, so automobile assembly plants are generally located near large metropolitan areas. **Single-market manufacturers**, such as clothing manufacturers shipping to New York City, also cluster near their markets. As von Thünen noted for farmers, perishable products need to be close to large urban markets.

Site factors are particular to a geographic location and focus on varying costs of land, labor, and capital. Modern factories are located in suburban or rural areas, and not in center cities, where land costs are prohibitive for the space necessary for production. Factories are usually more efficient if they operate on one or two levels, and land costs in center cities encourage businesses that can locate in skyscrapers. Climate may also impact location decisions, with some industries drawn to relatively mild climates and opportunities for year-round outdoor recreation activities. Some executives may prefer sites with good access to cultural or sports events. The cost of labor is another consideration, especially for **labor-intensive industries**, such as fiber-spinning, weaving, or cutting and sewing of fabric into clothing. Textile industries require skilled workers, and so they often choose locations where labor costs are low. In recent years, this factor has encouraged clothing manufacturers to move to China and other Asian countries where labor is cheaper. Businesses typically borrow money to expand, so sometimes location is influenced by the willingness of banks in a geographical location to provide loans to entrepreneurs. For example, in the late 20th century, high tech companies clustered in California's Silicon Valley partly because banks sometimes offered large incentive packages to persuade businesses to locate within their city limits.

For some businesses, transportation of both resources and finished products are a negligible part of their total costs. Such firms are said to be footloose, or neither resource or market-oriented. For example, both parts and finished products in the manufacture of computers are expensive, so that transportation costs are only a small part of total production costs.



Primary industrial regions of the world. Most of the primary industrial areas of the world exist within a "belt" that stretches from North America, through Europe, southern Russia, China, South Korea and Japan. Even within this belt, many other uses of land exist, including primary economic activities such as farming. Secondary industrial regions lie outside the belt in concentrated areas of South America, Africa, Southeast Asia, and Australia.

When industrial centers are mapped, four areas emerge as **primary industrial regions**, or areas of the largest agglomeration of industry:

- Western and Central Europe
- Eastern North America
- Russia and the Ukraine
- Eastern Asia

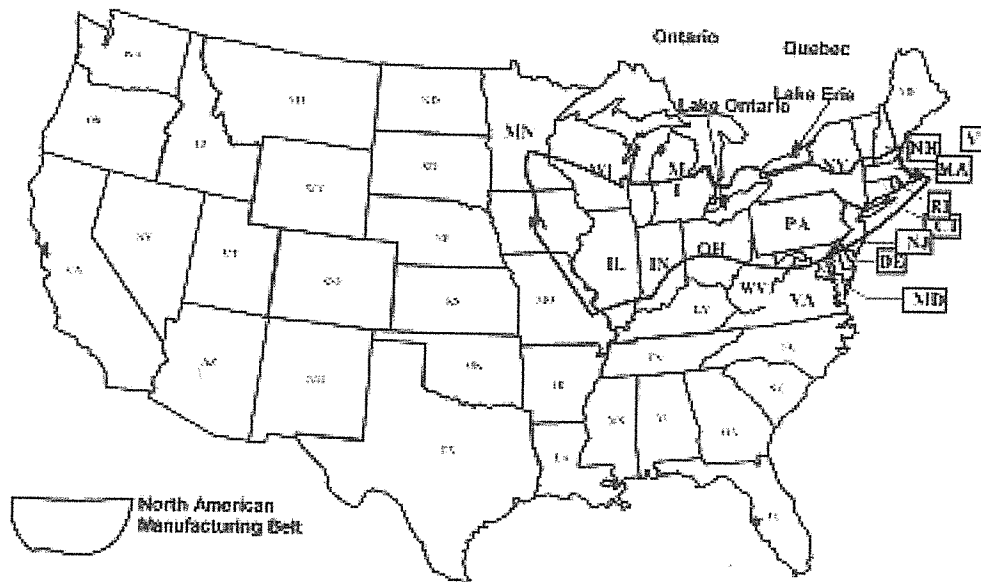
Each of these regions includes a core of industrial activities with other clusters some distance away. Industries are also located in **secondary industrial regions**, where agglomeration is somewhat less, but still significant. These secondary regions include Venezuela, Argentina, and Brazil in South America, South Africa and Nigeria in Africa, coastal areas and the Ganges River area of India, Malaysia, and southern Australia.

Western and Central Europe

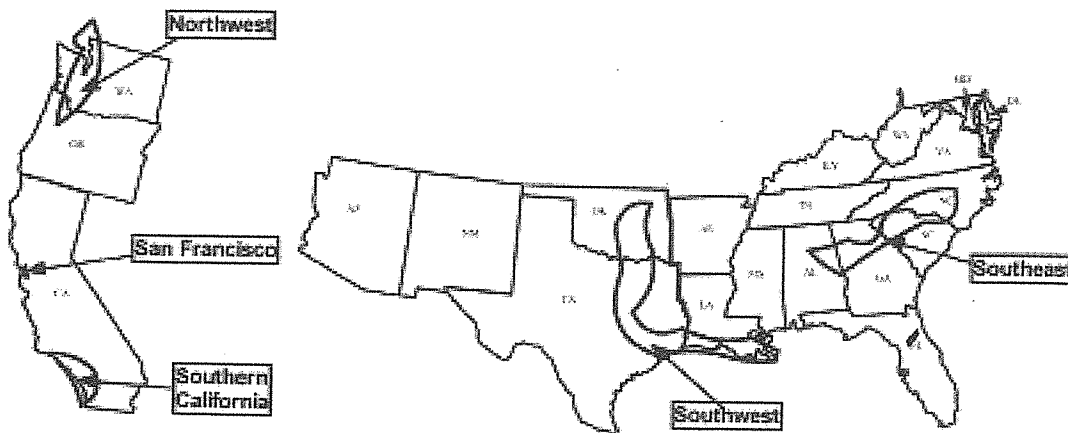
Despite the devastation of World War I, European industry recovered and expanded rapidly in the post-war years. In the industrial core itself, the Ruhr River area of Germany became Europe's greatest industrial complex, combining proximity to large markets, accessible transportation, and abundant natural resources to spark its growth. Products of heavy industry, including tanks and weapons for Hitler's armies, poured from the region by the 1930s. German industry became specialized, as Saxony produced optical equipment, cameras, textiles, and ceramics – products of light manufacture. World War II virtually destroyed the German industrial base and damaged industrial infrastructure all over the continent, leaving Europe's industrial future in question. However, with American aid to new factories, much has been rebuilt, incorporating new technologies that have revived European economies overall. Even with colonial empires dwindling during the 1950s and 1960s, Europe's economic and political influence have allowed it to withstand the damage, although other parts of the world would come to challenge its industrial preeminence.

North America

World Wars I and II weakened Europe's economy, allowing the United States to emerge as the world's strongest industrial power by the mid-20th century. Despite damage to Pearl Harbor in 1941, the wars were fought mainly outside the borders of the U.S., and at the same time, production of war materials bolstered its developing industrial economy. Canada also benefited, with a major American Manufacturing Belt that included southeastern Canadian cities such as Windsor, Toronto, and Montreal. The North American Manufacturing Belt extends from its northeastern edge around the cities of Boston and New York south through Philadelphia and Baltimore, westward through Upstate New York and Pennsylvania, and through the states that bound the Great Lakes. Canadian and U.S. manufacturing complexes meet in two horseshoe-shaped zones around the western ends of Lakes Ontario and Erie.



North American Manufacturing. North American manufacturing has dispersed to other regions, but the core area pictured above remains dominant.

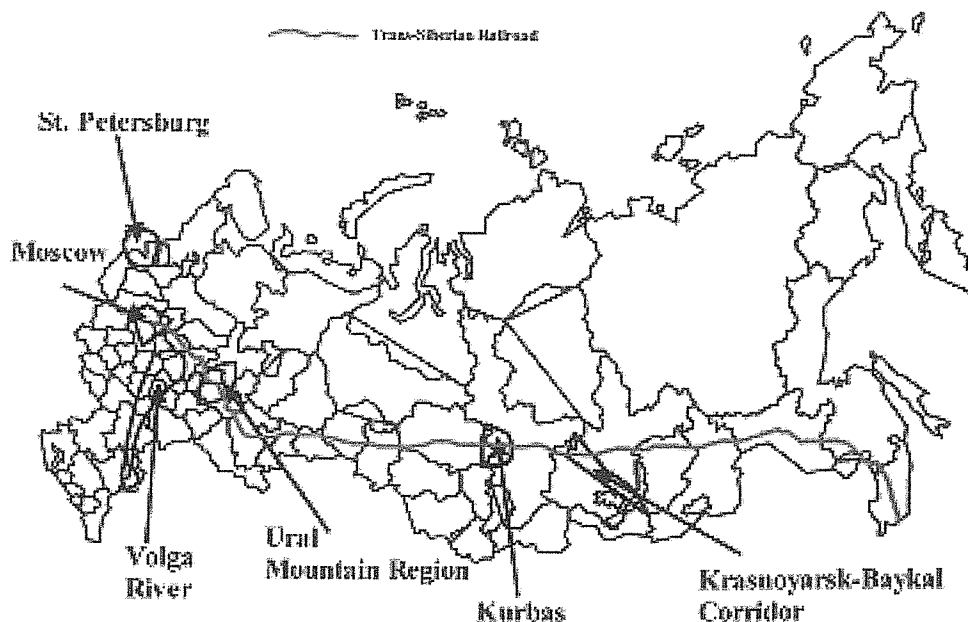


Other North American Manufacturing Regions. During the 20th century manufacturing spread to other areas of North America from the Manufacturing Belt in the Northeastern United States. These newer areas include the Southeast, Southwest, Northwest, the San Francisco area, and Southern California.

Other important industrial areas developed in North America during the 20th century. The Southeastern district extends from Birmingham, Alabama, to Richmond, Virginia, with Birmingham producing iron and steel, and the area eastward from Atlanta, Georgia, to Richmond manufacturing cotton, tobacco, and furniture. Another area stretches from Oklahoma southward to the Dallas-Fort Worth area, Houston, and New Orleans. Originally rooted in meat packing and flour milling, this area has become more and more important for the oil industry. Other industrial districts are in northern California (around San Francisco), southern California (from Los Angeles to San Diego), and the Pacific northwest from Portland Oregon, north through Seattle, Washington, and Vancouver, British Columbia in Canada.

Russia and the Other Former Soviet Republics

By the end of the 19th century Ukraine in the western Russian Empire had been affected by the diffusion of the Industrial Revolution as it spread eastward across Europe. When Russia became the Soviet Union in the 20th century, Ukraine produced much of the country's coal, and it grew into one of the world's largest manufacturing complexes by the mid-20th century. Other manufacturing areas grew around Moscow and Leningrad (now St. Petersburg) which provided large markets for industrial products. Although the communist government controlled industrial development, industrial patterns still followed logical patterns based on geographic location, markets, transportation, and natural resources. Much manufacturing during the 1930s followed the Volga River, an area that combined accessibility to raw materials and ease of transportation by the river. After World War II a series of dams were constructed along the Volga, making electrical power plentiful. Canals linked the Volga to both Moscow and the Don River, making it easy to transport raw materials, including plentiful oil and natural gas from nearby reserves. Other regions in Russia follow the Trans-Siberian Railroad that connects the western cities across southern Siberia all the way to the Pacific coastline.



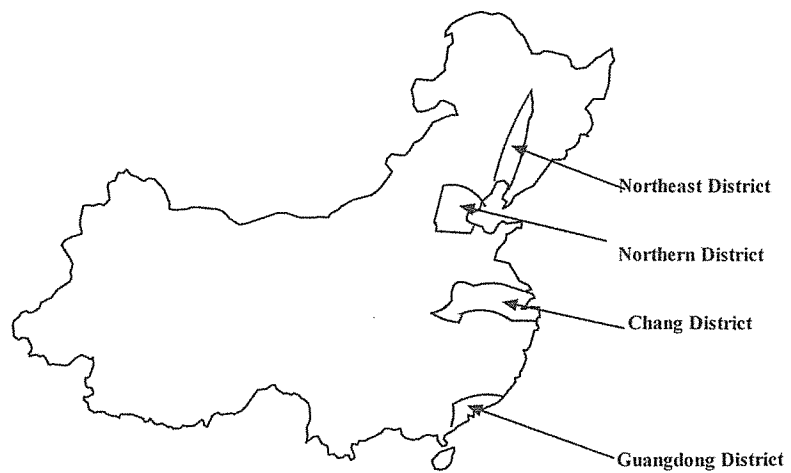
Russian Industrial Areas. Although many of the industrial regions of the former Soviet Union are outside the boundaries of the modern Russian Federation, several industrial areas remain, including the region around the capital city of Moscow, St. Petersburg, the Volga River, the Ural Region, the Kurbas Region, and the Krasnoyarsk-Baykal Corridor. The eastern regions follow the Trans-Siberian Railroad.

Eastern Asia

- **Japan** – The first country in Eastern Asia to industrialize was Japan, partly because its geographical location in the northern Pacific Ocean placed it out of the path of most 19th century imperialist powers. As a result, it was never colonized. Its economic development began during the second half of the 19th century with the **Meiji Restoration**, a remarkable government-sponsored campaign for modernization and colonization. Under the leadership of a few **oligarchs**, or industrial and military leaders that came to political power, Japan modernized industries, organized armed forces, and transformed education and transportation systems to follow the western model. The Japanese also established colonies to provide raw materials that were not available in their homeland. After the setbacks caused by the massive destruction of World War II, Japan managed to rebuild its economy so that by the 1980s it was a major post-industrial society. Japan’s dominant region of industrialization is the **Kanto Plain**, which includes Tokyo and other nearby cities and suburbs that form a huge metropolitan area. Many industries and businesses chose Tokyo as their headquarters in order to be near government decisions makers. Japan has three other key industrial districts, each surrounding major metropolitan areas.
- **The “Four Tigers”** — Japan’s economic dominance of East Asia was first challenged in the late 20th century by the “Four Tigers” of East and Southeast Asia: South Korea, Taiwan, Hong Kong, and Singapore. Britain transferred control of Hong Kong to China in 1997, fueling the already developing economy of China. All Four Tigers used the strategy of **export-oriented industrialization** to directly integrate their economies into the global economy by concentrating on economic production to find a place in international markets. The countries have watched the “product life cycle” that follows stages: first an innovator country produces something new; next that country moves on to other innovations. Meanwhile, other countries think of ways to make the first product better and cheaper, and export it back to the innovator country. For example, Asian countries have prospered from this strategy with automobiles and electronics in their trade with the United States.
- **China** – China has long been a political power, but its major industrial expansion did not begin until the mid-20th century under communist leaders. Industrial development occurred first under the supervision of Soviet planners, and again under the Chinese Communist Party, especially since 1979. Its earliest industrial heartland was the **Northeast District** in Manchuria, centered on the region’s coal and iron deposits near the city of Shenyang. Other major industrial areas developed around the cities of Beijing, Shanghai, and Hong Kong. In recent years industry has increased at a very rapid pace in many other Chinese cities, so that China had successfully challenged Japan for economic and political leadership in East Asia by the early 21st century.



Tokyo Fish Market. These giant tuna were brought to the central fish market in Tokyo to be sold to wholesalers who service the vast population centered on the Kanto Plain.



Chinese Industrial Areas. China's first large industrial area was the Northeast District, centered on coal and iron deposits located in the basin of the Liao River. Today three other regions are growing rapidly: the Northern District around the capital city, Beijing; the Chang District around the cities of Shanghai and Nanjing; and the Guangdong District around Hong Kong and Guangzhou.

In recent years other parts of the **Pacific Rim** (countries that border the Pacific Ocean on their eastern shores) have also experienced industrialization. More and more cities of China are industrializing, partly through government-designated areas called **Special Economic Zones** where foreign investment is allowed and capitalistic ventures are encouraged.

SECONDARY INDUSTRIAL REGIONS

Several **secondary industrial regions** lie south of the world's primary industrial region. These regions developed later, and their industrial centers are not as large, but their economies are growing. One region is Southeast Asia – including Thailand, Malaysia, Indonesia, and Vietnam – that shares the growing prosperity of the Pacific Rim. In northern Africa an industrial region exists around Cairo, and in South Africa around Johannesburg. In the Western Hemisphere, Mexico and Brazil have substantial manufacturing industries that have grown up around major cities. In Brazil a manufacturing triangle has formed between São Paulo, Rio de Janeiro, and Belo Horizonte, and in Mexico industry has developed along a corridor from Mexico City to Guadalajara.

Maquiladora

A manufacturing zone was created in the 1960s in northern Mexico just south of the border with the United States. Workers in this *maquiladora* district have produced goods primarily for consumers in the U.S., and a number of U.S. companies have established plants in the zone to transform imported, duty-free components or raw materials into finished industrial products. Industrialization of the zone was promoted by the **North American Free Trade Agreement (NAFTA)**, a treaty signed in 1995 by Mexico, the United States, and Canada, which eliminated barriers (including most tariffs) to free trade among the three countries. Today hundreds of thousands of workers are employed in the *maquiladora* district, and their interactions with the U.S. market provide a good example of the new **international division of labor** in which some components of products are made in one country and others in another. U.S. companies have been criticized for avoiding employment and environmental regulations imposed within the borders of the U.S., hiring young women for low pay, no benefits, and work in buildings that are environmentally questionable.

Since globalization and physical restructuring have encouraged the building of low-cost offshore assembly factories in places like China, and countries in Central America, maquiladoras in Mexico have been on the decline for the past few years. According to U.S. federal sources, approximately 529 maquiladoras shut down and investment in assembly plants decreased by 8.2 percent during 2002. Despite the decline, over 3,000 maquiladoras still operate along the 2,000 mile-long United States–Mexico border, providing employment for approximately one million workers, and importing more than \$51 billion in supplies into Mexico. Maquiladoras, in general, are best represented among operations that are particularly assembly intensive.

Industrialization and Tertiary Development in India

Very important changes are occurring in India, where industrialization is expanding as a result of recent government policies. The development is occurring in several urban areas around the country. Although India has no major oil reserves, it does have much hydroelectric potential and large coal and iron ore deposits. It also has a large labor force and a geographical location midway between Europe and the Pacific Rim.

NAFTA: A BOON OR HINDRANCE TO NORTH AMERICAN ECONOMIES?

The North American Free Trade Agreement (NAFTA) between Mexico, the United States, and Canada in 1995, was hailed as a free trade area that would rival the European Union as the world's wealthiest and most populous market. However, integrating the markets of such three different countries has been problematic, considering Mexico's lower standard of living and wage structure. U.S. and Canadian labor unions are concerned that with the removal of tariffs, more manufacturers will relocate to Mexico to take advantage of lower wages for workers, leaving many U.S. and Canadian workers without jobs. Environmentalists fear that firms will move to Mexico in order to avoid costly government regulations for pollution in the United States and Canada. Even though Mexico has passed environmental protection laws, enforcement is lax, and companies are infrequently fined for violations. Many fear that this loss of industry will hurt the U.S. and Canadian economies in the long run. Meanwhile, Mexico faces a new problem: maquiladora jobs are now being lost to countries where wages are even lower. For example, Mexican wages are about twice those in China, where wages are only about \$1 an hour. Since wage rates constitute an important site factor in deciding the location of industries, many firms are moving from Mexico to China.

In recent years India has benefited from increased global access to and cost reductions of information technology and electronic data transmission. Computer software development is rapidly growing around Bangalore and Hyderabad, and many back-office jobs have been outsourced from western companies to India. Customer interaction services ("call centers") formerly based in the United States have relocated to India, processing claims for life and health insurance, and taking care of banking transactions, airline tickets, and medical appointments. There the companies hire Indians with good English-speaking skills to talk with customers halfway across the globe in the United States and Europe. As a result, the Indian economy has developed a strong tertiary sector, increasingly integrating it into the world market.

GLOBAL INEQUALITIES

The Industrial Revolution set in motion the dramatic global inequalities that exist among people and nations today. Areas that industrialized early are generally still the most prosperous, with many other areas still largely untouched by industry, often resulting in poverty for the people that inhabit them. Today an increasingly integrated global economy provides challenges for all countries, despite their levels of development, although the problems for more developed countries generally differ from those of less developed countries.

CHALLENGES FOR MORE DEVELOPED COUNTRIES

An important challenge for more developed regions is the protection of their markets from new competitors, with competition now occurring more and more frequently within regional **trading blocs**, or conglomerations of trade among countries within a region.

Impact of Trading Blocs

The three most important trading blocs are:

- 1) **North America** – Most trade barriers between the United States and Canada have been eliminated over the past few decades, and Mexico was brought into the bloc by the North American Free Trade Agreement (NAFTA) in 1995. Since then, the three NAFTA countries have been negotiating with other Latin American countries to extend the trading bloc to new areas of the Western Hemisphere.
- 2) **The European Union** – Most barriers to trade have been eliminated among the members of the EU, with membership extended to Bulgaria and Romania in January of 2007. Even European nations that are not members of the EU (such as Switzerland and Sweden) depend heavily on trade with members.
- 3) **East Asia** – No formal organization of states exists in East Asia, but Japanese companies play leading roles in the economies of other countries in the region. Although many political tensions exist among the nations, the rapid economic development of many Pacific Rim countries has created a strengthening trade bloc in East Asia.

The free movement of most products across the borders has led to closer integration of industries within North America and within Europe. For example, parts of complex products (like cars) are made in different countries within each bloc, and are transported freely across borders to assembly plants. However, at the same time, competition among blocs has increased in many ways. Trade barriers, such as taxes, lengthy permit procedures, and quotas on exports, have been placed between blocs. For example, the Japanese government maintains quotas on the number of cars that Japanese companies can export to the United States. Most cooperation and competition within and among trading blocs takes place through **transnational corporations**, or companies that operate factories in countries other than the ones in which they are headquartered. Most transnational corporations are also **conglomerate corporations** comprised of many smaller firms that support the overall industry. For example, a car company like General Motors actually consists of many smaller firms that produce car parts and other products that automobiles need. Most transnational corporations are headquartered in the U.S., but others are located in Japan or Europe.

Disparities within trading blocs are problematic in all three areas. Within the European Union industrialization is concentrated in Germany, France, and the United Kingdom. Within those individual countries, some areas are more industrialized (and thus richer) than others. For example, in France most industry and wealth are concentrated around Paris, creating economic disparities between Paris and the rest of France. In Germany, the eastern part (formerly the communist-run German Democratic Republic) drags far behind the western region. Within the NAFTA countries, Mexico's economy lags behind those of the United States and Canada.

Deindustrialization

During the past few decades, employment in manufacturing as a share of total employment has fallen dramatically in the more developed countries, a phenomenon widely referred to as “**deindustrialization.**” Generally, the number of jobs has increased in the service or tertiary sector as the percentage of jobs in

industry has decreased. The trend, particularly evident in the United States and Europe, is also apparent in Japan and more recently in the Four Tiger economies of East Asia (Hong Kong, South Korea, Singapore, and Taiwan). Deindustrialization has caused considerable concern about the affected economies and has given rise to a debate about its causes and likely implications. Many regard deindustrialization with alarm and suspect it has contributed to widening income inequality in the United States and high unemployment in Europe. Some suggest that deindustrialization is a result of the globalization of markets and has been fostered by the rapid growth of trade between the advanced economies and the developing world. These critics argue that the fast growth of labor-intensive manufacturing industries in the developing world is displacing the jobs of workers in the advanced economies. Others are more optimistic, believing that the adjustments between industrial and service sectors will work themselves through, and that advances in the service sector, rather than in the manufacturing sector, are likely to encourage the growth of living standards in advanced economies in the future.

CHALLENGES FOR LESS DEVELOPED COUNTRIES

Less developed countries face the challenge of reducing the disparity in wealth between them and the more developed countries. Industrial development not only lifts the value of exports, it often generates money to buy other products. Problems that LDCs encounter include:

- **Distance from markets** – Wealthy consumers in more developed countries are generally far away, so industrializing countries have had to invest scarce resources in constructing and subsidizing transportation facilities, such as airports, docks, and ships.
- **Inadequate infrastructure** – Support services for industrial development are often lacking in less developed countries. These include not only direct support, such as transportation, communications, and equipment production, but also fewer schools and universities to educate industrial workers, technicians, managers, and executives.
- **Competition with existing manufacturers in other countries** – Particularly problematic for LDCs is the control exerted by transnational corporations headquartered in MDCs but doing business globally. These companies have sought out low-cost labor in LDCs, but have kept highly skilled jobs in the MDCs. This selective transfer of some jobs to LDCs is called the **new international division of labor**, a process that keeps global inequalities in place, discourages new industries from developing in LDCs, and prevents wealth from flowing from MDCs to LDCs.

INDUSTRIALIZATION AND THE ENVIRONMENT

As a result of the Industrial Revolution, coal replaced wood as the leading energy source in North America and Western Europe. Whereas this change relieved the environmental pressure of deforestation apparent in both areas before the Industrial Revolution, it increased the likelihood that coal, and eventually petroleum and natural gas, would be depleted as natural resources. Population growth has exacerbated the problem but energy use in more developed countries is far greater than it is in less developed countries. **Fossil fuels**, including coal, petroleum, and natural gas, are residues of plants and animals that were buried millions of years ago. When these substances are burned, they generally cannot be replaced because the process of creating the fuels takes millions of years. The world faces an energy sustainability problem partly because the three fossil fuels, especially petroleum, are rapidly being depleted.

FOSSIL FUEL RESERVES

Just how much petroleum, coal, and natural gas remains on earth is uncertain. Energy deposits that have been discovered are called **proven reserves**. These may be measured with reasonable accuracy. However, we don't know how many **potential** (undiscovered) **reserves** there are. New deposits are being discovered each year, but petroleum is being consumed at a more rapid rate than it is being found, and world demand is increasing rapidly, especially with the acceleration of industry and wealth in China and India. Extraction of fossil fuels is also an issue, since most of the more accessible resources have already been used. Today more off-shore drilling is going on, as companies try to extract petroleum under ocean and sea floors. Likewise, oil companies are considering the challenge of removing oil from under the frozen tundra of Siberia. In both cases, extraction is more time-consuming and expensive. The hazards of off-shore drilling are illustrated by the Deepwater Horizon oil spill in the Gulf of Mexico which flowed unabated for three months in 2010, and continues to seep. It is the largest accidental marine oil spill in the history of the petroleum industry, and all of the environmental consequences of the disaster will not be clear for years.

CONSUMPTION OF FOSSIL FUELS

Not surprisingly, more developed countries, with about $\frac{1}{4}$ of the world's population, consume about $\frac{3}{4}$ of the world's fossil fuels. People in these countries have more cars and larger homes to heat, and businesses and industries need energy to run their machinery and their plants. However, this traditional pattern is changing. As countries with large populations, such as China and India, develop industries, their share of the world's consumption of energy is increasing. Some estimates show that LDCs may soon consume half or more of the world's energy, putting more pressure on the finite fossil fuel reserves.

TOP CONSUMERS OF OIL

1. United States	20,700,000 bbl/day
2. China	6,534,000 bbl/day
3. Japan	5,578,000 bbl/day
4. Germany	2,650,000 bbl/day
5. Russia	2,500,000 bbl/day
6. India	2,450,000 bbl/day
7. Canada	2,294,000 bbl/day
8. South Korea	2,149,000 bbl/day
9. Brazil	2,100,000 bbl/day
10. France	1,970,000 bbl/day

Source: NationMaster.com

- 1) **Prevention** – Some government policies have encouraged destruction of the environment, including low livestock grazing fees, cheap gasoline, or company access to government lands and forests. These policies may be reversed, but of course not without protests from people and companies affected. The Chinese One-Child Policy is an example of prevention of over-use of natural resources through limiting population growth.
- 2) **Technological change** – Technological possibilities include installing pollution-capturing filters for industrial runoff and recycling of industrial wastes.
- 3) **Mitigation** – Damage may be undone or reduced once it has occurred. For example, chemical spills may be cleaned up, lakes may be deacidified, and fish ladders may be added to dams.
- 4) **Compensation** – Political bodies may negotiate compensation for those negatively impacted by industrial wastes. If workers successfully sue companies in government-sponsored courts for damages done due to careless treatment of the environment, companies will be encouraged to avoid those damages. For example, a company whose chemical wastes have resulted in illness and/or death among its workers may be held legally responsible for their damage.

INDUSTRIAL POLLUTION

Industrial development has greatly increased air, water, and land pollution, adding waste that cannot be accommodated. Some pollution is natural, such as ash and gases from volcano eruptions and erosion from natural flooding. Pollution is also a consequence of agricultural practices. However, industrial products have greatly added to the overall pollution of air, water, and land resources on earth.

One concern is **global warming**, or the increase in earth's temperature caused primarily by the burning of fossil fuels. Earth is warmed by sunlight that passes through the atmosphere, strikes the surface, and is converted to heat. When fossil fuels are burned, carbon dioxide is discharged into the atmosphere, where it traps some of the heat leaving the surface heading back to space. This process is called the greenhouse effect, an anticipated warming of earth's surface that could melt the polar icecaps and raise the level of the oceans enough to destroy coastal cities. Consequences could include massive migrations inland and countless economic and political disasters.

Another by-product of air pollution is **acid rain**, which forms when sulfur dioxide and nitrogen oxides are released into the atmosphere by burning fossil fuels. These pollutants combine with water vapor and eventually work their way into lakes and streams. Results include corrosion of buildings and monuments, fish kills, stunted growth of forests, and loss of crops. Countries of the former Soviet Union, including Russia and Ukraine, are especially impacted by acid rain. Aging factories from the Soviet era still emit chemicals that make their way across the region and beyond. In the United States and Western Europe, government regulations on emissions are having positive results, with water and air pollution levels in many areas testing considerably lower than they did before the regulations were put in place. This evidence is now supporting stricter controls over factory emissions in the developing world.

TERMS AND CONCEPTS

acid rain
 agglomeration
 break-of-bulk