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An early knowledge economy: the adoption of paper, human capital and economic change in the medieval Islamic Middle East, 700- 1300 AD

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An early knowledge economy: the adoption of paper, human capital and economic change in the medieval Islamic Middle East, 700-1300 AD

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Abstract: The adoption of paper in the early days of the Islamic rule changed literacy practices in the Middle East and eventually around the world, yet the circumstances of its adoption and its impact on the Middle Eastern economy are not well known or understood. This study determines that paper use was linked to an increase in purchasing power and to a shift in cultivation patterns from cereals to textile plants. It shows that the decline in the price of paper and books played a role in the standardization of the Arabic language and in the transition from oral to written practices, the formation of new knowledge, and the spread of literacy. The result was improvement in human capital and rising labor productivity, especially in manufacturing. Finally, the flow of paper documents in the economy changed norms of contract enforcement.

Keywords: Medieval Middle East, economic change, purchasing power, prices and wages, Agricultural shift, literacy, Human Capital, technology.

JEL Codes: J24, N95, N75, N90, N70.

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Recent literature has changed our perception of economic progress in medieval history. No longer an extended stubborn ‘stagionist’ period,¹ medieval Europe is now viewed as having laid down the foundation to a new age of economic growth, the Industrial Revolution and the ‘Rise of the West.’² With a demonstrable rise in per capita income, in GDP and in standards of living in the late Middle Ages and the pre-modern era, economic growth has been linked to improvements in human capital.³ The quality of the data available, enhanced by mega databases of books and manuscripts and the sophistication of the analysis applied to it, has made book production a measurable proof of knowledge accumulation used in the next phase of economic progress.⁴ More intense scrutiny of the manifestations of intellectual life in the Early, 9th century, and High Middle Ages, 12th-14th centuries, uncovered additional factors of human capital formation leading to economic growth, albeit through the medium of religious institutions.⁵ Pre and post Black Death evidence of high wages and income growth has revealed a long-term upward trend, though one affected by Malthusian pressures.⁶ The role of human capital in the Malthusian equilibrium debate has been demonstrated as well by evidence of lower birth rates among women with employment income in pre modern Europe,⁷ fine tuned in the new economic growth theory which combined the effect of women’s education, higher standards of living and human capital on birthrate.⁸ Technological innovation, the traditional instrument of economic change leading to growth, no longer has to rely on proxies of growth such as increases in population size and urbanization rate. It can now be measured with precision as in the case of the heavy plough effect on agricultural productivity in early medieval Europe, shown to be responsible for 11.2% increase in

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¹ Persson, *Pre-Industrial Economic Growth*; Goldstone, “Efflorescences and Economic Growth.”

² Van Zanden, *The Long Road*; Buringh and Van Zanden, “Charting the ‘Rise of the West’”; Bolt and Van Zanden, “The Maddison Project.”

³ Reis, “Economic Growth, Human Capital Formation”; Van Zanden, *The Long Road*; Buringh and Van Zanden, “Charting the ‘Rise of the West’”; Mokyr, *The Lever of Riches*; Mokyr, *The Enlightened Economy*; Jacob, *The Cultural Meaning*; Jacob, *The First Knowledge Economy*.

⁴ Buringh, *Medieval Manuscript Production*.

⁵ Blum and Dudley, “Standardized Latin and Medieval Economic Growth”; Cantoni and Yuchtman, “Medieval Universities, Legal Institutions.”

⁶ Findlay and Lundahl, “Demographic Shocks and the Factor Proportions Model”; Allen, “The Great Divergence in European Wages”; Abramitzky and Braggion, “Malthusian and Neo-Malthusian Theories.”

⁷ Voigtländer and Voth, “How the West ‘Invented’ Fertility Restriction”; Van Zanden, “The Malthusian Intermezzo: Women’s Wages and Human Capital Formation”; Clark, *A Farewell to Alms*.

⁸ Galor and Weil, “Population, Technology, and Growth”; Galor, *Unified Growth Theory*.

urbanization from 900 to 1300 AD, and for 10.3% of the overall increase in population density.⁹ The scope of the investigation was widened thematically and methodologically by including medieval institutions such as feudalism and merchants associations.¹⁰

The numerous references to “economic change” throughout the paper disclose a preference for using the concept in lieu of economic growth, which other authors on the medieval economy have used.¹¹ This is especially true in the case of the medieval Middle East. The study of the effect of an exogenous shock, such as the one triggered by the Justinian Plague and the Black Death,¹² placed the region in the upper level in terms of standards of living.¹³ Wages were at times as high as 2 or 3 times the subsistence minimum in Egypt and Iraq in aftermath of the Justinian Plague, a considerable rise in standards of living that revealed the unique character of economic change to the development of the new society in the Middle East. On a different scale but similar in outcome is Watson’s thesis of an agricultural revolution in the Middle East sustained by newly introduced crops as agents of change. This thesis is now fully accredited by demonstrated early high urbanization rates for the Middle East, upon which it was predicated in the first place.¹⁴ This feat of growth could not be maintained for the long haul, but the medieval Arabic sources provide solid information on multiple similar fluctuations and transformations that improved economic performance. Using economic change rather than economic growth to describe them is justified.¹⁵ One such significant change occurred in the quality of human capital and with it a rise in labor productivity. This study examines the role played by the adoption of paper in this process and the long-term effect it exercised on human capital formation and economic performance.

Ancient civilizations of the Near East invented the alphabet and used an array of writing materials to commit their knowledge and actions to posterity. They used potsherds, clay tables, bricks, stone and marble as writing surfaces, materials that were not easily transported, mass-produced or made to circulate. Papyri and parchment were easier to write on and to move around, but were of limited resource base and costly to manufacture. The cumulative effect of the restrictions imposed by writing materials limited the scope of functional literacy, hindering the development of languages, knowledge acquisition, storage and dissemination, scholarly explorations, professional sophistication and technical progress. Papermaking, one of the great inventions of humankind, originated in China around 200 BC, but did little to correct the disadvantages of other writing surfaces until the Arabs adopted it in the Middle East in the 8th century, from where it was to spread to Europe. While the adoption of paper in the Islamic Middle East was a moment in world history, the circumstances and economic context of the

⁹ Andersen, Jensen, and Skovsgaard, “The Heavy Plough and the Agricultural Revolution in Medieval Europe,” p. 22; Bosker, Buringh, and Van Zanden, “From Baghdad to London: Unraveling Urban Development.”

¹⁰ On feudalism: North, *Structure and Change in Economic History*. On merchants associations and contract enforcement: Greif, “Reputation and Coalition in Medieval Trade”; Greif, “Contract Enforceability and Economic Institutions in Early Trade”; Greif, “Cultural Beliefs and the Organization of Society.”

¹¹ Blum and Dudley, “Standardized Latin.”

¹² Pamuk and Shatzmiller, “Plagues, Wages, and Economic Change in the Islamic Middle East, 700–1500.” On the methodology see Allen, “The Great Divergence.” Claims by medieval historians that population decline began prior to the plague, notwithstanding: Wickham, *Framing the Early Middle Ages*; Jordan, *The Great Famine*.

¹³ Bolt and van Zanden, “The Maddison Project”; Cipolla, *Before the Industrial Revolution*.

¹⁴ Watson, *Agricultural Innovation in the Early Islamic World*; Squatriti, “Of Seeds, Seasons, and Seas”; Bosker, Buringh, and Van Zanden, “From Baghdad to London.”

¹⁵ On the historiography: Shatzmiller, “Economic Performance and Economic Growth in the Early Islamic World”; Shatzmiller, “The Economic History of the Medieval Middle East.”

process elude us. The version given by the Arab chronicles, and recurring in modern scholarship, speaks of Chinese papermakers taken prisoners in North-eastern Iran in 750 AD, who taught the Arabs paper making techniques.¹⁶ The story may have a grain of historical truth to it. Artisans were taken prisoners regularly and exiled so the new lands could use their skills, furthermore, prisoners in particular were associated with paper making because of the difficult physical nature of the job. This does not take anything away from what happened to paper in the lands of Islam, nor from clarifying the process and the links to human capital formation and the role of books in the economy.¹⁷

As this study demonstrates, the adoption of paper and the subsequent decline in the price of paper and books played an important role in human capital formation and led to a rise in labor productivity, most significantly in the manufacturing sector. Furthermore, the wide circulation of paper documents in the economy also facilitated efficient contract enforcement. With the help of a new database of diagnostic indicators for the medieval Middle Eastern economy, I provide a solid statistical base for the analysis and implementation of the findings in a quantitative and comparative setting.¹⁸

The paper is organized as follows: the first sections focus on prices and their analysis. Paper and papyri average prices are calculated and compared to prices of basic goods, and then compared to average wages of skilled and unskilled labor in an attempt to establish purchasing power. I also establish the long-term evolution of the price of books over five centuries and conclude that the purchasing power of skilled and unskilled workers extended to consumption of writing material, including paper. The dramatic decline in the price of paper and books uncovered by the 11th century further links book consumption to income levels and standards of living over the long haul. Next, I explore the factors behind the decline in the price of paper and books and show that a shift in cultivation patterns in favor of textile plants resulted in cheap rags, the raw material used in papermaking. I also review the technology and conclude that technology using cheap energy in the form of watermills and trip hammers in the processing of linen rags played a role as well. The last two sections deal with the effect on economic performance. The availability of paper and books is synchronized with the standardization of the Arabic language, the transition from oral to written culture, the rise in literacy rates and the new systems of constructing, storing and disseminating complex knowledge. I explore the effect of the proliferation of technical manuals on human capital and increased division of labor in raising productivity in the manufacturing sector. The rise in the use of paper documents in the economy, and in particular by merchants in the conduct of trade and by the courts, explored in the last section, favored efficient contract enforcement. Conclusions follow.

PAPER, BOOKS, AND PURCHASING POWER IN THE MIDDLE EAST

Arab chroniclers provide enough price indications for both papyri and paper during the first three centuries of Islamic rule in the Middle East, the 8th-10th centuries, that it is possible to study the place of writing material in terms of the basket of basic consumers goods afforded by wages of workers in

¹⁶ Bloom, *Paper*, pp. 42–5.

¹⁷ On Islamic paper and books: Pedersen, *The Arabic Book*, pp. 54–71; Hanna, *In Praise of Books*.

¹⁸ The Arabic primary sources have an abundance of empirical evidence. A new database is now available at <http://medievalislamicconomy.com>. The database includes commodities prices, wages, consumption, money, coinage, weights and measures and related diagnostic data for measuring standards of living.

medieval Iraq and Egypt. Using data collected by Ashtor in *Prix et salaires*,¹⁹ and by Malczykcki in his paper on the papyri industry,²⁰ I first establish the average price of the writing material, papyri and paper. Calculations were somewhat complicated by the fact that papyri, unlike paper, was sold in Iraq and Egypt either one sheet at a time, or in 3 1/2 loose leaves in a scroll (*tūmār*, pl. *tawāmīr*), or in a *qirtās*, one roll consisting of 6 *tūmārs* of 21 separate sheets each.²¹

TABLE 1
AVERAGE PRICES OF PAPYRI AND PAPER, EGYPT AND IRAQ, 8TH-10TH CENTURIES
(In gold dinars)

Region	Papyri (100 sheets)	Paper (100 sheets)
Egypt	1.9322 (8 th -9 th centuries)	0.3257 (9 th -10 th century)
Iraq	6.3406 (9 th century)	2.5622 (9 th -10 th centuries)

Sources: See the online database, *Measuring the Medieval Islamic Economy*.

Paper, on the other hand, was sold from the beginning in bundles: In the case of Iraq, two out of four paper price observations give a price for a unit of 100, while two out of the two entries for Egypt give the price for units of 100 sheets.²² The first paper price indication from Egypt in 848 AD refers to a unit of 100, but quantities could range from thirty to a hundred sheets in a bundle sold in both regions.²³ In order to facilitate a comparison of long-term average prices of both papyri and paper, the price of 100 sheets units of papyri was used as well, rather than that of rolls of 21 sheets. The results presented in Table 1. Prices of single sheets, *tūmārs*, and *qirtās*, in Egypt and Iraq, were calculated as well: The price of 1 sheet of papyri in Egypt was 0.0193 dinars in the 8th-9th centuries, but higher in Iraq in the 9th century, 0.0634 dinars. When calculated in *tūmārs*, the average price of 3 ½ papyri sheets was 0.0676 dinars in Egypt in the 9th century while it was 0.2219 dinars in Iraq for the same time period. The average price of a *qirtās*, a papyri roll, was 0.4058 dinars in Egypt in the 8th-9th centuries and 1.3315 dinars in Iraq in the 9th century. The first observation to be made is that from the very beginning paper was less expensive than papyri. A single sheet of paper could be bought in Egypt during the 9th-10th centuries for 0.0033 gold dinars; it was more costly in Iraq over the same time period, 0.0256 dinars. The higher price of papyri in Iraq was most likely related to additional costs due to shipment from Egypt over a long distance. Yet, paper prices were lower than papyri prices in both Egypt and Iraq, while both papyri and paper prices were higher in Iraq than in Egypt.

With the prices of basic goods in Egypt and Iraq already available to us in a previous study,²⁴ it is possible now to compare the average price of writing material, paper and papyri, to the average price of wheat, meat, beans, olive oil, as well as linen. Table 2 presents the average price of papyri and paper in early medieval Iraq and Egypt, 8th-10th centuries, in comparison to the average prices of these basic commodities.

¹⁹ Ashtor, *Histoire des prix et des salaires*.

²⁰ Malczykcki, "The Papyrus Industry," pp. 189–94. For early paper in Europe: Buringh and Van Zanden, "Charting the 'Rise of the West'"; Blum and Dudley, "Standardized Latin."

²¹ Ashtor, *Prix*, p. 89.

²² Ashtor, *Prix*, p. 90. The price may have included the starch sold for 1/8 dinar, required for smoothing the surface.

²³ Ashtor, *Prix*, pp. 60–1, 89–90.

²⁴ Pamuk and Shatzmiller, "Plagues."

TABLE 2
AVERAGE PRICES OF POPYRI, PAPER AND BASIC COMMODITIES, EGYPT AND IRAQ, 8th-10th
CENTURIES
(In gold dinars)

Commodity	Egypt	Iraq
Papyri (per 100 sheets)	1.9322	6.3406
Paper (per 100 sheets)	0.3257	2.5622
Wheat (per kg)	0.0046	0.0047
Beans (per kg)	0.0058	
Meat (per kg)	0.0368	
Olive Oil (per kg)	0.0378	
Linen (per meter)	0.0533	

Sources: Pamuk and Shatzmiller, "Plagues."

When the average price of a single sheet of papyri or paper is compared to the average price of a kilogram of the basic commodities, the results display as follows:

1 sheet of papyri in Egypt was:

418% times as expensive as 1 kg wheat
334% times as expensive as 1 kg beans
52.5% times as expensive as 1 kg meat
51.1% times as expensive as 1 kg olive oil
36.2% times as expensive as 1 m linen

1 sheet of paper in Egypt was:

70.5% times as expensive as 1 kg wheat
56.3% times as expensive as 1 kg beans
8.84% times as expensive as 1 kg meat
8.61% times as expensive as 1 kg olive oil
6.11% times as expensive as 1 m linen

1 sheet of papyri in Iraq was:

1349% times as expensive as 1 kg wheat

1 sheet of paper in Iraq was:

545% times as expensive as 1 kg wheat

If writing material was much more expensive than a unit of basic good the question arises of its affordability. In other words, what was the purchasing power capability of workers in Egypt and Iraq? To answer this question I used the data on average wages of unskilled urban workers in medieval Iraq and Egypt already available, and added to it new wage data for skilled labor, a group more likely to consume writing material, to have a better understanding of income levels of wage earners.²⁵ There was a caveat nonetheless, as wage data for skilled labor was only available for Iraq but not for Egypt. The reasons for the absence of wage data of skilled labor in Egypt is related to a delay in urbanization there, and with it a delay in the development of government institutions, where demand for skilled literate and numerate personnel in Iraq was centered. The early urbanization in Iraq created employment opportunities for a large number of literate and skilled personnel whose services were generously compensated. Though all sorts of professionals in Iraq during the 8th-10th centuries were highly remunerated, wages of teachers in particular were high, ranging between 10 dirhams for teaching a course to 200 dinars a month. The high wages paid to professionals and teachers may not be

²⁵ Pamuk and Shatzmiller, "Plagues," pp. 201-8.

out of sync. As seen in Table 3 average wages for skilled labor in Iraq were higher than wages of unskilled, as expected. The early and strong urbanization of Iraq was to play an important role in generating demand for paper from the administrative units and educational establishments under the Abbasids, though it would not explain the evolution in the price of paper and books on its own. Bureaucratic necessity, the enlargement in the duties of the bureaus, and dissatisfaction with papyri alone could not have led to the developments we see. The skilled group was not the only group able to afford writing material at these levels: With wages of urban unskilled labor as high as 2 or 3 times the subsistence level, it is possible to postulate that demand for writing material was coming from a wider population base than high earners alone. Average wages of unskilled labor in Iraq were lower than in Egypt all the way up to the 10th century, when unskilled wages became comparable.

TABLE 3
DAILY AVERAGE WAGES OF SKILLED AND UNSKILLED LABOR, EGYPT AND IRAQ, 8th-10th
CENTURIES
(In gold dinars)

Time Period	Iraq – Skilled (Professionals)	Iraq – Unskilled	Egypt – Unskilled
8th Century	0.3409	0.0073	0.0208
9th Century	1.3191	0.0217	0.0325
10th Century	0.9895	0.0533	0.0533

Notes: However, some of data had to be removed from the calculation for the sake of achieving more balanced results. For instance, five entries of wage information were removed from the calculations in the category of teachers/professionals due to their extraordinary nature. If they were to be included, these five entries would have produced standard deviations of 14.52 and 222.61 for the 9th and 10th century respectively (none of the five entries came from the 8th century). Excluding the five entries produced standard deviations of 0.77 and 0.91 for the 9th and 10th century respectively, closer to the standard deviation of 0.37 for the 8th century. It does not void the value of the results.

Sources: See the online database, *Measuring the Medieval Islamic Economy*.

This is an important conclusion to be reiterated: the average prices of papyri and paper may have been high in comparison to the price of basic goods, but not in relationship to income levels among wage earners of both skilled and unskilled labor. This income elasticity permitted wage earners to consume high-end goods such as fine clothes made of cotton and linen, and imported spices and exotic dishes, which first appeared in the courtly menus and later made their way into the cooking manuals. While still a luxury item during the introductory period, purchasing writing material was made possible by relatively high standards of living, including strong purchasing power and low priced consumer goods in Iraq and Egypt. A change in per capita income and in income distribution, a consequence of the post-Justinian economic prosperity, may account for the demand for paper in the early Middle East, but demand cannot explain entirely on its own the adoption of paper and the spread of its use. For that to happen further changes had to take place, to be explored below. The price of books provides an additional indicator of the process.

THE DECLINE IN THE PRICE OF BOOKS

By the end of the 10th century papyri was no longer used anywhere in the Middle East and, probably even more significantly, there were no more paper prices in the Arabic sources except those in which paper was sold in bulk. For instance, by the beginning of the 11th century 28 camel loads of paper of a specific manufacture were shipped together with 20 bales of one kind and 10 bales of a third manufacture from Syria to Egypt. 5,000 sheets of thin paper and 1,000 sheets of ‘*talhi*’ paper were sent from Egypt to Tunis, valued at 250 dinars.²⁶ Paper bundles containing thousands of paper leafs and counted in camel loads were shipped by boats to different regions of the Middle East. On the other hand, book prices, which were previously unavailable, began to appear in the sources. Only 1 book price was found for each of the 9th and 10th centuries. By the 11th century book prices appeared in sources by the dozens: 45 book prices in the 11th century, 50 in the 12th century and 74 for the 13th, with the most coming from one source: the *Genizah* documents, letters and records written in Judeo-Arabic by members of the Jewish community of medieval Cairo.²⁷ The prices came from inventories of booksellers or copiers, books from estates sold at an auction, books given as collateral, with some written in Hebrew and others in Arabic, but used freely by Jews.²⁸

TABLE 4
AVERAGE PRICES OF BOOKS IN COMPARISON TO DAILY WAGES, EGYPT, 9th-13th CENTURIES
(In gold dinars)

Time Period	Price of One Volume	Average Daily Wage for Unskilled Urban Worker	Days of Work to Buy One Volume	Number of Book Prices Used
9 th Century	4.2105	0.0325	130	1
10 th Century	2.5000	0.0533	47	1
11 th Century	2.7989	0.0678	41	45
12 th Century	0.8653	0.0600	14	50
13 th Century	0.5153	0.0644	8	74

Sources: See the online database, *Measuring the Medieval Islamic Economy*.

The results of the intertemporal investigation are presented in Table 4 and displayed by Graph 1. They show that the average price of a book volume in Egypt went from 4.2105 dinars in the 9th century to 0.5153 dinars in the 13th century. They also show that the decline was gradual between the 9th and the 11th century and sharp between the 11th and the 12th, with an additional minor decline in the 13th century.

²⁶ Goitein, *Mediterranean Society*, pp. 80–1 and note 2. Transcribed in Judeo-Arabic and translated into Hebrew, Gil, *Texts from the Cairo Genizah*, pp. 459–62.

²⁷ Allony, *The Jewish Library in the Middle Ages*.

²⁸ Ethnic identity of book owners did not affect the price of books.

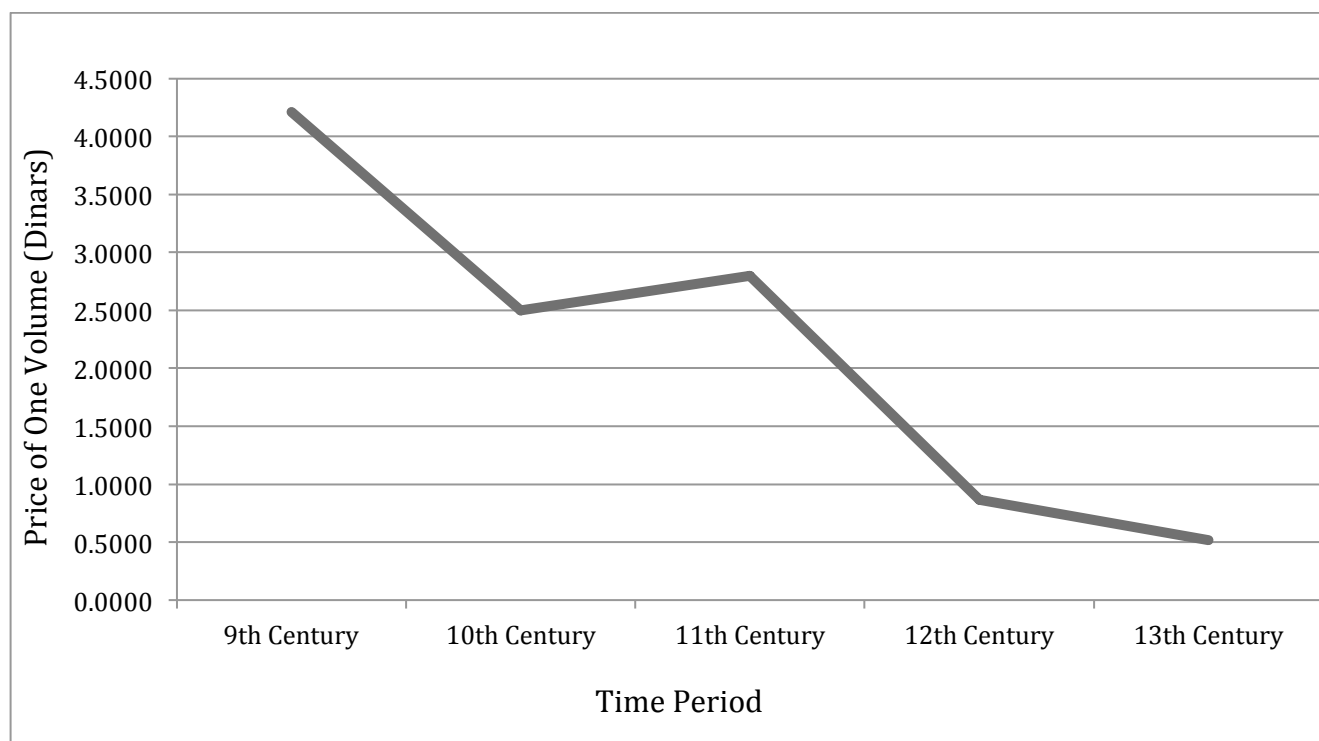


FIGURE 1
BOOK PRICES, EGYPT, 9th-13th CENTURIES
(in gold dinars)

Sources: See the online database, *Measuring the Medieval Islamic Economy*.

By converting the average price of book volumes for each century from the 9th to the 13th to daily wages of unskilled labor, it is possible to calculate the number of days' earnings a laborer should spend to purchase a book volume. The results presented in Table 4 show that during the 9th century an unskilled worker had to work 130 days in order to purchase a book, while the same worker had only to work 15 days in the 12th century and only 8 days in the 13th century. The decline in the ratio of book prices to wages was not the result of a rise in wages since wages in Egypt also declined during the period under consideration as population levels began to recover, and wages reaching their lowest point in the mid-13th century.²⁹ Rather the reason may be found in the decline of the price of paper and the commercialization of textile manufacturing and distribution.

AGRARIAN CHANGE AND COMMERCIALIZATION

Chinese paper was made of assorted materials: hemp, mulberry tree bark, raw fibers, pulp of bamboo and rosewood, as well as some rags.³⁰ This blend was typical to all pre-Islamic paper found in various locations throughout China, Korea, India, Central Asia, in the Buddhist texts of the Dunhuang caves on the Silk Roads, and the Soghdian merchants' letters from Samarqand. In contrast, Islamic

²⁹ Pamuk and Shatzmiller, "Plagues," pp. 204–8 and Figure 3.

³⁰ Bloom, *Paper*, pp. 29–45.

paper was made solely of flax and linen rags from its conception in the 9th century.³¹ By this time the two major Islamic textile industries, cotton and linen, had come into existence, and as they expanded made paper's raw material inexpensive and widely available. While cotton never played a significant role in Islamic papermaking, cotton cultivation and trade were equally significant for the rise of the textile industry and thus provide further insight into the story of the adoption of paper.³²

The early shift from extensive cereal farming to cultivation of textile plants was the result of lack of demand for wheat and the decline in wheat prices in the aftermath of the Justinian plague. The initial demographic shock of the 6th century was further exacerbated in the Middle East in the 7th-8th centuries by a series of recurrences before and after the Islamic conquest.³³ The vanishing settlements of the Sawad in Iraq, the plains of the Tigris, densely settled in the Sasanid Persian period, were shown by archeological studies to be abandoned.³⁴ The area around Baghdad was only sparsely populated when conquered by the Muslims in 638, with only half of the villages and cities occupied. In Egypt, 12 out of the 16 cities occupied continuously between the 4th to the 7th centuries were either abandoned or had shown signs of decline by the 8th century.³⁵ The continued efforts of the incoming Muslim administration in Egypt to settle Arab tribes on the abandoned land told in the literary sources were unsuccessful.³⁶ While the government tried to redress the shortage of labor by returning fugitives to their villages and by forcing land tenure on them, depopulation was aggravated by plague recurrences in the 7th and 8th centuries. The end of wheat shipments to Constantinople also affected wheat prices in Egypt after the Islamic conquest.³⁷ The abundance of fertile land in Egypt, which usually follows a demographic decline, together with the low price paid for wheat and other cereals, provided a strong motivation to look for more profitable crops including flax. The empty beds of previous papyri cultivation were an additional incentive, strengthened by demand for fine clothing generated by rising incomes and income elasticity, and preferences for lucrative products.

TABLE 5
AVERAGE PRICES OF WHEAT, EGYPT AND IRAQ, 8th-12th CENTURIES
(Per kg, in gold dinars)

Time Period	Egypt	Iraq
8 th Century	0.0021	0.0009
9 th Century	0.0036	0.0029
10 th Century	0.0082	0.0103
11 th Century	0.0143	0.0079
12 th Century	0.0143	0.0083

Sources: See Pamuk and Shatzmiller, "Plagues."

³¹ Bloom, *Paper*, pp. 8–11. Bloom also suggests that central Asian papermakers were the first to perfect paper manufacturing entirely from rags but probably after the coming of Islam, so it could not have been the inspiration.

³² Bloom, *Paper*, p. 56.

³³ Pamuk and Shatzmiller, "Plagues," p. 209. Bloom, *Paper*, p. 76, suggests the conversion from grain to flax.

³⁴ Adams, *Land Behind Baghdad*, pp. 97–102.

³⁵ Alston, "Urban Population in Late Roman Egypt," especially p. 169, Table 2.

³⁶ Frantz-Murphy, "Land-Tenure in Egypt"; Pamuk and Shatzmiller, "Plagues," p. 202.

³⁷ Teall, "The Grain Supply of the Byzantine Empire, 330–1025."

The movement of wheat prices in Egypt and Iraq supports this claim. Table 5 shows that wheat prices were at their lowest levels during the 8th-10th centuries but began to recover as the population recovered. Settlement policies adopted by the central administration in Arabia in favor of Iraq immediately after the conquest resulted in denser settlement there. As a result, more than 20% of Iraq's population, some 300,000, was living in the cities, increasing the demand for grains earlier than in Egypt.³⁸ Graph 2 illustrates the change: Wheat prices began to rise in Iraq beginning in the 10th century and in Egypt by the 11th. Decline in settlement in the rural areas adjacent to the capital Baghdad in the 9th century added to the cost of wheat transportation in Iraq, contributing to an earlier rise in wheat prices. The practice of collecting wheat in lieu of cash taxes also contributed to higher prices.³⁹

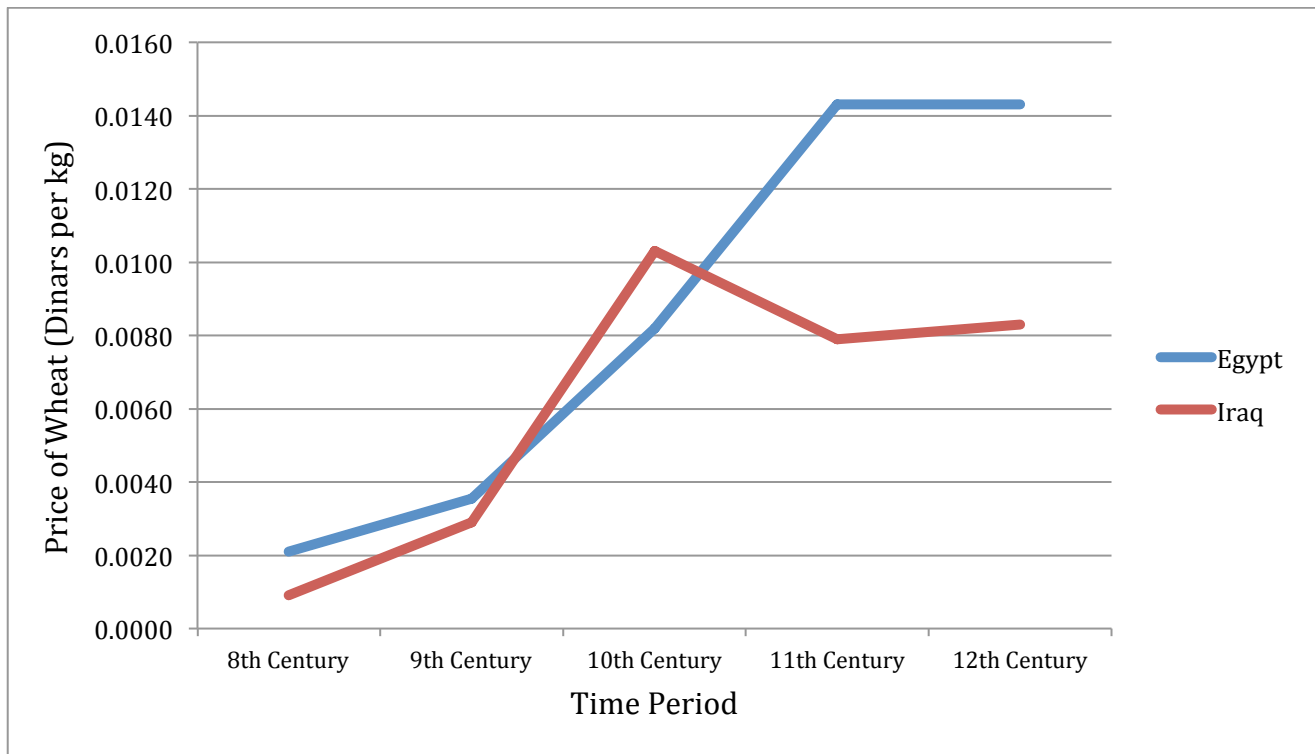


FIGURE 2
AVERAGE PRICES OF WHEAT, EGYPT AND IRAQ, 8th-12th CENTURIES
(Per kg, in gold dinars)

Sources: See Pamuk and Shatzmiller, “Plagues.”

Both the cotton and the flax cultivation patterns and industries were investigated, though without linking them directly to either wheat prices or to the effect of the Plague. Richard W. Bulliet studied

³⁸ Bosker, Buringh, and Van Zanden, “From Baghdad to London.”

³⁹ Adams rightly draws attention to the fact that taxes were paid in cereals, wheat and barley, adding transportation costs to the price of grains, and requiring an efficient transportation system. If taxes were collected in cash it would have lowered the price of wheat in the market at harvest times, when farmers sold wheat in mass to raise cash.

cotton cultivation in Iran,⁴⁰ and Gladys Frantz-Murphy studied flax cultivation in Egypt.⁴¹ Both linked the new crops to changes in the composition of the land-holding class in their respective regions of the Middle East. In the case of Iran/Iraq there was a new brand of Persian/Muslim landowner/entrepreneur and merchant/religious scholar who opted for cotton cultivation rather than grains: “The estimable theologian or mystic whose great-grandfather converted to Islam because he could better support his family by growing cotton for an Arab landlord than by harvesting wheat for a Zoroastrian village chief.”⁴² Frantz-Murphy suggested the existence of a new class of landowner/tax collector under the Tūlūnid administration, who invested in the new crop the tax money collected in the rural areas of Egypt rather than sending it to Baghdad.⁴³

TABLE 6
AVERAGE PRICE OF FLAX, EGYPT, 11th CENTURY
(In gold dinars)

Region	Dinars per kg	Dinars per ton
Alexandria	0.1742	174.2165
Busir		
(Low)	0.0551	55.1156
(High)	0.0992	99.2081
Cairo		
(Low)	0.0992	99.2081
(High)	0.1543	154.3237

Sources: See the online database, *Measuring the Medieval Islamic Economy*.

By the 9th century, cotton was commercially grown in Iran/Iraq. It may have grown in limited quantities before the arrival of the Muslims, but was now stimulated by growing demand for cottons in the cities.⁴⁴ Cotton manufacturing was centered in Baghdad, where individuals, some with religious background, undertook the commercialization and trade of the products.⁴⁵ In both Iran’s Nishapur and in Baghdad, occupational trade names related to cotton cultivation, manufacturing and trade accounted for 35-42 percent of all occupations.⁴⁶ New irrigation technology, the *qanat*, vertical shafts for tapping underground water, was adopted with improved productivity.⁴⁷

⁴⁰ Bulliet, *Cotton, Climate, and Camels*. Maurice Lombard suggested the reverse, namely, that the appearance of paper launched a growing demand for fibers and tissues: Lombard, *Les textiles dans le monde musulman VII^e-XII^e siècle*, pp. 202–5.

⁴¹ Frantz, *Saving and Investment in Medieval Egypt*; Frantz-Murphy, “A New Interpretation of the Economic History of Medieval Egypt”; Mayerson, “The Role of Flax in Roman and Fatimid Egypt.”

⁴² Bulliet, *Cotton*, p. 5.

⁴³ Al-Ali, “A New Version of Ibn al-Mutarrif’s List of Revenues,” suggests that the high amount may have been an estimate and not taxes actually collected.

⁴⁴ Watson mentions “old world cotton” as one of the new crops introduced into the Middle East, which was rejected by Bulliet. Bulliet, *Islam: The View From the Edge*, pp. 67–79.

⁴⁵ Cohen, “The Economic Background.” For the Arabic terms of textile occupations, including those of cotton clothes makers: Shatzmiller, *Labor*, pp. 118–24. For analysis of the findings: Shatzmiller, *Labor*, pp. 240–50.

⁴⁶ Bulliet, *Cotton*, pp. 4–5.

⁴⁷ Al-Karagi, *La civilization des eaux cachées*.

Flax was largely commercialized in Egypt by the 10th century when the Fātimids arrived. The center of flax cultivation was in Būsīr, central Egypt, where it was grown, harvested and bundled, then transported to Cairo and Alexandria, mostly over the Nile. From Alexandria it was shipped to markets across the Middle East, North Africa and Sicily.⁴⁸ The *Genizah* documents detailing the flax and linen trade provide the price data used here to arrive at average prices in Egypt during the 11th-13th centuries. Understandably, the lowest price for flax was paid in Būsīr, the moderate one in Cairo, and the highest in Alexandria, with transportation costs, agents' fees, fluctuations in labor supply, and weather conditions accounting for the differences.⁴⁹

When the average flax prices presented in Table 6 are compared to wheat prices in Table 4 it is possible to see why farmers in Egypt did not move back to wheat cultivation when wheat prices began to rise. Even at their peak wheat prices remained lower than the average price of flax: The average price of a kilogram of wheat during the 11th century (its historical high) was 0.0467 dinars, while the price of a kilogram of flax, even in Būsīr where it was at its lowest, was 0.0551 dinars. Flax offered consistently better returns for all those involved in the industry, farmers and merchants alike. The supply of flax for linen cloth continued apace and with it continued the supply of linen rags for papermaking.

The rich price data provided by the *Genizah* documents makes it possible to compare the prices of books to that of clothing. Two price lists of *Genizah* clothing items were used for this purpose, one of simple wardrobe items for men and women collected by Ashtor,⁵⁰ and another of mostly elegant apparel for women collected by Stillman.⁵¹

The results are displayed in Table 7. The average prices of different items of clothing in the 11th-13th centuries in Egypt ranged between 1/3 dinar for an inexpensive item to 15 dinars for a luxurious, high quality garment. Prices were determined by the quality of the cloth, raw material, the pigments and dyes used to stain it, the amount of work invested in it, embroidery or gilding, or the elaborate decorations on the borders. The price of the two most common items, “*thawb*” and “*jukaniyya*,” a staple outfit for men and women, could fluctuate between 1 to 6.2037 dinars according to quality. When compared, the average prices of clothing items presented in Table 7 appear to have been lower than those of books in Table 4. By the 11th century, when the average price of a book had declined to 2.7989 dinars, it was lower than most elegant garments. By the 12th century, after the price of books declined further, the average book price of 0.8653 dinars was below the average prices of simple inexpensive textile items in Egypt. By the 13th century, when the average book price reached the lowest level of 0.5153 dinars, even consumers who could afford only the most basic clothing items could still afford to purchase a book.

⁴⁸ Stillman, “The Eleventh Century Merchant House of Ibn ‘Awkal”; Gil, “The Flax,” pp. 224–9. The *Genizah* data reflected in most cases prices of flax sold in Tunis, Mahdiyya, Qairawan, Sicily and elsewhere, namely the price of the exported item.

⁴⁹ Gil, “The Flax.”

⁵⁰ Ashtor, *Prix et salaires*, p. 173.

⁵¹ Stillman, *Female Attire in Medieval Egypt*.

TABLE 7
AVERAGE PRICES OF CLOTHING ITEMS, EGYPT, 11th-13th CENTURIES
(In gold dinars)

Item (Ashtor)	Price	Item (Stillman)	Price
Simple <i>thaub</i> (cloth)	1-2	<i>Thawb</i>	6.2037
Elegant <i>thaub</i> (cloth)	3-4	<i>Jukāniyya</i>	3.3750
Simple <i>ghilāla</i> (cloth)	1 1/2	<i>Mindil</i>	3.0446
Elegant <i>ghilāla</i> (cloth)	4	<i>Mukallaf</i>	2.7222
Simple <i>jukāniya</i> (cloth)	1/2	<i>Niqab</i>	1.2500
Elegant <i>jukāniya</i> (cloth)	1-3	<i>Radda</i>	2.1857
Simple <i>mindil</i> (scarf)	1/3-1/2		
Elegant <i>mindil</i> (scarf)	1-2		
Simple <i>wasat</i> (waist wrap)	1-1 1/2		
Elegant <i>wasat</i> (waist wrap)	2 1/2-3		
Simple <i>mal'a</i> (outer wrap)	1		
Elegant <i>mal'a</i> (outer wrap)	3-4		
Simple <i>milhafa</i> (coat)	1		
Elegant <i>milhafa</i> (coat)	2-3		
Simple <i>ridā</i> (cloak)	1		
Elegant <i>ridā</i> (cloak)	3		
<i>Makhtūma</i> (dress)	5 at least		
<i>Khil'a</i> (robe of honour)	10-15		
Turban	2-3		
Elegant mi'jar (headcover)	2-3		
Simple skullcap	1		
Elegant skullcap	2		
Head cover	1		

Sources: See the online database, *Measuring the Medieval Islamic Economy*; Stillman, *Female*.

The commercialization of the textile industry in the 11th century was linked to other developments that affected the use of paper and books.⁵² Egypt's flax was traded over new commercial arteries, North Africa and Sicily, and was accompanied by a constant stream of paper documents, whose impact on increased efficiency in trade is discussed below.⁵³ Paper and technical manuals were responsible for an increase in division of labor and rising labor productivity in textile manufacturing, also to be discussed below. Women's labor in the textile industry equally played a role in the growing demand for income elasticity items. The expansion of the textile industry offered employment opportunities for women and the wages they earned increased household income. Women exercised a monopoly over spinning of threads: wool, cotton, flax, silk, and over the manufacturing techniques of some of the fancy clothing

⁵² Commercialization in the Medieval Middle East, including that of textile production, still awaits a monograph and quantitative treatment. Studies based on the Geniza documents provide a starting point. See Goldberg, *Trade and Institutions*. Compare to: Brittnel and Campbell, eds., *A Commercializing Economy*.

⁵³ Goitein, *Mediterranean Society*; Gil, "The Flax Trade."

items, like silk dyeing and sewing.⁵⁴ An output system allowed female spinners and seamstresses to work from home while brokers distributed raw material, collected finished items and disbursed payment. The prevalence of women's participation in the labor market resulted in several developments: accumulation of property and income in women's hands, including the pricey items referred to in the bridal trousseaus, reinforced norms of respect for women's rights over property and income, which led to their formal codification in the Islamic law.⁵⁵ The commercialization of the textile industry may have been also the reason behind lower fertility rates in the medieval Middle East through the protection of women's wages and the property it generated.⁵⁶

TECHNOLOGY

The spread of flax cultivation in Egypt and the commercialization of the textile industry were influential but not the only factor behind the decline in the price of paper and books. Changes in technology, especially the use of a cheap source of energy, water and paper mills in rag processing, were equally a key factor.⁵⁷ Paper mills were reported as early as the 8th century in Baghdad (794) and in Samarra (836), where the Caliph al-Mu'tasim built a mill operated by Egyptians for processing papyri. Paper mills were reported for Syria in the 9th century.⁵⁸ By the 10th century, paper mills, whether sitting or floating, were reported for almost every city with a river running through it, including Baghdad, Damascus, Fustāt, Tiberias, Jativa, Tripoli, and Fez.⁵⁹ Paper mills were located in Fustāt together with a paper factory, *matbakh*.⁶⁰ In spite of the confidence of historians of Roman and Islamic technology that trip hammers were used, no source, archeological or textual, has been provided to support it.⁶¹ Bloom suggests that the spread of Chinese style rice dishes in the Middle East implies the existence of Chinese style trip hammer technology used for pounding rice, which was also used for pounding flax for paper.⁶² The question is significant since the water soaked rags were heavy, difficult to haul, raise and beat into a pulp, with several rounds of beating required before the pulp was ready to use. The job commanded strength and endurance and therefore was frequently done by prisoners. Support for the existence of water related technology including trip hammers might be derived from the 9th century technical manuals, many of which were devoted to water clocks and water machines.⁶³ The written papermaking manuals, which began in the 10th century, also contributed to the dissemination of technology at no extra cost across the Islamic lands. Paper became inexpensive because it could be manufactured wherever rags, technical knowledge and water were available. Labor costs exercised a more complex effect: When and where high wages were present it contributed to growing demand for

⁵⁴ Compare: Muldrew, "Th'ancient Distaff" and "Whirling Spindle."

⁵⁵ Shatzmiller, *Her day in Court*. Shatzmiller, *Labor*, pp. 347–68.

⁵⁶ Shatzmiller, forthcoming.

⁵⁷ Bloom, *Paper*, p. 45: "The chief contribution papermakers working under Arab rule was the perfection of rag paper through improved techniques for beating the fibers and by preparing the surface for writing by sizing it with starch."

⁵⁸ Bloom, *Paper*, p. 57.

⁵⁹ Al-Hasan and Hill, *Islamic Technology*, pp. 192–7. Pedersen, *The Arabic Book*, pp. 64–6.

⁶⁰ Goitein, *Mediterranean Society*, p. 81, note 2, p. 410.

⁶¹ Wilson, "Machines, Power and the Ancient Economy," and private communication.

⁶² Bloom, *Paper*, pp. 55–6, referring to al-Birūnī.

⁶³ Watson, *Agricultural Innovation*, pp. 77–136. Al-Hasan and Hill, *Islamic Technology*.

paper and books, and when and where wages were low, as when demographic recovery occurred, cheap labor led to lower costs.

The papyri industry offered no resistance. It began its decline even before the adoption of paper, ceding its place to parchment. When demand for writing material increased in the post-Justinian period, the papyri industry had no potential for growth. Cultivation of the plant was limited to Egypt, affected by a high or low Nile, seasonal fluctuations in labor supply, high transportation costs, price controls, speculation and the presence of monopolies.⁶⁴ It was not suitable for the new codex format in which books were made. Papyri sheets were brittle, damaged by creasing and frayed easily at the unprotected edges. As for parchment, it was resource devouring wherever it was used as writing material. The two European Bibles transcribed in Tours between 800 and 850 used 420-450 leaves of parchment.⁶⁵ The Islamic Qur'an copied in 870 AD in 30 volumes required skins of 300 sheep. In contrast, a hundred years later, in 995, paper was offered free of charge to the poor who wanted to make notes while visiting the library in Mosul,⁶⁶ and all Qur'ans were written on paper from 993 onwards.⁶⁷ A catalog of scripts, papers of various manufacturing styles, as well as books according to regions was compiled by Ibn al-Nadīm, a 10th century bibliographer.⁶⁸ Jews switched to paper in their writings except for Torah scrolls for which they continued to use Islamic made parchment.⁶⁹ The longtime consumers of Egyptian papyri, Armenia and Byzantium, switched to paper by the 10th century. Armenian early paper, 960 AD, was made of cotton fiber rags. In Byzantium, first raw cotton fiber was used, replaced by imports of Islamic paper and then by local manufacture.⁷⁰ When the introductory period came to an end, Islamic paper, unlike its predecessor, the Chinese paper, was manufactured cheaply all over the Islamic Middle East, changing literacy and human capital and with it standards of economic performance.⁷¹

LITERACY AND HUMAN CAPITAL

The link between paper, books, literacy and human capital, does not require convincing, but suggesting the existence of a literate workforce in the medieval period does. The discovery that an unskilled urban worker in 13th century Egypt could afford to purchase a book with his daily wages if he so desired without much sacrifice may appear exaggerated for medieval societies where expectations of literacy among the working population was low. In pre-modern societies, literacy rates hovered between 5-10% for antiquity⁷² and 10% in 16th century England.⁷³ The evidence provided below in support of literacy in the medieval Middle East, while indirect, is substantial enough to suggest that literacy rates were at least as high and probably higher.

⁶⁴ Stillman, "A Case of Labor Problems in Medieval Egypt."

⁶⁵ Blum and Dudley, "Standardized Latin," p. 224.

⁶⁶ Grohmann, *Libraries and Bibliophiles in the Islamic East*.

⁶⁷ Déroche, *The Abbasid Tradition: Qur'ans of the 8th to the 10th Centuries AD*.

⁶⁸ Dodge, ed. and tr., *The Fihrist of al-Nadim*.

⁶⁹ Haran, "Bible Scrolls in Eastern and Western Jewish Communities from Qumran to the High Middle Ages."

⁷⁰ *Islamic Codicology*, p. 51. Bloom, *Paper*, p. 56.

⁷¹ On Chinese paper and human capital: Schafer, *The Golden Peaches of Samarkand*, pp. 269–77; Bloom, *Paper*, pp. 38–42; Xu, "The Production and Circulation of Manuscripts and Printed Books."

⁷² Harris, *Ancient Literacy*.

⁷³ Reis, "Economic Growth," p. 201.

Literacy rates in medieval Islamic societies remain elusive, beginning with no evidence of schooling without primary schools attendance records or sufficient evidence on educational institutions. On the other hand there are numerous manuscript illuminations showing children attending school and practicing writing on tablets made of pottery or wood.⁷⁴ Primary school teachers used written instruction manuals for teaching, and queries about teaching the young were submitted to legal scholars and collected.⁷⁵ The work of schools and teachers was enhanced by new libraries in the cities, where borrowing privileges were extended, and booksellers, both fixed and itinerant, offered new volumes in book markets. The catalogs of public or semi-public libraries and estate inventories of private libraries indicate that, beginning in the 9th century, books were commonly used and highly valued.⁷⁶ High urbanization rates also suggest higher literacy rates. Cities offered not only easy access to multiple educational institutions, but also employment opportunities for the literate.⁷⁷ New higher education institutions, the *madrasas*, appeared in the 11th century and spread to every Islamic region in the Middle East and beyond.⁷⁸ Evidence of the premium placed on literacy is everywhere. Beginning in the 8th century, demand for literacy and literary skills was manifested by the administrative tasks required by the Abbasid court and Abbasid society, where secretaries, grammarians, astrologers, translators, and private tutors garnered high wages. Education was sought after for employment and self-improvement, as investment made for future returns in terms of income, social status and social climbing. As the economy became more complex, especially with the expansion of commercialization and transactions becoming more sophisticated, literacy and numeracy were in demand. In a society gearing for trade, merchants, financiers, and contractors, bureaucrats and professionals were expected to acquire a more powerful “transaction technology.”⁷⁹ Literacy, numeracy and mathematical skills brought rewards. The growing use of documents in the courts meant that judges and notaries were required to calculate shares of the respective heirs in Islamic and Jewish inheritance law, where estate division was complicated by the fixed number of heirs, each with a fixed percentage of the estate. Education was also sought after for personal gratification and amusement. Books became an item of standard consumption and autobiographies (an intellectual’s favorite pastime) a common literary genre.⁸⁰ Most importantly acquiring literacy became an affordable pursuit. With wages ranging between 2 to 3 times the subsistence minimum, literacy could be considered a consumer good and parents found it possible to

⁷⁴ Hirschler, *The Written Word*, plates 2–8, as well as for suggestions on how primary education was provided, and on classroom scenes.

⁷⁵ Günther, “Advice for Teachers.”

⁷⁶ Osti, “Notes on a Private Library in Fourth/Tenth-Century Baghdad”; Eche, *Les bibliothèques arabes: publiques et semi-publiques*.

⁷⁷ Bosker, Buringh, and van Zanden, “From Baghdad to London: Unraveling Urban Development”; Ashtor, *Prix*, pp. 67–8.

⁷⁸ On the introduction of the madrasa: Shatzmiller, *The Berbers and the Islamic State*.

⁷⁹ Reis, “Economic Growth,” p. 216; Bloom, *Paper*, p. 116; Cohen, “The Economic Background”; Constable, “Muslim Merchants in Andalusian International Trade.”

⁸⁰ For autobiographies of the greatest minds of medieval Islam see Gutas, *Avicenna and the Aristotelian tradition*, and *Ibn Khaldun, Al-taʿrīf bi-Ibn Khaldūn*.

invest in education.⁸¹ With higher standards of living, more families were able to pay not only for education but also to forgo their child's earnings.⁸²

In addition to literacy, human capital formation was improved most significantly by the standardization of the Arabic language, which made it possible to efficiently store and diffuse practice based knowledge.⁸³

The Arabic language of the pre-paper stage, the one revealed in pre-Islamic and early Islamic graffiti and early mosques inscriptions,⁸⁴ in the administrative letters on papyri,⁸⁵ in copies of early Qur'ans on papyri and parchment,⁸⁶ is a dysfunctional written language. For instance, letters, which could not be connected by ligature appeared as spaces of the same length as spaces between words, making reading extremely difficult. The Qur'ans of the 8th and 9th centuries were written in multiple dialects in Hijāzi and Kufic defective scripts, inscribed in block angular letters. They were personal anthologies of verses meant for oral recitation, rather than a cohesive written text. By the second half of the 9th century, literary Arabic was going through the standardization of its grammar, syntax, vocabulary, with its literary usages academically defined.⁸⁷ By the 10th century, utilitarian cursive scripts were adopted for use in documents and in books written on paper.⁸⁸ Instead of block letters, a cursive script was adopted, improving legibility, leaving it to professional calligraphers to develop an elegant script for the Qur'ans. The Qur'anic text was no longer recited from memory but was written down in the new standardized language, with rules of reading, pronunciation, punctuation and intonation specified in written Qur'an reading manuals.⁸⁹ With standardization, the Arabic language moved from an oral stage to that of a 'writerly' one and moved with it the entire spectrum of Arabic and Islamic culture.⁹⁰

The process of language standardization was repeated in the Hebrew language spoken by the Jewish communities in the Middle East, where paper and books played a similar role in transforming literacy practices from oral to writerly.⁹¹ The first large corpus of written Hebrew and Judeo-Arabic texts dates from the first half of the 10th century in Iraq, Palestine and Egypt. With the use of written material in Hebrew script, oral transmission was no longer practical. The growing literary activity included the legal code, rabbinical and sectarian (*Karaite*) literature, rabbinical *responsa*, Bible commentaries, grammar, poetry, and esotericism. The oral Torah was replaced by the written Biblical

⁸¹ Pamuk and Shatzmiller, "Plagues, Wages, and Economic Change," pp. 198. Hirschler, *The Written Word*, pp. 82–123.

⁸² Reis, "Economic Growth"; De Vries, "Between Purchasing Power and the World of Goods"; Ogilvie, "Consumption, Social Capital, and the 'Industrious Revolution'"; Galor, *Unified Growth Theory*, Blum and Dudley, "Standardized Latin."

⁸³ Blum and Dudley, "Standardized Latin", pp. 216–7.

⁸⁴ On the pre-Islamic Arabic language as a tool in identity formation: Fisher, *Between Empires*.

⁸⁵ On the Arabic script on papyri: Papaconstantinou, ed., *The Multilingual Experience in Egypt*.

⁸⁶ On the early Qur'ans: Déroche, *Qur'ans of the Umayyads*; Déroche, *The Abbasid Tradition: Qur'ans of the 8th to the 10th centuries AD*; Déroche, "Les manuscrits arabes du III^e/IX^e siècle."

⁸⁷ On the standardization of the Arabic language: multiple authors, "Arabiyya". Bloom, *Paper*, pp. 100–8, and additional publications cited below.

⁸⁸ Bloom, *Paper*, pp. 106–8: "The development of the new broken cursive script went hand in hand with the adoption of paper and carbon-black ink."

⁸⁹ Bloom, *Paper*, p. 103. Déroche, *The Abbasid Tradition*, p. 94.

⁹⁰ On the 'writerly' culture: Toorawa, *Ibn Abī Tāhir Tayfūr and Arabic Writerly Culture*; Macdonald, ed., *The Development of Arabic as a Written Language*; Hirschler, *The Written Word*; Bloom, *Paper*, pp. 101–5.

⁹¹ Drory, *The Emergence of Jewish-Arabic Literary Contacts*.

text, the *masoret*, and oral transmission of rabbinical literature was weakened and externalized.⁹² As writing became a normal way of communication, and poetry was collected as written text, traditional didactic instruments like recitation were replaced by new fields such as grammar and linguistic investigation.⁹³

The transformation of the language, enhanced functional literacy, and accessibility to cheap paper and books coincided with the formation of new and complex knowledge clusters. Two such clusters dating to the early Islamic Middle East were the translations of the Greek sciences, both applied and theoretical, into Arabic,⁹⁴ and the codification of the Islamic law.⁹⁵ A third cluster of practical yet complex knowledge, with a direct impact on human capital formation and labour productivity, were the technical manuals, a written guide to the performance of a specific trade. The first technical manuals, known as *adāb al-kuttāb*, were written for those who practiced the writerly skills such as secretaries.⁹⁶ They offered a written guide complete with samples of one's duties in the government bureau. Others were written for administrators of justice and government policies, merchants and record keepers, teachers, and calligraphers.⁹⁷ 21 early written manuals for tax collectors and administrators survived.⁹⁸ Technical guides were written by and for market inspectors, brokers, notaries, physicians, pharmacists and druggists, astronomers, mathematicians, and navigators, displaying daily positions of the sun, moon and five naked-eye planets for a given year. By the 10th century, the genre was extended to include manuals for the manufacturing occupations.⁹⁹ Several technical manuals were written for each of minters and supervisors of the mint, including descriptions of tools and instruments, crucibles, vessels, fuels, chemicals and other ingredients, and their weights and measures.¹⁰⁰ Paper making manuals, bookbinding instructions, guides to soap making, including recipes and chemical components, proliferated. Manuals for ink making included recipes numbering between 18 and 11 for each visible, invisible and colored ink, of how to remove traces of ink, as well as leather soaking techniques.¹⁰¹ Cookbooks contained hundreds of recipes with various ingredients and spices.¹⁰² A technical manual for water carriers was written as a tool to help the water carrier memorize his verses together with technical aspects related to the pail and the rope.¹⁰³ The agricultural manuals for Iraq, Egypt, Yemen and Muslim Spain included agricultural calendars, cultivation methods, fertilizers, and timings for planting, harvesting and rotating crops.¹⁰⁴ A guide to *qanat* digging and irrigation technologies was written in 1017 AD.¹⁰⁵ Various alchemy procedures were detailed in the manuals for 'gold making' with instructions, quantities and

⁹² Drory, *The Emergence*, pp. 173–8, 184.

⁹³ Drory, *The Emergence*, pp. 34–5.

⁹⁴ Gutas, *Greek Thought, Arabic Culture*; Heck, *The Construction of Knowledge in Islamic Civilization*.

⁹⁵ Schacht, *An Introduction to Islamic Law*.

⁹⁶ Sourdel, "Le 'livre des secrétaires' de Abdallāh al-Baghdādī"; Bosworth, "Abū Abdallāh al-Khwārazmī on the Technical Terms of the Secretary's Art."

⁹⁷ Bloom, *Paper*, p. 106. Manuals for calligraphy were used in transforming writing into decorative art, as fine calligraphic script moved from Quran to documents.

⁹⁸ Shemesh, tr., *Abu Yusuf's Kitab al-Kharaj (Taxation in Islam)*, pp. 3–6.

⁹⁹ Shatzmiller, *Labor*; Shatzmiller, "Human Capital Formation."

¹⁰⁰ Ehrenkreutz, "Extracts from the Technical Manual on the Ayyūbid Mint in Cairo."

¹⁰¹ Zaki, "Early Arabic Bookmaking Techniques"; Gacek, "On the Making of Local Paper."

¹⁰² Arberry, "A Baghdad Cookery-Book."

¹⁰³ Mokri, "Un traité persan relatif à la corporation prolétaire des porteurs d'eau musulmans."

¹⁰⁴ Pellat, *Cinq calendriers égyptiens*; Varisco, *Medieval Agriculture and Islamic Science*.

¹⁰⁵ Al-Karaji, *La civilisation des eaux caches*; Stiros, "Accurate Measurements with Primitive Instruments."

operations.¹⁰⁶ Muslim apprentices were expected to use written technical manuals, follow written instructions and have some numeracy skills for handling credit and account books.¹⁰⁷

No claim is made here that all Muslim artisans were literate but that many were, given the large number of technical manuals. Furthermore, reading and writing on manufacturing techniques and using technical material in general improved the quality of the labour force and increased labor productivity. This is supported by a high degree of division of labor in the manufacturing sector as well as in the service sector.

A detailed analysis of division of labor using occupational classification methodology revealed the sophisticated quality of human capital in the major branches of the industrial trades.¹⁰⁸ Occupational classification in sectors of employment in the Middle East according to skills, based on a wide range of Arabic sources detailing labor organization, revealed an extensive division of labor with 418 ‘unique’ occupations during the period between the 8th-11th centuries. The service sector, which demanded a higher degree of literacy, provided 522 ‘unique’ occupations for the same period. The highest degree of division of labor occurred in the textile industry, followed by food processing and metal industries, the three branches that employed between them the majority of the labor force.¹⁰⁹ When compared to the number of clothing/fabric/shoe making occupations in preindustrial England,¹¹⁰ the Islamic manufacturing sector reveals a higher level of specialization and division of labor, with 166 different occupations in the textile branch compared to 90 occupations in England.¹¹¹ The degree of division of labor remained constant during the later Middle Ages. In the period between the 12th and the 15th centuries there were 398 ‘unique’ manufacturing occupations in the Arabic sources, while division of labor in the service sector increased to 883 unique occupations. Patterns of human capital formation must have persisted. In comparison, written instructions for the building trades do not appear before the 16th century in Europe.¹¹² In the case of the medieval Middle East the evidence cited confirms the link drawn in the literature between high wages, growing levels of income, demand for literacy and education, and rising literacy rates as leading to an improvement in human capital and rising productivity.¹¹³

PAPER DOCUMENTS AND CONTRACT ENFORCEMENT

Books played a role in the long-term preservation and transmission of complex public knowledge, while the use of paper documents storing private case pertinent information increased efficiency in trade and contract enforcement.¹¹⁴ The small number of archival documents so far discovered stands in

¹⁰⁶ Holmyard, *Kitāb al-ilm al-mukhtasab fī zira’āt adh-dhahab*.

¹⁰⁷ Shatzmiller, “Human Capital Formation in Medieval Islam”; Shatzmiller, “Artisans (pre-1500).”

¹⁰⁸ Shatzmiller, *Labor*, pp. 11–33, 169–323.

¹⁰⁹ Cipolla, *Before the Industrial Revolution*, pp. 76–8, on the structure of demand.

¹¹⁰ Clark, Cummins, and Smith, “Malthus, Wages, and Preindustrial Growth,” pp. 388–9.

¹¹¹ Unlike the list from England, the Islamic occupational list excluded makers of leather clothing items, since classification was based only on textile raw material. On the other hand, it included the sellers of the specified items as a separate occupation. Shatzmiller, *Labor*, 118–123.

¹¹² Prak, “Mega-structures of the Middle Ages.”

¹¹³ Reis, “Economic Growth,” p. 206.

¹¹⁴ Blum and Dudley, “Standardized Latin,” p. 222; Greif, “Contract Enforceability and Economic Institutions in Early Trade.”

contrast to the exhaustive number of book manuscripts, which survived.¹¹⁵ However, when documents survived, as is the case of the *Genizah* documents, they provide strong evidence of the crucial role they played. The *Genizah* collection is estimated at 350,000 documents housed worldwide, most of them dating between the 11th-13th centuries, written on paper,¹¹⁶ with many being private letters written by merchants.¹¹⁷

Almost every transaction made by Jewish traders left a paper trail in the *Genizah* and from the content it is easy to see why merchants took eagerly to writing. Profitable transactions hinged on efficiency in execution, on controlled flow of information, on buying and selling strategies, knowledge of commodities prices and financial instruments, all of which could be transmitted in an efficient manner thanks to paper. The availability of cheap paper, together with the skills needed to use it, literacy and writerly culture, ensured that the information would circulate in multiple copies, creating optimal conditions that the desired information would reach its destination in a timely manner. At one instance, thirteen copies of one letter were sent from Alexandria to Tunisia with five different boats.¹¹⁸ Multiple copies of letters also ensured that transaction records will survive and can be used in court in case of disagreement and conflict over the outcome. Given the size of the business community, the practice of the Jewish court in Fustāt displays unusual familiarity not only of persons but also of individual's handwriting. In several instances the court confirmed the identity of the writer based on his handwriting: "his handwriting was well known to the court," and litigants testified in court: "this is my hand writing."¹¹⁹ That private letters and documents became legal evidence is not in doubt: "Their letters are as important as their words," says the clerk when letters were presented in court and merchants confirmed statements of accounts.¹²⁰ The letters were used in court to establish the circumstances of a transaction, its financial details, and establish responsibility. The court then issued its decision in separate judgments written in documents and preserved among the other documents in the *Genizah*. Hundreds of such documents issued by the judges of Jewish court were published recently, documenting contract enforcement by formal institution applying written Jewish law.¹²¹

Paper documents were so conspicuous in litigation that litigants were suspected of writing them after the fact.¹²² Two brothers claim in the Jewish court that a man cannot prove his claim since he holds no deeds of purpose.¹²³ Muslim litigants and documents written in Arabic were treated on the same footing as documents in Hebrew by the Jewish courts. Documents of debt recognition could be

¹¹⁵ Kaplony, "The Interplay of Different Kinds of Commercial Documents."

¹¹⁶ Personal communication of Dr. Ben Outhwaite, director of the Taylor-Shechter collection in Cambridge. Dr. Outhwaite believes that the confusion about the size of the *Genizah* documents is due to the fact that everyone seems to count them differently (folios versus separate pieces, shelf marks versus folios, images versus pieces, etc.). The Cambridge collection holds probably two-thirds of the world's *Genizah* items, about 200,000 pieces.

¹¹⁷ On the merchants letters: Goldberg, *Trade and Institutions*. Goitein, *Mediterranean Society*. Greif, "Reputation and Coalition." Greif, "Contract Enforceability and Economic Institutions."

¹¹⁸ In another case one letter was sent in four copies from Alexandria to Tunisia. Goitein, *Mediterranean Society*, p. 162.

¹¹⁹ Gil, "The Jewish Merchants," p. 289: "Testimony of a witness who saw the plaintiff in possession of a statement of accounts or a letter written by him to a certain defendant, is valid."

¹²⁰ Gil, "The Jewish Merchants" p. 288: "The statements of accounts were deemed legally valid, as were the letters."

¹²¹ Ackerman-Lieberman, *A Partnership Culture: Jewish Economic and Social Life seen through the Legal Documents of the Cairo Genizah*. Contains the documents translated from the Judeo-Arabic into English.

Idem. "Commercial Forms and Legal Norms in the Jewish Community of Medieval Egypt."

¹²² Gil, "The Jewish Merchants," pp. 289–90.

¹²³ Gil, *Documents*, 127.

presented to the court in Arabic and accepted as proof of debt by an Arab to a Jew. When letters were written in Hebrew and addressed to Arabs they were read to them in court.¹²⁴ Finally, the merchants of 11th century Egypt, like the 18th century Europeans, marveled about writing being “a way of keeping up contacts, giving news of himself, receiving money, and announcing his return when he was away from home.”¹²⁵

The combination of paper documents, literacy and writerly culture facilitated contract enforcement by the court because the new paper instruments not only remained available as proof but because they contributed to greater efficiency in the conduct of trade. Payments were made using paper instruments, the *suftaja* and *ruq’a*, slips of paper bearing a brief written formula headed by the name of the man writing the promissory note.¹²⁶ The confirmation of the payment was also made using paper. Credit letters on paper were preferred to sending coins; the process was less risky and freed capital during the two-month period it took the letter to make its way. Paper documents were needed to release cargoes from the port.¹²⁷ Tax records, state records or the records of the Jewish charitable endowments were kept to secure the flow of income and enforce accountability.¹²⁸ The records of the Poorhouse, *Kodesh*, in Fustāt-Cairo, accountable to the Jewish community who supported them, issued records of taxes, guardians’ fees and bribes in detailed ledgers of wages, tools, and building material.

The tools of the trade also developed, especially the accounting techniques. Orderly banking accounts, ledgers, journals, accounts listing debits and credits, and double-entry bookkeeping records, were among the records left by the *Genizah* merchants.¹²⁹ The double-entry bookkeeping practice is of interest here because the practice was credited to Genoa, Florence and Venice.¹³⁰ Peragallo traced the origin of double-entry accounting to Roman practices even though it is not in evidence before the 14th century. Historians familiar with the *Genizah* records suggested rather that the European models were “precursors of more advanced ones used by bankers and merchants in countries which were trading partners of Egypt.”¹³¹ The delay in adopting them is not at odds with precedent. Europeans also took time to adopt the use of paper and Arabic numerals in accounting practices. Even though paper was known in Europe since the 11th century, the oldest Venetian ledger in existence, from 1417, is still written on sheepskin.¹³² By the same token the ledgers from Genoa, Florence and Venice show that Europeans continued to use the Latin alphabet until the end of the 15th century. Arabic numerals were introduced to Italy in the 12th century.¹³³

The flow of paper documents fundamentally changed the work of the courts. The shift from orality to writerly culture in the legal practice was not always recognized because of the insistence of law on oral eyewitnesses, but as Janet Wakin observed, “in the early Islamic world while doctrine may have neglected the written instrument, in practice it was indispensable.”¹³⁴ The codification of Islamic law

¹²⁴ Gil, “The Jewish Merchants,” pp. 300–3.

¹²⁵ Reis, “Economic Growth,” p. 209.

¹²⁶ Gil, “The Jewish Merchants.”

¹²⁷ Gil, “The Jewish Merchants,” pp. 301–6.

¹²⁸ Gil, “Maintenance, Building Operations, and Repairs”; Gil, *Documents of the Jewish Pious Foundations*.

¹²⁹ Goitein, “Bankers Accounts from the Eleventh Century A.D.”

¹³⁰ Peragallo, *Origin and Evolution of Double Entry Bookkeeping*.

¹³¹ Corgie, “Accounting Fragments Stored in the Old Cairo *Genizah*,” p. 29.

¹³² Peragallo, *Origin*, pp. 32–4.

¹³³ Arabic numerals were introduced in Florence in 1202. Peragallo, *Origin*, p. 22: “Some 133 years later, the superior numerical system had made little headway.”

¹³⁴ Wakin, *The Function of Documents*, p. 9.

during the 9th-10th centuries coincided with the standardization of the Arabic language and the move to writerly culture, replacing norms of behavior with a written code of law. By the 10th century manuals containing hundreds of contract formulas were available for the practicing notary.¹³⁵ The notarial manual reproduced legally correct prepared contracts for every transaction, from changes in personal status to economic matters, sales, purchases, rents and hires. All that was needed was inserting the names of the contracting parties. The easy access to contracts and the multiple copies of contracts which could be made, stored and easily retrieved when needed, facilitated the work of the court and made the process of going to court more efficient.¹³⁶ The public notary enjoyed an official status at the court and could testify to the content of the documents he provided. The courts, including the one run by the ruler, required that a written document accompanied any appeal and was submitted to the court in advance for any petition. The role of the witness has changed as a result, and witnesses became permanent ‘professional’ observers attached to the court, used when needed to witness the signing of documents. The mandatory use of documents in court changed the standards of proof law and made the process more efficient and quicker.¹³⁷

The combination of cheap paper, writerly culture and literacy helped usher commercialization and changed standards of contract enforcement.¹³⁸ The existence of multiple documents privileged efficient and organized information gathering and storage and facilitated centralized record-keeping functions by reducing transaction costs. The change enhanced predictability in commercial relations, forced the honoring of agreements, increased credibility in adjudication of disputes, and made litigants adhere to judgments. It reduced uncertainty and ensured contract enforcement in a timely and cost effective manner.

CONCLUSION

This study traced the adoption of paper in the Middle East to a rise in demand for writing material in a society experiencing growth in income per capita. A rise in the standards of living, an outcome of economic change, created in the aftermath of an exogenous demographic shock, resulted in income elasticity and demand for luxury goods, such as fine clothing, fancy foods and writing material. Papyrus may have been in decline already at this point but the transformation of a technological innovation into a key economic factor could not have materialized without demand. Instead, a switch in cultivation patterns in favor of textiles, flax in particular, in itself a result of that early economic change, inadvertently led to considerable declines in the prices of rag papers and books. This made these goods into staple items of consumption in society. The spread of the new writing material was intrinsically critical to the scholarly activity in early medieval Iraq, the so-called ‘Golden Age’ of Islam, while it is less known for its effect on the economy. The standardization of the Arabic language, the shift from orality to writerly culture, and the increase in literacy rates which the use of paper helped initiate,

¹³⁵ On the Maliki notarial formularies in Spain: Shatzmiller, *Her Day in Court*. On the Hebrew contracts formularies: Rivlin, *Shitre Kehilat Alyucena (Bills and Contracts from Lucena)*.

¹³⁶ Blum and Dudley, “Standardized Latin,” p. 216.

¹³⁷ Compare with the West: Reis, “Economic Growth,” p. 208: “growth of the state and the gradual replacement of traditional norms by the written law, both of which raised the premium on this ‘transaction technology.’”

¹³⁸ Greif, “Reputation and Coalition in Medieval Trade”; Greif, “Contract Enforceability and Economic Institutions in Early Trade”; Greif, “Cultural Beliefs and the Organization of Society.”

resulted in growing labor productivity and efficiency in the conduct of trade and contract enforcement. However, the entire spectrum of ‘information technology,’ the increase in book production, the new ways knowledge was created, accumulated, stored and diffused, the increased functional literacy, could not have materialized in a society existing on subsistence level. Previous societies in the Middle East including Mesopotamia,¹³⁹ Rome,¹⁴⁰ Byzantium,¹⁴¹ probably enjoyed higher standards of living and income levels per capita than previously thought; yet no evidence has come forward to suggest a rise in literacy rates.

The evidence examined here did not suggest a role for institutions in this process. Neither religion nor religious institutions, such as the monasteries and scriptoria that played a role in the rise of functional literacy and book production in early medieval Europe, could be documented in this case. Legal and political institutions did not play a role, nor did the court’s bureaucracy initiate the process on its own. On the contrary, paper was as instrumental in the development of the religion and religious practices as it was in the development of the Islamic law. The Abbasid bureaucracies, whose *diwans*, administrative structures and units that were later imitated in every corner of the Islamic world, did not play a role in triggering it either. Nor did the Abbasid court, nor any other court for that matter, generate enough demand to drive the new product into cheap mass production. On the other hand, the Islamic institutions did not interfere with the process either. Islamic institutions did not prevent incentives for economic growth created by one economic change from flowing into the economy and generating subsequent ones. It may also confirm the centrality of economic change to innovation. As Joel Mokyr noted in his seminal work, *The Lever of Riches*, “Technological innovation will not occur in a society, which is malnourished, superstitious or extremely traditional with tight social constraints preventing it from being open to diversity and tolerance.”¹⁴² Islamic society acquired, during its first three hundred years in the Middle East, relaxed structures, an inherited ethnic mix, multiple languages and intellectual traditions and flexible political and economic institutions. It was a society open to diversity and tolerance, best suited to accommodate change.

¹³⁹ Földvári and van Leeuwen, “Comparing Per Capita Income in the Hellenistic World: The Case of Mesopotamia.”

¹⁴⁰ Scheidel and Friesen, “The Size of the Economy and the Distribution of Income in the Roman Empire”; Scheidel, “Real Wages in Early Economies: Evidence for Living Standards from 1800 BC to 1300 CE.”

¹⁴¹ Milanovic, “An Estimate of Average Income and Inequality in Byzantium Around the Year 1000.”

¹⁴² Mokyr, *The Lever*, p. 12.

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