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The Great Silk Exchange: How the World was Connected and Developed

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Students of the silk trade are blessed with the rare fortune to study an international trade that is almost as ancient and as continuous as the records of human civilization. Silk, with its appeal of lustrousness, elasticity and durability, has long been considered a symbol of luxury, elegance and sacredness, and was rightfully dubbed the queen of fabrics, the thread of gold. Even in the days of antiquity when transportation was primitive and treacherous, silk, with its high value per weight and the ease with which it could be carried, stored and packed, overcame what Braudel called the "tyranny of distance," which precluded long-distance trade of most commodities. Silk trade on a global scale has gone on for a recorded period of about 3,000 years.

The history of the silk trade evokes images of another well-known historical entity: the Silk Road, the famous overland route that traversed the heartland of the Eurasian continent. The term Silk Road (*die Seidenstrasse)* was a term coined by the 19th century German explorer Baron Ferdinand von Richthofen. Although silk was perhaps the most

important commodity that traveled along the Road, others such as precious metals and stones, spices, porcelain and textiles also passed through. However, the Silk Road was perhaps more significantly an avenue for the exchange of ideas. Some of the most fundamental ideas and technologies in the world – the technology of making paper, printing, and manufacturing gunpowder, among many others – made their way across Asia via this highway. Migrants, merchants, explorers, pilgrims, refugees, and soldiers brought along with them religious and cultural ideas, domesticated animals, plants, flowers, vegetables, fruit, plagues and disease, as they joined this gigantic cross-continental exchange. The Silk Road, as so rightfully claimed, was the melting pot, the lifeline of the Eurasian Continent (Franck and Brownstone 1986: 2; Werblowsky 1988). In East Asia, Silk Road has long been enshrined as a symbol of cross-cultural exchanges of religions, commodities and technology.

This chapter, motivated by the concept of the Silk Road as an avenue of exchange of goods and ideas, explores the history of global trade and technological diffusion. The trading history of silk presents a classic case for studying the incremental and cumulative nature of growth of trade and the stock of knowledge made possible by the increasing human interactions and improved means of transportation. This paper is divided into three parts: the first brings together a brief narrative of the long history of the silk trade and the technological diffusion of the overland route. The second focuses on the sea route. The third presents a discussion of the interactions among trade, technological and institutional progress and the transportation systems on the overland and sea routes.

Silk Road: the overland system

The Road: its beginning and consolidation

Sericulture and silk weaving had been established in the Yellow River and Yangtze River areas of China thousands of years before Christ. Production of silk started in China between perhaps 5000 and 3000 BC (Fan and Wen 1993: 2). This great Chinese invention began with the ingenious discovery of reeling silk threads off wild silkworm cocoons, followed by the conscious domestication of silkworms. The making of silk could be roughly divided into three main stages. Sericulture denotes the process of planting mulberry trees, feeding silkworms, and subsequently collecting cocoons spun by the silkworms. Then from these cocoons, farmers could reel off long and continuous threads and wind them onto bobbins to form the so-called raw silk. Finally, raw silk (sometimes after an additional process of twisting or "throwing") was left to silk weavers (or knitters) to turn into silk cloth.[1]

Although Chinese silk was discovered in Europe as early as 500 BC, well-recorded trading only started in the Han dynasty (202 BC to AD 220). The aggressive sixth emperor of the Han dynasty, Wu-ti, in an imperial effort to expand Chinese territory and influence, sent out his militiaman Zhang Chien on a mission to explore China's western frontier in 138 BC. The knowledge of the environment and nomadic tribes and kingdoms brought back by Zhang Chien aided the Chinese conquest of Western Asia (currently the XinJiang province of China) around 120 BC. The long existing private silk trade saw its first boom when the western frontier came under the control of a single, central, consolidated power – the Western Han dynasty (202 BC – AD 9) (Li, M.W. 1991: 1-15). According to Joseph Needham (1954: 176, 181), the first recorded through caravans from

China arrived in Persia around 106 BC and thereafter the trans-Asian silk trade was regularized.

The Road started out from the capital city of China, Chang-An (now Xian), and crossed into the newly acquired northwest frontier of China.[2] Beyond the sphere of Chinese influence, the route continued on westward, through the elaborate trading networks of the other major Eurasian civilization zones, under the control of the Kushans in Central Asia, the Parthians in Persia, and the Roman empire in Europe. Hudson divides the whole route into four sections: (1) as far west as the Pamirs, i.e. to the western boundaries of modern XinJiang (China's western frontier); (2) from the Pamirs to the Merv oasis, i.e. Bactria or Sogdiana (in current Northwest Afghanistan); (3) from Merv to Seleuceia in modern Iraq; (4) from Seleuceia to the Roman frontier.[3]

The collapses of the Han dynasty in AD 220, the Parthian empire in AD 227, the end of the Kushan age in AD 330 along with the later disintegration of the Roman empire, brought severe disruptions and dislocation to this first great era of booming silk traffic opened up by the Silk Road. The fate of the silk trade on the eastern end of the Silk Road after the collapse of the Han dynasty was closely tied to the abilities of the various Chinese dynasties to control the Western frontier. Usually, trade benefited from the central protection and control of a powerful government, such as the Sui dynasty in China (AD 581-618). Times of political disintegration left the trade at the mercy of various contentious local leaders. Close to the western end of the Silk Road, the Byzantine empire and the Sassanid empire in Persia survived the collapse of the so-called classical age of long-distance cross-cultural interactions between China under the Han dynasty and the

Roman empire (Bentley 1996: 763). Although long-distance trade became riskier and diminished as various Hunnish, Turkic and Mongol peoples divided and raided Central Asia, trade between Persia and Byzantium flourished.

One of the most important developments between the 4th and 6th centuries was that the growth of a large silk trade stimulated the establishment of silk weaving industries in both Byzantium and Persia (Needham 1988: 418; Lopez 1945). The Byzantine and Persian importation of raw silk from China and Central Asia became much more important than that of the finished silk fabrics. Although the superior quality of silk material and the vigorous long-distance trade led to the early widespread diffusion of silk consumption on the Eurasian continent, diffusion of the knowledge of sericulture lagged far behind largely due to the difficulty of contacts between China and the outside world. The Romans, for example, with no clue to the origin of the silk materials, expended enormous amounts of treasure on importing Chinese silk, which was claimed to be worth more than its weight in gold in Rome (Boulnois 1966: 45-6; Fang 1983: 165).

The high price of silk, due to worldwide demand and high transaction costs as well as constant disruptions in trade, provided a strong incentive for regions and states to acquire the knowledge of sericulture. Slowly, the knowledge of how to make silk threads began to unravel beyond Chinese territory along the trade routes. Understandably, details regarding the timing and mechanism of the early technological diffusion of silk were largely lost in the long lapse of time, except perhaps in the form of legends. One such legend was the acquisition of the Chinese secret of sericulture by a Central Asian Kingdom located in Khotan, (now Hotan) in the Western part of China, the province of XingJiang. The legend

had it that a Chinese princess married to the Central Asian King secretly brought silkworm eggs hidden in her hair. Thereafter, sericulture took root and Khotan became a prosperous silk producing center. It is possible that Khotan might have been responsible for the further westward spread of Chinese sericulture knowledge to other parts of Central Asia, or even Persia and eventually Europe (see Table 2.1). The second legend presented more solid evidence on the spread of the knowledge of sericulture to Europe. Two monks were said to have smuggled silk cocoons in their canes out of the East and presented them to the court of the Byzantine Emperor Justinian in Constantinople in AD 552 (see Table 2.1). However, large scale sericulture had to wait another two centuries to take firm root in the Middle East.[4]

Table 2.1 Chronology of silk development

Time	*Diffusion of Sericulture*	*Development of Silk Manufacturing*
c. 3000 BC	Sericulture was discovered and Utilized in China (Matsui, p.3, Fan et al, p.2)	
c. mid-100 BC	Sericulture brought to Khotan (West China) (Matsui 1930; Fang 1983: 71-2)	
	(AD 200, Li, M.-W. 1991: 147)	
	(AD 420-440, Boulnois 1966: 138)	
c. 100 BC	Sericulture brought to Korea by Chinese immigrants (Needham1988: 418)	
c. AD 100		Silk Weaving in Syria and Palestine (Needham 1988: 418)
AD 282	Sericulture took root in Japan (Needham 1988: 418)	
c. AD 300		Silk weaving in Persia and Byzantium (Needham 1988: 418)
500-640	Sericulture introduced to Persia (Xu 1990: 43)	
552 AD	Sericulture Introduced to Byzantium (Needham 1988: 419)	
c. 8th century		Silk weaving brought to Spain by Arab conquest (Edler 1930: 12)
c. 9th	Sericulture brought to Sicily (Edler 1930: 13)	
c. 10th	Large Scale production of raw silk export in Southern Spain (Edler 1930: 12)	
Late 12th and early 13th centuries		Silk Weaving took root in North Italy, esp. in Lucca (Edler 1930: Ch. II)
14th Century	Sericulture spread to North Italy (Edler 1930: 49)	Silk weaving in France, and Cologne, Zurich, Givet. (Edler 1930: 22)
15th Century		Silk weaving started in England (Edler 1930: 22)
16th Century	Large scale sericulture took root in France (Leggett 1949: 250)	Silk industry also flourished
1530-80	Sericulture flourished in Mexico (Borah 1943: Ch. II, Census, 1880)	
1623	Sericulture experimented in North America (Brockett 1876: 27)	

Chinese scholars also emphasized a so-called southern Silk Road which started from Southwest China and passed through Sichuan and Yunan provinces in China, and Burma to reach India (Jiang 1995; Liu 1988: Ch. 1). Ancient Indian texts mentioned Chinese silk at least as early as 400 BC. Further, unlike the Romans and Greeks who had strange conjectures about the origin of silk, the ancient Indians were fully aware that silk derived from the cocoons spun by silkworms, and they learned how to reel silk from wild silkworms very early on (Ray 1995: 270-1). Trade in silk between China and India was quite substantial. In fact, as Liu Xinru argued, during the fourth and sixth centuries China's diminished exports of finished silk fabrics to Persia and Byzantium were made up by increased sales to India (Liu 1988: 64-75).

The high age of overland trading in the era of Tang China and Abassaid Persia

The establishment of the powerful Tang dynasty in China (AD 618-960), which was to see the peak of classical Chinese civilization, heralded the second phase of the overland Silk Trade. The first two hundred years of the Tang dynasty (the seventh and eighth centuries) brought new prosperity to the silk trade, expanded China's western territory, and set up permanent government institutions in those regions. The prosperity of the area was indicated by the increased number of oasis towns and settlers along the road.[5]

The high age of the Tang dynasty in China also coincided with the rise and expansion of Islam in the Middle East and Central Asia. The eastward surge of the Islamic power in the 7th and 8th centuries led to its military show-down with the Tang military stationed in China's western frontier in AD 751. The victory of the Muslims over China on

the Talas River (in northern Turkestan) was a major turning point for the history of the overland silk trade. First, it enabled the continuing eastward intrusion of the Islamic sphere of influence and led to the Tang dynasty's loss of control over China's western frontier. This and the gradual internal weakening of the Tang government led to the partial closing of the overland Silk Road to China for almost four hundred years, until the era of the Mongol empire.[6] China's weakened control of its Northwestern territories and subsequent political and military turmoil were, in some way, responsible for the gradual southward migration of its economic, agricultural, industrial and population center from the Yellow River area towards the Yangtze River and the coastal regions. By the time of the Sung dynasty (AD 960-1279), the most productive silk centers found their home in the lower Yangtze River delta, far away from Xian, the starting point of the old Silk Road. This locational shift led to the increasing use of the sea route for silk exchange Fan and Wen 1993: 58).

The other significant event, however, was that through the capture of Chinese prisoners in the Talas river, many of whom were skilled technicians, the Arabs obtained access to the rich technological knowledge base of China (Needham 1954: 236). The knowledge and the cultivation of silk were widely diffused from China to Persia, Anatolia, and regions controlled by Byzantium. In particular, the Chinese method of obtaining long and unbroken silk threads from whole cocoons by killing the worm inside before it breaks out was widely adopted (Liu 1995: 43). The Islamic conquest of Sassanian Persia and parts of the Byzantine empire not only absorbed major silk producing regions, but also eased the spread of sericulture and the silk industry to North Africa and Southern Spain.

If the closing of the first phase of the silk trade saw the rise of silk weaving production centers in Persia and Byzantium, the second phase witnessed the effective end to the Chinese monopoly of sericulture and the successful adoption of raw silk production in the Islamic world. Persia, Anatolia, and the southern Mediterranean regions were to become primary production and export centers of raw silk and silk fabrics. The silk trade on the Eurasian continent then partitioned into two rather self-contained trading circuits. While Chinese raw silk or silk fabrics largely went to Japan, Southeast Asia, parts of Central and South Asia, Persian silk (mostly raw silk) became the major supply source for the Middle East, Europe and North Africa.

The age of the Pax Mongolica *and after*

In the third phase of the silk trade, the entire overland route witnessed a vigorous revival when Mongol tribes, under Genghis Khan (1167-1227), broke out of the Karakorum steppe and built the largest empire across the Eurasian continent the world had ever seen. For the first time in history, the whole of Asia and Eastern Europe, from Shanhaikuan (in northeast China) to Budapest, and from Canton to Baghdad, was united under one political authority. The expansionary Mongol rulers acted to ensure the safety of the trade routes, building effective post stations and rest stops, introducing the use of paper money and eliminating artificial trade barriers.[7] According to Robert Lopez, by 1257 Chinese raw silk appeared in the notarial records in the silk producing area of Italy, Lucca (Lopez 1952: 73). In the 1330s, a single merchant sold thousands of pounds of Chinese silk in Genoa (Reyerson 1982: 130). Between the 1260s and the 1350s, cheap Chinese raw silk was said to have arrived in

Europe in “unlimited amounts”.[8]

The over-extended Mongol empire began to collapse by the mid-fourteenth century. China was re-united under the native Chinese Ming dynasty (1368-1644). But the old problem of controlling the Northwestern territories which had haunted every Chinese emperor since the empire’s founding was to surface again and again. Compared with the Mongol Yuan dynasty, Ming China’s grip on this territory was much more tenuous. Silk trade between China, Central Asia and the Middle East went on intermittently, and at times, according to Morris Rossabi, became very active. It continued into the fifteenth and early sixteenth centuries. However, periodic warfare and shifting control of territories by different kingdoms in Central Asia brought severe disruptions to the trade. The greatest menace came from local banditry and extortion, usually due to the absence of political and military protection from powerful empires. This point found reaffirmation from the revitalized overland trade between the Manchurian Qing China (1644-1911) that brought effective stability to China’s western territories, and the Czarist Russia in the eighteenth and early nineteenth centuries. Silk fabrics produced in China’s Lower Yangtze River area went northward and passed into southern Siberia and northern central Asia under Russian control (Fan and Wen 1993: Ch. 11). The success of the Russian-Chinese caravan commerce, as Rossabi argued, hinged on the relative safety on the northern trade routes. Banditry was virtually nonexistent, and custom duties were minimal, as the caravans merely traveled across one country instead of many disparate petty kingdoms and tribal units (Rossabi 1990: 368).

The fate of the Silk Road on the western end after the collapse of *Pax Mongolica*

was more favorable, in contrast to the vicissitudes of its eastern end. The quick rise and expansion of the Ottoman empire in the fourteenth century filled the power vacuum left by the collapse of the Mongols and provided crucial protection for the trade. By this time, Persia had clearly emerged as the most important raw silk producer and exporter. The provinces to the south and west of the Caspian Sea – in particular, Shirvan, Karabagh and above all Gilan – sent out raw silk to important trading centers such as Tabriz, Bursa, Istanbul, Aleppo, Genoa, Venice and later Lyon (Inalcik 1994: 218-55). Although Mediterranean Europe and Syria were to develop a strong sericultural base in the next couple of centuries, they relied, to a significant degree, on Persian raw materials during this period. This trading pattern, with silk production centers in Southern Europe importing raw materials from Persia, through a largely overland caravan route (combined sometimes with the use of the Black Sea, the Persian Gulf and the Red Sea) lasted into the mid-eighteenth century, until the disintegration of the Safavid Persian state.[9]

The end of the Mongol age in the East coincided with the brewing Commercial Revolution in late Medieval Europe, which marked the beginning of another epochal event in the history of the silk trade: the beginning of the Western European silk weaving industry. Important silk manufacturing towns, such as Lucca in Northern Italy, began to establish themselves in the mid-thirteenth century. The industry and technology quickly diffused across the Continent (Edler 1930: Ch. II).

Although the Western Europeans had most likely acquired sericultural and silk making technology from the Arabs and East Romans through the crusaders' movement and warfare in the twelfth and thirteenth centuries, contemporary scholars have also emphasized

the China connection. Both Dieter Kuhn and Claudier Zanier, in their comparative studies of pre-modern technology, unequivocally noted that the key elements of the early European silk-reeling and throwing equipment could find their origin in earlier Chinese versions (Needham 1988: 418-33; Zanier 1994). Chinese sericulture and silk production had reached a peak in terms of both quality and productivity in the Song dynasty, immediately before the Mongol rule in China (Needham 1988: 384-90; Fan and Jin 1993: Ch. 4). The opening-up of the Eurasian continent by the Mongols marked the high stage of East-West exchange as symbolized by the famous travels of Marco Polo.

Silk Road: the sea route

Early maritime trade

The sea route, sometimes considered the second Silk Road, linked the South China Sea to the Indian Ocean, and through either the Persian Gulf or the Red Sea, connected to the Mediterranean. It brought out Chinese silk almost as early as the land route. In the early days, primitive ships and navigational tools and lack of geographical knowledge enabled the seafarers to cover only short distances, staying close to the shore lines. Paralleling the overland route, the sea route served as an effective alternative (Needham 1954: 176-80).

The rise of Islam played a crucial role in the development of the sea route as it did for the land route. During the eighth and ninth centuries the Islamic shipmasters penetrated into the Indian Ocean and Southeast Asia, China and even reached Korea and Japan (Needham 1954: 179; Hourani 1951: Ch. II). As illustrated earlier, pressure from Islamic and other forces on the Northwestern frontier had pushed China's external trade

increasingly towards the sea route, to Japan, Southeast Asia and the Indian Ocean. (Chen and Wu 1981: 12; Li, M.-W. 1991: 135-51).

Towards the end of the 12th century, Chinese traders dominated in the Pacific waters. (Needham 1954, vol. 1, p. 180) The Mongol Yuan dynasty pursued an expansionary trade policy and greatly extended Chinese overseas trading into the South China sea and the Indian Ocean. Chinese maritime supremacy culminated in the grandiose expedition led by the Muslim eunuch of the Ming Dynasty, Zheng Ho, during 1400-1431, who sailed sea-going junks to Borneo, the Philippines, Ceylon, Malabar and even East Africa. While the Ming government was actively involved in the official tributary trade, its policy towards the burgeoning private trade was usually restrictive and inconsistent (Li, J.-M. 1990: 60-3). The rather abrupt withdrawal of the Ming naval presence in the Pacific waters at a time of rapidly growing private trade in the mid-fifteenth century opened the way for the arrival of the first European power: Portugal, which by 1488 found its way to East Asia, by bypassing the mighty Ottoman barrier and rounding the Cape of Good Hope.

The ascendancy of European technological leadership and the rise of European merchant empires

In Europe, silk weaving technology continued its westward diffusion from the early silk production centers in Northern Italy across the Continent. The technological diffusion was in many ways aided by the periodic migration of skilled artisans caused by the persecution of the Protestants. The seventeenth and eighteenth centuries saw the rise of important silk textile production centers such as Milan, Lyon, Zurich, Krefeld in Germany and Spitalfields

in London.

While European silk weavers continued to rely on raw silk imports from Persia and Levant, Northern Italy and Southern France also emerged as principal producers and exporters of raw silk in the seventeenth and eighteenth centuries (Belfanti 1993: 269-71). Moreover, European silk production technology advanced rapidly from the seventeenth. As argued by Claudier Zanier, European silk reeling technology, with the Italian Tavelle and French Chambon system, and the rigid axle transmission mechanism, probably surpassed that of China in the late seventeenth and early eighteenth centuries.[10]

Meanwhile, Italians also greatly improved the process of silk throwing although the idea of the twisting-frame - the arrangement and motion of dozens of parallel spindles - probably originated in China, it was rarely used after the Song and Yuan dynasties. In Italy, the twisting frame became a big silk throwing mill of higher capacity in the fourteenth and fifteenth centuries (Needham 1988: 420-33). In the early eighteenth century, the Lombe brothers in Britain smugg0led this technology out of Italy and developed the famous Derby silk throwing plant, a large-scale water powered, mechanized, manufacturing plant, the earliest institution that resembled a modern factory (Pacey 1990: 106).

During the seventeenth and eighteenth centuries, various experiments and improvements of the silk looms culminated in the invention of the so-called Jacquard loom by the Lyonese Joseph Jacquard in 1804. The Jacquard loom greatly enhanced the previously existing draw-loom - another Chinese invention - by attaching a punched card system, which could handle complicated weaving patterns at greater efficiency. Towards the first part of the nineteenth century, steam power began to be applied to all the

production processes, from reeling to throwing and weaving (Federico 1997: Ch. 7).

Southern European sericulture also benefited tremendously from advances made in European agronomic, biological and genetic science during this period. European scientists, guided by the methodology and tools of modern experimental science, enthusiastically studied the Chinese and Japanese sericultural texts acquired and translated in the eighteenth and nineteenth centuries (Foss 1986; Morris-Suzuki 1992; Zanier 1994: 71-94). Towards the latter part of the nineteenth century, European sericultural technology surged ahead, aided by major discoveries, such as Pasteur's germ theory and Mendel's genetic law.

The rise of powerful merchant empires on the Iberian Peninsula and in Northwestern Europe marked the formation of a truly global trading system. However, the early intrusion of European navigation into the Pacific waters initially had limited impact on the pattern of the world silk trade. First, although some Chinese silk went directly to Europe on the sea route, Europe by then received its raw silk supply chiefly from Persia largely through the overland route. Secondly, as mentioned earlier, domestic substitution of raw silk production gradually took hold in Southern Europe. Europeans did continue to look eastward for raw silk supply - for diversification, and mostly for a cheaper and lower grade of raw silk.[11] With the establishment of the East India Companies, Britain and Holland began to explore ways of bringing raw silk directly through the Cape Route. In the early seventeenth century, they succeeded in partially diverting the raw silk exports of Iran from the caravan route to the sea route.[12] The search for cheaper raw silk brought the British further eastward along the sea route. After the mid-seventeenth century, the British East India Company started using large-scale imports of raw silk from Bengal. Towards the late

seventeenth century, British and Dutch merchants sailed further eastward for direct purchase of raw silk for Europe. Over the next two centuries, Britain succeeded in bringing out substantial amounts of Chinese raw silk through the Chinese government's restricted foreign trade port cities.

Silver for silks: the emergence of a global market

Although, by the time of the Cape Route breakthrough, Chinese silk had long lost its once exclusive appeal, Europeans still managed to play an important role by tapping into the pre-existing trading circuit in the Pacific. This was well-illustrated by Portugal's intermediary involvement in the on-going silver for silk trade between Ming China and Tokugawa Japan. In the 1530s, Ming China ended its century long official tribute trade with Japan because of unresolved disputes and also banned private trade. During that time, the Japanese silk weaving sector relied heavily on the imports of Chinese raw silk (Fan and Wen 1993: 262). This led to the booming smuggling trade between China and Japan. Using Macau, a base it seized from China in 1557, the Portuguese traders launched the so-called triangular trade of Nagasaki-Macau-Canton that illicitly exchanged Japanese silver for Chinese silk.[13] Dutch as well as private Chinese merchants took over this transit trade in the early seventeenth century, using Taiwan as an intermediary base.

The persistent outflow of precious metals from Japan to China helped prompt the Tokugawa shoguns' tight control of foreign trade and, in particular, the sweeping restrictions imposed in 1685 on imports of Chinese silk (Morris-Suzuki 1992: 106). These measures provided powerful incentives for creating a domestic supply of raw silk for the

growing silk-weaving sector. With the support of local domains, Japanese farmers responded vigorously and absorbed Chinese sericultural knowledge through the translation of Chinese texts on agronomic and handicraft technology (Morris-Suzuki 1994: 17; Ma 1997: 24-6). These efforts paid off as silkworm rearing was successfully acclimatized to the Japanese environment and raw silk production diffused widely throughout Japan in the next century. As domestic raw silk production increased, raw silk prices went down sharply towards the middle of the eighteenth century and the volume of transit trade of silk between China and Japan started to decline towards the end of the eighteenth century (Fan and Wen 1993: 276).

While Chinese silk lost out in the face of successful domestic substitution in the Japanese market, it gained new ground across the Pacific, in the newly colonized South and Central American markets. The Andalusian regions in Southern Spain had a long and thriving history of sericulture and silk industry under the Islamic rule. The Christian take-over in 1477 infused the refreshing Italian styles and designs into the industry (LEgget 1949: 235). As part of the grand trans-oceanic transfer of animals and plants to the New Continent, the Spaniards successfully introduced sericulture and silk industry into Mexico in 1530. The culture and the industry were able to expand quickly (Borah 1943; Bazant 1964: 54-61).

However, the birth of a Mexican silk sector, the fruit of successful trans-Atlantic migration of European agriculture and technology, turned out to be short-lived. The same forces that once landed silkworms in South America then crushed it, as Europeans continued westward and opened the Pacific for trade, which exposed the young Mexican

silk industry to the onslaught of the world's oldest and most competitive silk industry, that of China. The year when the city of Manila was founded by the Spaniards, 1571, marked, as Flynn and Giraldez (1995) have forcefully argued, the birth of Pacific trade and the emergence of global trade. The Canton-Manila-Acapulco triangular trade of silver for silks between China and New Spain could be viewed as a Pacific extension of the concurrent Nagasaki-Macau-Canton silver for silks exchange intermediated through the Portuguese and later the Dutch; but it was an extension of global proportion, as silk quickly found its way into the gigantic swirl of the global flows of precious metals in the wake of the discovery of gold and silver mines in the New World.

China's huge demand for silver resulted mainly from the Ming government's conversion to a silver standard, which provided significant arbitrage possibilities because of the gold/silver ratio discrepancies between Asia and Europe. China became a huge "suction pump," drawing silver first from Japan, then from Mexico and Peru. According to conservative estimates, fully 75 percent of the 400 million pesos of silver bound for the Philippines during the period 1565-1820 ended up in China. On average, roughly two million pesos of silver were shipped through Manila in the seventeenth century. However, it is important to note that the strength of the "suction power" from China was sustained by silk threads - Chinese silk was the single most important export item to both Japan and Spanish America. In the high stage of the trade, China sent three- or even four-million pesos worth of silk goods a year to New Spain. For example, in 1727, China exported close to one million pounds of raw silk as well as a large amount of finished silk products to New Spain (Fan and Wen 1993: 282).[14]

The success of Chinese silk products stemmed from their price competitiveness in comparison with Spanish and Mexican products, and the Chinese ability to adapt their products to Spanish fashion (Fan and Wen 1993: 279-80). Chinese silk not only demolished nascent Mexican sericulture and severely affected the young weaving industry there, but also effectively outcompeted the Spanish silk products in Spanish America. The burgeoning exports of raw silk also greatly stimulated the commercialization and specialization of the Chinese economy. In particular, they induced the rise of important silk producing, financing and trading towns in the coastal regions of Ming China (Chaun 1972: Ch 14; Fan and Wen 1993: 284). The Manila-Acapulco-Canton trade waned towards the early nineteenth century after the independence of Mexico. However, the opening-up of the Pacific route was a significant geographic break-through for the history of the silk trade. Chinese silk for the first time, instead of going westward, reversed its direction and went further east to be connected to the New Continent.

The modern Silk Road and the coming of a full circle: 1850-1930

The essence of the modern Silk Road era was the evolution of a single global market which unified all the extant regional trading circuits. The global silk trade also seemed to have come full circle as East Asia regained its predominant position and became the world's most important supplier of raw silk. Raw silk from China and Japan simultaneously went both ways, westward to Europe and eastward to North America. Except that at this time, East Asian predominance no longer rested on its long monopoly of technology but on the principle of comparative advantage.

The era started with the British engagement in the Opium War from 1839 to 1842 which forcibly opened China to foreign trade with the establishment of the treaty ports, where traded commodities could enter and leave free from any restriction or tariff. After a sharp decline during the war period (1838-42), Chinese silk exports recovered and reached close to two million pounds in 1845 (Shih 1976: 111; Fan and Wen 1993: 291). The treaty port system was extended to Japan in 1858. The Japanese raw silk industry, with more than a century and half of successful import substitution experience, quickly became another important raw silk exporter. By the early nineteenth century, London had clearly emerged as an important center for the silk trade. The age of *Pax Britannica,* like the previous *Pax Mongolica,* reunified the silk trade of the Eurasian continent. However a fundamental change in this pattern of dual trading circuits in the East Asia bloc and the Euro-Middle-East bloc, had to await the coming of an internal crisis occurring within the world of the silk trade.

During the 1850s and 60s, the silkworm disease called pebrine broke out in Southern Europe and gradually spread to the Middle East. In its worst years, the sericultural crop in Europe declined by as much as 75 percent (Cayez 1979: 558-9). At this critical juncture, the British silk connection at the other end of the Eurasian continent rose to crucial importance. Between 1850 and 1860, Chinese and Japanese exports to Britain roughly quadrupled (Sugyiama 1988: 88).

In 1869, the Suez Canal opened. Through the Red Sea route, French silk merchants could import directly from China and Japan. Between the 1880s and the 1930s, more than half of the raw silk used on the looms in Lyon, the world's silk weaving capital, came from

East Asia. Marseilles, Lyon and later Milan supplanted London and emerged as the world's most important trade centers of raw silk in the latter part of the nineteenth century. The maritime Silk Road thus ended its almost three hundred years of detour around the southern tip of the African continent. The long-cherished dream of Venetian merchants to obtain silk directly from China, the vision that sent the explorers of the fifteenth century out of the western end of the Mediterranean, had come true.

Meanwhile, Chinese and Japanese silk crossed the Pacific again, this time to North America. The British colonial government long encouraged the transfer of sericulture and the silk industry to North America. However, scarcity of labor (particularly, skilled labor) and lack of sericultural traditions severely impeded progress. On the eve of the Civil War, the US silk-manufacturing industry remained small and produced unsophisticated products and its sericulture was next to non-existent. The erection of a tariff on the finished silk products for revenue purposes during the Civil War set the stage for the U.S. silk industry to take off. The American industry benefited significantly from the almost simultaneous decline of the British silk industry, resulting mainly from the British government's abolition of the import tariff - a result of its free trade stand - against the more competitive European particularly French products. Significant numbers of British skilled silk workers and entrepreneurs, particularly from the town of Macclesfield, emigrated with European technology and machinery to lay the foundation for America's leading silk town: Paterson in New Jersey. Behind the tariff wall, the U.S. silk industry grew quickly and by the twentieth century it had become the world's largest importer of raw silk. By the 1920s and 30s, the production of the U.S. silk industry exceeded that of all European countries

combined and doubled that of the Japanese silk industry. The US silk industry developed a reputation for large-scale, capital intensive production of standardized silk products (Ma 1996).

The spectacular growth of the American silk industry created an enormous demand for raw silk. Although imports of Chinese raw silk had begun as early as 1788 (Xu *et al.* 1990: 50), substantial amounts of raw silk crossed the North Pacific from China and Japan to San Francisco in 1867 after the establishment of the regular shipping line between China and the U.S. The raw silk was routed through the Continent to the silk-manufacturing centers around New York city through the inter-continental railway system, completed in 1869 (Ma 1996: 338). The highly mechanized, large scale nature of the U.S. silk manufacturing placed exacting demands on the quality of imported raw silk. Japan succeeded in this competition and took an increasingly larger share in the U.S. market. By the mid-1910s, Japan, overtaking China, became the world's largest raw silk exporter. And by the 1920s and 30s, Japan supplied 75 to 90 percent of the total world raw silk exports (Ma 1996: 339). By then, the bulk of the global silk trade was carried through the Pacific route.

Another distinguishing aspect of the modern silk road era was the massive reverse flow of technology from the West to the East, that is from Europe to Asia. The superior silk-reeling technology developed in southern Europe in the eighteenth and nineteenth centuries went with the European merchants as the traders moved progressively eastward in their search for raw silk. The technology was brought to the Levant, Turkey, and India (Owen 1987; Quataert 1987; Bag 1989: Ch. IV). And most importantly, European

silk-reeling technology and the factory system intruded into the traditional production system of China and Japan in the mid-nineteenth century. However, it was Japan after the Meiji Restoration of 1868 that displayed the greatest receptivity to European technology and science. Within several decades after the initial arrival of European silk-reeling machines, Japanese sericulture and the silk-reeling industry had experienced a fundamental transformation through the successful borrowing and innovation of Western mechanical engineering and biological and genetic science. Japan also pioneered the introduction of the French Jacquard weaving loom in the early 1870s. As I have argued elsewhere, rapid technological progress and productivity improvements, backed by Japan's successful concurrent industrialization experience, accounted for much of Japan's rising share in the U.S. raw silk market, the world's largest by the early twentieth century. By the 1920s, Japanese sericultural and silk-reeling technology captured global leadership. The direction of technological transfer again changed course, this time from Japan, first to China, its long time teacher, then to Italy, its more recent teacher (Ma 1997). If the global silk trade finally came full circle around the globe in the modern era, so did the silk technology. Or to be more exact, the technological leadership of raw silk production in the 20th century returned to the easternmost end of the Silk Road: Japan.

Trade, invention, institutions and the systems of transportation

The engine of growth: trade and invention

In close to two millennia, silk thread, starting from that treacherous, winding trail on the wild Western frontier of China, made its way around the globe. Sericulture and silk making,

based on a set of simple and ingenious ideas, landed on all the major continents of the world by the sixteenth century. Ernest Pariset, a nineteenth-century French scholar of silk, divided the long history of silk into four great ages: the age of the Chinese, the age of the Arabs (and Byzantines), the age of the Italians, and the age of the French. Not long after the publication of this book in 1862, Pariset began to call people's attention to the possible loss of Lyon's leadership in world silk production and trade to the rise of the mass-producing U.S. manufacturing (Allen 1904: 43). Both Table 2.1 and Figure 2.1 capture this progressive westward surge of silk trade and industry across time and space.

What could be the driving force behind this grand march of silk across time and space? The history of the Silk Road reveals that these "mysterious" and powerful forces may just lie within the process itself - specifically I mean the process of trading not only in goods, but also in knowledge. The silk exchange is nothing but part of the historical dynamics of human interaction. It is part of a process where trade induces diffusion of inventions which induces further growth of trade, an accelerating spiral of growth of trade and technological exchange.

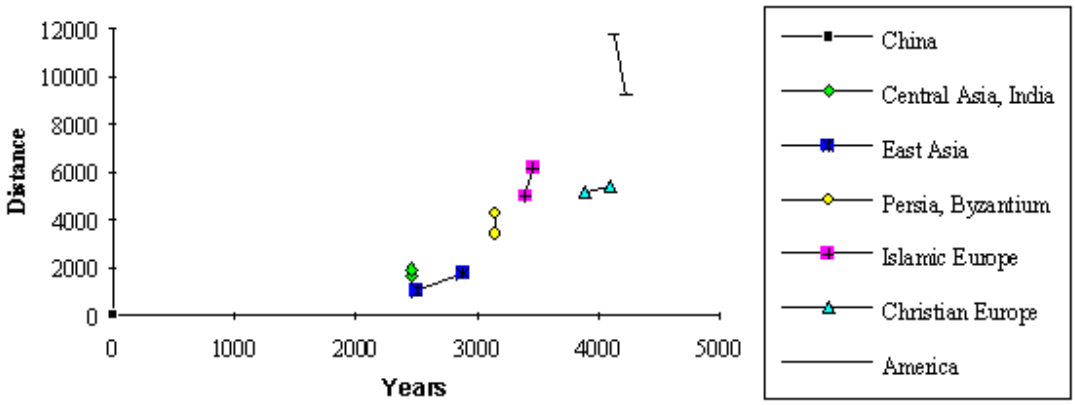

Figure 2.1 Westward diffusion of sericultural knowledge

Notes: 2600 BC has been set as the starting period (years = 0); Central Asia: Xian to Khotan = 1716 miles; India, Xian to Jammu, Kashmir = 1962 Miles; East Asia, Xian to Seoul, Korea = 1063 miles and Xian to Tokyo, Japan = 1767 miles; Persia, Xian to Tabriz, Iran = 3429 miles; Byzantium, Xian to Istanbul = 4237 miles; Islamic Europe, Xian to Istanbul to Messina = 4237 + 756 and Messina to Seville = 1161miles; Christian Europe, Messina to Milan = 598 miles and Milan to Lyon = 211 miles; America, Seville to Mexico City = 5591 miles and Milan to London to New York = 596 + 3434 miles

These ranged, to name just a few, from the technological progress made in the area of the domestication and management of animals for overland transportation; to the improvements in ship design and construction; the invention and diffusion of the lateen sail as well as the concurrent progress in navigation; to the inventions of the writing system, paper, and printing, which made possible the recording of commercial transactions as well as taxes on traded commodities; and to the development of standardized measurement systems and weighing instruments which eventually led to the use of carefully weighed and stamped metal coins and later paper money as media of exchange, saving the transaction costs incurred in barter trade.[15] The following two sections make a comparative institutional analysis between the two major modes of transportation for the silk trade.

A Caravan World

The modern English word *trade,* derives from an Old Saxon word for footstep *trada*. It is a term appropriate to the long-distance trade of silk in the early age of the overland route, where the traces of footsteps led the caravans through deserts and mountains in the search for commercial profits. The geographical and environmental conditions were certainly no lure for the hapless merchants and travelers: vast and open deserts, along with lofty mountains and plateaus, and the constant threat of aggressive nomadic tribespeople.

The greatest technological and institutional innovation in the means of transportation in the overland Silk Road was the adoption of camels and the subsequent rise of a camel-based caravan economy in Central Asia, North India, the Middle East and North Africa. The use of two-humped camels that could stand the extremes of heat and cold, and scent water from great distances, and warn of treacherous sandstorms as well as the existence of oasis towns in between opened up the possibility of long-distance travel. The creation of oasis towns helped too. In his classic study on the camels, Richard Bulliet argued that camels, in comparison to horses or oxen that pulled wheeled vehicles, were able to carry more and walk faster, had greater tenacity and endurance, greater powers of abstinence from food and water and cost less to maintain (Bulliet 1975: 23; McNeill 1971: 1115). One of the greatest advantages of camel caravans was that they needed little public infrastructure for long-distance trade. Camels did not need specially constructed roads or bridges, since they could traverse nearly any terrain and ford most streams without difficulty. Caravansaries, places to deposit goods safely while animals and men were resting and eating, were the only facilities caravans needed, and the type of rest place was just as

important for wheeled transport. The capacity of camels enabled merchants to cross regions otherwise impenetrable. Improvements in the breeding and the managing of camels and the making of saddles gradually reduced the costs for overland transportation. Bulliet (1975: 164) observed that the much heavier traffic on the Silk Road after about AD 100 was closely associated with the parallel rise in the diffusion of camels in Central Asia. After about AD 300, camels in Central Asia and the Middle East started to replace the wheel there, creating what William McNeill called a "caravan world."[16]

McNeill further argued that the smooth operation of the caravan transport network was also the resulted of the intimate symbiosis between the urban merchants and nomadic tribesmen in Middle Eastern society. The spread of the nomadic trading economy of caravans rode the surging tide of the expansion of Islamic territories in the seventh and eighth centuries. After about AD 700 the caravan world and the world of Islam became almost co-terminous (McNeill 1971: 1118-9). Economic, social and legal institutions began to evolve around a caravan-based economy in Islamic societies. The increasing importance of nomadic tribespeople and urban merchants gradually created an environment generally favorable to the protection of caravan trade through the use of moderation of customs and taxation against that of one-time plundering.

Even compared with the rising importance of ocean transportation, early overland caravan-based transportation was competitive. McNeill (1971: 1122) argues convincingly that between AD 300 and 1300, the superior capacity of ships was not a decisive advantage, partly because shipping was seasonal, liable to shipwreck, and exposed to piracy, but also because economic production was not yet attuned to a massive exchange of bulk

commodities. As a result, for a thousand years and more, animal portage competed successfully with shipping in the moving of light-weight luxury goods between China, India, the Middle East, and Eastern Europe. Steensgaard made one calculation of transportation costs along the overland silk trade based upon an English merchant's records. He found that a journey of seventy-nine marching days between Northern Persia and Turkey in 1581-1582 cost the merchant no more than 3 percent of the sales price of the silk transported. Thus Steensgaard concluded that in terms of pure transportation costs (excluding the custom duties) silk transportation by camel was actually cheaper than by ship.[17]

The Maritime System

Compared with other luxury commodities, such as spices, porcelain, other textile materials and precious metals, silk was much more closely bound to the land route and was usually the last to switch to the extensive use of sea routes (Abu-Lughod 1989: 327; Li, M.-W. 1991: 46; Steensgaard 1973: 168). This was clearly due to its light weight, durability and ease for packing and storing. To understand the eventual waning of the overland route, we need to examine the most crucial feature distinguishing it from the maritime transportation system.

In nearly any terrain, camels could travel approximately 20 miles in six hours without difficulty. Still the entire trip from China to Europe, extending more than 5,000 miles, would take more than a year and a half (Rossabi 1990: 356). A single attendant could manage about six camels. Strings of camels, tied head to tail, were guided by one man in front and guarded by a second in the rear. Each camel could carry about 300-500 pounds of

goods (McNeill 1971: 1115). As characterized by Steensgaard (1973: Ch. 1), it was the trade of peddlers, buying and selling small quantities on continuous travels from market to market. The trade was small, slow and characterized by the passing of goods through a chain of intermediaries. The peddling nature of the trade meant that, even when the volume of goods traded was considerable, the peddlers possessed little advance information concerning their targeted market. Since markets were isolated from one another, price differentials were often extraordinarily high, even between commercial centers located only moderate distances apart. High premia were needed to compensate the merchants for the uncertainty and risk in trade.

Evidently, the concentration of so much wealth in a caravan plodding through territories under sometimes dubious political authorities was an invitation to robbery. Steensgaard (1973) emphasized the high protection costs incurred by the peddling trade, because customs duties, risk of attack by robbers, and extortion on the part of local authorities constituted some of the most important entries among peddler expenses; furthermore these expenses were unpredictable. Using merchants' travel accounts and letters, Steensgaard concluded that unpredictable protection costs contributed significantly to the irregularity of supply and therefore to violent short-term price fluctuations of raw silk in the seventeenth and eighteenth centuries' overland silk market (particularly in areas outside the political control of the Ottoman empire and the Safavid state). Protection costs also accounted for a much higher share than the pure transportation costs in the final value of goods. This can be seen in the long history of the silk trade. The rhythm of the various phases of silk trade echoed closely the rise and fall of political empires. Trade always

thrived under the patronage of central powerful empires from Han and Tang China and to Rome, Mongols, Ottoman, Safavid Persia and Russia, which offered security against robbery and brigandage, maintained the roads, and levied predictable customs dues.[18]

Viewed from this perspective, the superiority of the sea route became clear. The sea wind that powered the ships was free and frequently traveled routes offered no problem, since one vessel's sails do not spoil the wind for another's. The problem of congestion and possible damage to the environment due to too many travels along the land route was not a problem on the wide and open sea. Protection costs for ships at sea were usually less troublesome than for caravans, if only because a ship traversed uninhabited expanses, whereas a caravan was seldom far from populated places, and caravans concentrated wealth in a way that tempted innumerable plunderers (McNeill 1971: 1119, 1123).

However, the early primitive ship-building and navigational technology, as well as limited geographical knowledge, initially prevented full exploitation of the non-rivalry and non-exclusive nature of the open sea. The early stages of ocean transportation shared many characteristics of a peddling trade over land routes: sailing short stages with little cargo and high crew costs (Curtin 1984: 119). However, according to Pierre Chaunu (1969), the pace of technological progress in marine transport rapidly overtook that in land transport after the thirteenth century. Continuous progress in nautical technology enabled ships to sail farther, faster and cheaper on the open sea; and with the discovery of an all-sea route from Europe to Asia and the crossing of the Pacific, it was only a matter of time before the sea route dominated global long-distance trade.

The "chains of markets" and all their associated problems which had long

"shackled" the overland trade route began to dissolve on the vast open sea. The nature of the open sea meant that survival of long distance trade no longer depended solely on the shifting political cycles of giant land-based empires. So long as traders had enough power to fend off seaborne piracy, they could bypass intermediaries and trade directly with destination port cities through all-sea routes. To a degree, this paved the way for the rise of European merchant empires, such as Portugal, Spain, Holland and England, with small populations and limited natural resources, but strong naval power. The cost of keeping sea routes open and safe for lucrative long-distance trade – the suppression of seaborne piracy and the securing of strongholds at strategic trading ports - was much lower than controlling overland routes, which normally required the military conquest and administration of alien territories.

This is Steensgaard's major point in explaining the success of sea routes in competing with land routes. Goods sailing along sea routes were no longer subject to various arbitrary taxes and extortion by local authorities and risks of attack by roving bandits on the overland route. In fact, the armed trading policies of the British and Dutch East India Companies internalized previously-unpredictable protection costs and risks of loss via land routes, and turned them into more well-defined entries of their internal military budgets. Reduction of the risk element in transportation costs brought greater certainty to trade, reduced price fluctuations and enhanced the transparency of price formation (Steensgaard 1973). Further institutional (as well as technological) innovations, such as the development of marine insurance, as well as the gradual evolution of well-defined merchant law and its enhanced enforceability in Holland and England, brought

further improvements to the marine transportation system (North 1991). If, as argued by McNeill, there existed a symbiotic relationship between the Islamic world and the Caravan world; clearly, the same was also true of the European expansion and the maritime transportation system (Chaunu 1969).

After the mid-nineteenth century, with the laying of the inter-continental under-sea cable, the maritime transportation system ushered in a single, unified global market for raw silk, with standardization geared towards mass consumption and silk prices around the world moving in close unison. As the world knitted together, supply and demand shocks transmitted quickly from one region to another, sometimes within months, weeks, or even days (Ma 1996; Federico 1997: Ch. 8). By the twentieth century, a pound of raw silk sold in New York was only about one to five percent higher in price than a pound of raw silk of the same grade sold in Shanghai or Yokohama (Ma 1996). This contrasts sharply with the situation in 1620 and 1621 when prices of silk (both raw and finished fabrics) in Manila had risen almost tenfold upon reaching the port of Lima, Peru (Chuan 1972: 468). This huge drop in price difference over the Pacific reflected long run improvements in marine transportation.

Conclusion: from luxury to mass consumption

Silk, with scarcity resulting from the high transportation and communication barriers, had long been a luxury product, having served gods, saints, emperors and aristocrats around the world. It became a symbol of political authority and social status; the code of silk dress once defined the political and religious hierarchy of the Tang China and the Islamic empires

(Liu 1996). It was not just a symbol of wealth, it was wealth - silk was used as a medium of exchange in China and Central Asia. Wealth, unfortunately, was often associated with evil as it became the target of envy and the cause of much human warfare; yet silk had served for peace – it was usually the most important gift item in China's long history of tributary trade to appease the Central Asian kingdoms. In the modern age, silk became intimately linked with high fashion.

Luxuries are "goods whose principal use is rhetorical and social, goods are simply incarnation signs, the necessity to which they respond is fundamentally political" (Liu 1996: 2). The welfare effects of early long-distance trade in luxury goods have always been dubious. But the exchange of the commodity such as silk (a private good) which brought forth the exchange of ideas (a public good) changed the nature of long-distance trade in luxury goods. The fundamental value of the silk exchange was its enduring testimony of the great cultural, religious and technological dialogue taking place across time along the legendary Silk Road. The impact of the sharing, learning and accumulation of productive knowledge (a non-exhaustible public good) on human welfare far surpassed the mere trade of a luxury good.

The historical diffusion of the technologies of silk-making, transportation and communication, over time, brought down considerably the costs of both making and moving silk around the world and inadvertently set off a dynamic process which saw the gradual erosion of status of silk as a luxury good. Furthermore, this progressive democratization of silk started earlier than expected. For example, even in the days of Byzantium and Tang China, both of which had a state monopoly on the production of high

quality silks, the widespread diffusion of sericulture from Central Asia to the Mediterranean began to change people's attitudes towards this exquisite material. The accessibility of the silk materials and increased local production seriously weakened the royal monopolies in Byzantium and China. Silk textiles were gradually transferred into a common commodity, sometimes expensive and sometimes more reasonably priced (Liu 1996: 194).

This progressive "democratization" of silk accelerated over time. In the high age of the seventeenth century Pacific silver-for-silks trade between China and New Spain, Chinese silks could be found on the backs of even ordinary persons and on the altars of churches all over Spanish America (Li, L. 1981: 65). However, it was the twentieth-century U.S. silk-manufacturing industry that gave the most radical expression of silk "democratization." Large scale and mechanized factories in the U.S. used raw silk imported from thousands of miles away; they mass produced silk goods of a standardized quality and pattern, specifically geared towards average consumers. By then, silk, the queen of fabrics, the thread of gold, served all echelons of a society, including the working classes.

Therefore, the full significance of silk as a commodity should be viewed in this context: silk was among the early products which broke the tyranny of distance, reduced the barriers to human exchange, promoted the spread of ideas, and ultimately led to the division of labor and expansion of the market - the so-called Smithian growth.

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Notes

[1] Chinese scholar Zhao, Feng (1992: 218-21) distinguished three major historical regions of textile culture around the world. According to him, the Mediterranean textile circuit which included West Asia, Northern Africa and Europe developed technology in the utilization of wool and hemp. The India subcontinent, pioneered the use of cotton, whereas East Asia excelled in the use of silk. Distinct features of weaving and dying technology also characterized these three regions.

[2] However, since the Silk Road also extended into Japan in the seventh and eighth centuries, the eastern terminus of the Road was in Japan (see Werblowsky 1988: 53).

[3] For a description and mapping of the silk road, see Boulnois 1966, Franck and Brownstone 1986, Needham 1954: 170-90.

[4] As in so many other cases, knowledge and technology for commercially viable sericulture and silk production involved more than several pieces of information. Details on the type of mulberry trees suited to local soil conditions and temperature, the methods of pruning, propagating the trees, and the cutting of the leaves, the raising of silkworms as well as the construction and operation of reeling tools were indispensable. This is why the diffusion of this technology was a cumulative and ongoing process requiring extensive human contact and repeated local experiments.

[5] See Li, M.-W. 1991: 8. The well-know Chinese Buddhist monk and scholar, Shuang-Zhang, took advantage of the situation to travel along the Silk Road to India in AD 629. His translation and interpretation of the original Buddhist texts helped popularize Buddhism in East Asia, while his writings, based on his travels, greatly enhanced the Chinese understanding and knowledge of the geography and culture of these areas.

[6] Needham 1954: 187. The road was opened and closed for silk trade several times depending on the political situation. See Boulnois 1966: 195.

[7] See Fan and Wen 1993: 462-7, Li, M.-W. 1991: 153. Often cited as evidence for the safety of the Silk Road was a merchant's handbook of the fourteenth century which said: "The road which you travel from Tana (at

the mouth of the Don) to Cathay is perfectly safe, whether by day or night, according to what the merchants say who have used it" (Needham 1954: 188). This is also the time when the famous Polo brothers made their voyages to China between 1260-1269 and 1271-1296.

[8] See Inalcik 1994: 218. However, the arrival of Chinese raw silk, although more competitive in price, did not drive Persian and Turkestanian silk out of the Italian market. One possible explanation, as argued by Lopez, was the deterioration of quality of Chinese raw silk resulting from the long distance traveled on the Silk Road (1952: 74-5).

[9] In the sixteenth and seventeenth centuries, Russia also started purchasing Persian silk, shipped on the Volga river, and in sledges and carts, via Armenian merchants. (see Curtin 1984: 188-92).

[10] Both the Italian Tavelle and French Chambon systems involved wringing several silk threads dry and twisting them together to enhance the cohesiveness and eveness of the silk thread - features essential for high quality raw silk (see Zanier 1994: 38-52).

[11] Sericulture never found a home in Britain, which had a booming silk weaving sector in the eighteenth and nineteenth centuries.

[12] However, the project for such a diversion, with cooperation between Britain and Persia, met with only limited success. The British East India Company received only modest quantities up to the 1640s: proof that the silk trade was bound to the caravan route. By 1630, for example, the India spice traffic through the Ottoman controlled caravan route was completely lost to the Cape route controlled by the British and the Dutch (see Chaudhuri 1978: 345; Inaclik 1994: 249; Steensgaard 1973: 168).

[13] Precious Japanese metals, mainly silver, but also including gold and copper, exchanged for Chinese silk (see Flynn and Gilraldez, 1995, 1996a, 1996b; von Glahn 1996; Fan and Wen 1993: 272).

[14] For major literature on the subject of silver for silks exchange, see Chaudhuri, K.N. 1978; Chuan, Hang-Sheng, 1971: vol.1, Ch 12, 13 and 14; Fan and Wen 1993: 279-84; Flynn and Giraldez, 1995, 1996a, and 1996b and von Glahn 1996: 434.

[15] See Reid 1996: Ch. 2. Lius Rivera-Batiz and Paul Romer (1994) developed a growth model where output growth originated from the expansion of the world's total stock of productive knowledge. In their model, they defined the source of the growth of knowledge as coming from economic integration, more specifically, the concatenation of different nations' knowledge bases. Interestingly, the exchange through the Silk Road was cited as a supporting case for their model.

[16] See McNeill 1971 and Bulliet 1975 for the different development paths of the use of camels and their combination with other domesticated animals and carts in North India, Persia, Arabia, Central Asia, and North Africa; and for animals other than camels used as power source and transportation tools.

[17] The custom dues and protection costs totaled about twice that amount. See Steensgaard 1973: 32-3, 40. This unique symbiosis of the Caravan world and the Islamic world not only provided an important understanding of the persistence of the overland silk trade, but also gives an adequate explanation to the differential developments of the two ends of the Silk Road. Although the "caravan world" stretched through vast areas of the Eurasian continent, it stopped short of both China and Western Europe. The Chinese internal transportation system was based largely on canals, water-ways and the public road system, whereas Western Europe relied heavily on its natural riverways, and Mediterranean Europe on its numerous harbors and easily navigated waters. Neither transport system made much use of caravans. See McNeill 1971.

[18] This is the central idea behind the game-theoretic model developed by Edi Karni and Subir Chakrabarti (1997). Their model shows that chains of markets under independent jurisdictions with non-cooperative tax policies (on traded goods going through the markets) entail externalities detrimental to trade; and that the monopolization of the chain markets (under, for example, a central political power) could internalize the costs associated with these externalities, increase the volume of trade and the tax revenues through the implementation of cooperative tax strategies.