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Panza, L;Li, Z;Song, Y

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The evolution of Ottoman–European market linkages, 1469–1914: Evidence from dynamic factor models*

Zhuo Li[‡], Laura Panza[‡], Yong Song^{‡†}

[‡]*The University of Melbourne*

Abstract

This paper exploits data on a set of traded goods to undertake the first comprehensive empirical analysis of market integration between the Ottoman Empire and Europe from 1469 to 1914. Computing dynamic factor models via Bayesian inference, we overcome such data constraints as missing observations and a small sample size. The results of this analysis suggest that there were persistent market linkages until the first half of the 19th century, followed by a decline in price convergence. We also find that the intensity of Ottoman–European conflict had a negative effect on integration, especially during the 1844–1914 period.

JEL Classification: C11, C32, F15, N75

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[†]Corresponding author. Department of Economics, FBE Building Level 4, University of Melbourne, Victoria 3010, Australia. E-mail: yong.song@unimelb.edu.au

1 Motivation

Economists have long debated the origin and evolution of commodity market integration as well as its implications for economic development. The reason for this debate is that measuring the extent to which global and regional markets are connected is crucial for understanding *market efficiency*—that is, how quickly price signals are transmitted across borders—and thus for assessing the effectiveness of market institutions designed to improve allocative efficiency. Despite the importance of this topic, little is known about long-run integration or about pre-19th-century integration.¹ This paper offers new insight on the subject by undertaking an analysis of commodity market integration between two key regions of the international economy, the Ottoman Empire and Europe, during the period 1469–1914.

The large body of literature on Ottoman–European economic relations views development in the economic history of these two regions as being deeply entwined and interdependent. Accounts in the standard historiography vein identify economic exchange as an important area of interaction between these two cultures—notwithstanding their political rivalries and recurrent military confrontations.

This conventional wisdom has been challenged by Bosker et al. (2012), who claim a *lack* of interdependence between Europe and the Islamic world (including the Ottoman Empire) as indicated by the lack of integration between Christian and Muslim cities from about 1000 to 1800. Using “urban potential” to identify integration, these authors find that the difference in religious denomination—between European and Middle Eastern cities—was a significant barrier to these regions’ economic integration (Bosker et al., 2012, p. 1419).² Although the notion of urban potential relates more to market access than to conventional measures of integration, Bosker et al. use their index of that potential in regressions designed to test for the existence of economic linkages between Europe and the Islamic world. They interpret the empirical results as evidence for a lack of significant interactions between the two areas (Bosker et al., 2012, p. 1427).

This alternative perspective on the evolution of Ottoman–European linkages runs counter to traditional historical accounts, which portray these regions as being linked by strong economic ties

¹See Federico (2012) for a comprehensive summary of the literature investigating how market integration evolved across locations.

²Bosker et al. (2012, p. 1423) define the *urban potential* of a predominantly Muslim (resp. Christian) city as the distance-weighted sum of the population of all other Muslim (resp. Christian) cities.

and significant commercial relations from the 15th century until the outbreak of World War I. We are thus led to raise the following questions. To what degree were Ottoman and European commodity markets influenced by each other's development? How strongly were their markets integrated? Did the two regions interact predominantly in the political and military sphere but not in the economic one? We answer these questions by testing for co-integration via Bayesian inference, thus providing a quantitative assessment of the strength of the links between European and Middle Eastern markets. In that sense, our paper speaks not only to the literatures on market integration and long-run economic development but also to studies (e.g., Shiue and Keller, 2007) that focus on the changing patterns in market performance before and after the first Industrial Revolution. Our major contribution is to offer empirical evidence on the patterns of long-run economic integration between Ottoman and European commodity markets; toward that end, we provide quantitative estimates regarding the nature of the linkages between these two regions.³

In particular, we use data on the consumer price index (CPI) and on a set of traded goods to investigate the dynamics of price transmissions between Istanbul and 19 European cities between 1469 and 1914. By rigorously estimating integration dynamics via the *longue durée* approach, we gain an in-depth understanding of the historical relationship between two key regions of the international economy and also derive insights concerning their long-run growth and development processes. We can make these advances in knowledge because, as intimated previously, market integration reflects the ability of institutions to allocate goods efficiently.⁴ Furthermore, the behavior of commodity markets is indicative of the extent to which European and Middle Eastern economies were linked and of those regions' market orientation; hence analyzing that behavior is crucial for understanding whether (or not) the economic rise of Europe occurred independently of this close

³The relationship between European and Ottoman prices has been previously studied by Pamuk (2001, 2004), but our paper is the first to provide a comprehensive empirical analysis of commodity market integration. Pamuk's seminal contributions stem primarily from his collection of Ottoman price data and construction of an Ottoman consumer price index (Pamuk, 2001, 2004). Those two papers also compare price trends in the Ottoman Empire with those in Europe by plotting CPI series; a similar approach is adopted by Özmucur and Pamuk (2007), who focus on real wages. Our analysis complements yet enhances the existing qualitative literature.

⁴Such institutions are viewed by many as a major contributor to incentives that eventually led to the Industrial Revolution (North, 1981; North and Thomas, 1973).

regional partner’s rise.⁵

After computing the degree of Ottoman–European market integration, we use our estimates in testing the extent to which military conflicts affected the transmission of commodity prices. The economic ties between the Ottoman and European worlds were recurrently severed by wars, so we assess whether such disruptive conflicts prevented the continuation of economic relations. This assessment facilitates interpreting some of our price pass-through estimates, as we find that conflict had a negative effect on market integration, especially in the second half of the 19th century—a period for which we find reduced co-movement of prices. In fact, it was during this time that the Empire was losing territory in its populous and economically advanced European possessions, which had the effect of increasing its distance from European cities.

When measuring commodity market integration, problems commonly arise if the data sets being processed range over a long time horizon and if observations across series are insufficiently overlapped or altogether missing. Our empirical strategy employs Bayesian inference to compute dynamic factor models and draws on Beveridge–Nelson decomposition (Beveridge and Nelson, 1981).⁶ In our setting, the long-run equilibrium between two series is captured by a stochastic trend, while each series is allowed to follow its own stationary process (and thus to embody individual dynamics). This method allows us to deal with two key challenges. First, missing data are not interpolated; they are instead treated, in accordance with Bayesian estimation, as parameters.⁷ Second, we do not assess the existence of market integration by testing the null of no co-integration against the alternative (as in, e.g., the Johansen co-integration test); rather, we compare models’ posterior probabilities to draw inference on three hypotheses: no, weak and strong market integration. This strategy yields results that are easier to interpret than those derived via standard co-integration approaches, which—despite their asymptotic validity—may generate conflicting outcomes when the null and alternative hypotheses are switched for small sample sizes.

⁵An enduring controversy in economic history is how much Europe’s breakthrough—as a dominant industrial economic power—depended on its relation with the rest of the world (Findlay and O’Rourke, 2007, pp. 330–31).

⁶Empirical analysis has seen the increasing adoption of Bayesian methods; see, for instance, Moral-Benito (2012) and Uebele (2011).

⁷Imputing missing observations by interpolation may seriously distort the behavior of the series, yet using only contiguous observations would result in the loss of useful information.

Our findings strongly suggest the existence of a long period of market integration between Europe and the Ottoman Empire, one that persisted from the late 16th century to the first half of the 19th century and that was followed by a weakening of the price transmission process. Finding support for integration is in line with most historiographical accounts, but it challenges Bosker et al.’s 2012 analysis of Islamic–European economic relations.⁸ That said, the decrease in price pass-through during the second half of the 19th century stands in contrast to extant qualitative studies. By providing plausible explanations for these results, we offer a new interpretation of how the market linkages evolved as a function of (i) changes in Ottoman comparative advantage during the first wave of globalization and (ii) the role of conflict—given that, during this period, the Empire was disintegrating both politically and economically. Yet we must also emphasize that, despite the Ottoman Empire’s fragmentation and weakened market integration with Europe, living standards for the Empire’s religious minorities (most notably, Christians and Jews) actually improved in these years. Exploiting advances made possible by the choice of law available to non-Muslim subjects, these minorities were allowed to conduct business outside the jurisdiction of the Islamic court system and hence to capitalize on their European commercial ties (Kuran, 2004).⁹

2 The development of Ottoman–European economic relations

How strong were the links between Ottoman and European markets? How did the extent of integration between them evolve and respond to the economic and political changes shaping more than 400 years of bilateral commercial relations? To answer these questions, we start by giving some background information about the evolution of those economic linkages that will help readers assess just how much commodity market integration was actually present. Thus we shall focus on the intensity, composition, and geographical spread of bilateral commercial relations as well as on the available evidence regarding price movements, which are key to understanding the process of price transmission. Note that the existence of trade between two countries is a necessary but not sufficient condition for their markets to be integrated. This distinction reflects that a change in one country’s trade volume, as might follow from shifts in import demand or export supply, could be

⁸Especially since, as shown in Section 5.3, peripheral European cities (i.e., Madrid and Krakow) exhibited a degree of integration with Europe’s core that was similar to that of Istanbul.

⁹Minorities advanced economically by adopting Western business methods, forming economic alliances with those in the West, and using Western courts to settle disputes.

driven by a wide variety of factors—such as an expanding land frontier and/or population growth—that need not be related to commodity market integration. So in order to compile robust evidence on market integration, we must look at changes in the dispersion of commodity prices between locations. That is, we must assess the degree of *price convergence*, which signals that trade-creating forces do indeed affect domestic commodity prices.¹⁰ In what follows, we discuss evidence from the literature on Ottoman–European price movements.

Exhaustive accounts of Middle Eastern and European history have documented the evolution of their economic linkages (see, among others, Braudel, 1995; Inalcik and Quataert, 1994; Langer, 1935; Pamuk, 1987). Those links were initially shaped by Ottoman political and military dominance beginning with the conquest of Istanbul in 1453, which gave the Empire an unparalleled strategic base from which to control the Black Sea and the Mediterranean. The navy of Mehmet the Conqueror was able to overturn Venice’s supremacy in the eastern Mediterranean at the end of the 15th century, thereby establishing Istanbul as one of the largest transit centers of the north–south trade artery between the Black Sea (and Danubian ports) and the main cities of the eastern Mediterranean, Arabia, and India (Cleveland, 2004, p. 40). The Empire’s presence on the Continent—via its territorial expansion into eastern Europe, which reached the doors of Vienna—and its control of the Balkans reduced the geographic distance between the two regions. These developments made the Empire’s capital of Istanbul a powerful economic, political, and cultural center; because of that city’s strategic location, it was also the principal Ottoman market competing with Europe.¹¹

The strength of commercial and economic relations between Europe and the Ottoman Empire varied throughout the centuries. Those relations were affected by the evolution (in terms of geographic location and distribution) of bilateral commercial networks, which mirrored the decline of the Mediterranean and the rise of the Atlantic as the fulcrum of global trade. A key turning point was the Treaty of Karlowitz (1699), as it marked the end of the Empire’s territorial expansion and the start of a decline in its political power. Its economic structure and trade patterns also

¹⁰Changes in commodity prices lead, in turn, to a redistribution of resources among economic activities.

See O’Rourke and Williamson (2002) for a detailed explanation of the role that prices play in measuring commodity market integration.

¹¹Inalcik and Quataert (1994, p. 182) document the competition, over grain supplies, between Venice and Istanbul.

underwent considerable changes: the Ottoman raw materials previously dedicated to internal consumption and industry were increasingly being exchanged for products manufactured in Europe.¹² Moreover, 19th-century technological advances due to the Industrial Revolution—which led, inter alia, to significantly expanded road, canal, and rail networks as well as to unprecedented reductions in bilateral transportation costs—had the effect of intensifying economic interactions. These interactions were coupled by variations over time in bilateral trade composition and patterns that reflected comparative advantage and specialisation. Thus the Ottoman Empire was transformed from a state of manufacturing self-sufficiency (at the beginning of our data period) to a net importer of manufactured goods and an exporter of raw materials (by the end of that period).

The lack of reliable statistics on trade flows between the Ottoman Empire and Europe precludes our developing a complete picture of their commercial exchange dynamics. However, available studies—most of a qualitative nature—document the development of substantial trade relations between the 15th century and the outbreak of World War I, thereby suggesting that interconnected markets did exist (see e.g. Barkan, 1975; Berov, 1974).¹³

The historical literature also offers insights on price movements between Europe and the Empire. Berov (1974) suggests that average Ottoman price levels, in terms of silver, were comparable to those in England, France, Italy, and the Netherlands. Barkan (1975) and Braudel (1995, pp. 517–42) argue that the wave of inflation transmitted from Europe to Ottoman territories during the 16th century, a result of the large monetary inflows from the New World, led also to considerably increased prices for basic commodities in the Empire. Thus a large proportion of goods (e.g., wheat and other grains, copper, wool) were diverted from the domestic to the European market, which naturally led to shortages and higher prices at home (Barkan, 1975).¹⁴ The increase in commercialization and

¹²At the same time, European merchants began to play a larger role in Ottoman commerce. Their penetration into the Ottoman economic sphere was sanctioned by a system of privileges established through a series of commercial treaties known as *capitulations*. The first such capitulation was negotiated with France and exempted French merchants from Ottoman taxes, which allowed them to import and export goods at low tariff rates while remaining under the legal jurisdiction of the French consul in Istanbul.

¹³Barkan (1975) writes extensively about the high level of interdependence between economic and political spheres in Europe and the Near East; he associates the Ottoman Empire’s decline with the disruption of its traditional trade routes in the Mediterranean and the concomitant rise of the Atlantic economy.

¹⁴See also Pamuk (2001).

monetization of the Ottoman realm, along with the inflation transmitted from Europe, are widely viewed as factors that contributed to the rise in average prices throughout the Empire. In addition, Pamuk (2001, p. 81) considers the high level of development in maritime transportation and the sophistication of commercial networks in the Mediterranean as signs of interconnection between Europe and the Empire.

Most of the available literature on economic relations between Europe and the Empire is necessarily of a descriptive or qualitative nature. We are aware of only two works, the papers of Pamuk (2004) and Özmucur and Pamuk (2007), that have compared the behavior of Ottoman and European prices. By plotting data on CPI and wages in Istanbul and various European locations, these authors provide suggestive evidence of long-run integration between the two regions. Yet both of these works acknowledge the need to extend this research by investigating the process of Ottoman–European integration in more depth and by providing a more comprehensive empirical analysis, thereby augmenting the predominantly qualitative discussion with quantitative evidence (Pamuk, 2004, p. 465). Such extensions would add more rigor to their analysis while improving our understanding of variations in the extent of Ottoman–European market integration. We undertake that task in this paper. Thus we draw on the co-integration literature to give the first empirical analysis of the dynamics of price transmission between Istanbul and various European cities—and of the variation observed over a period of around 450 years.

3 Data

We use two types of annual data: the CPI and the prices of a set of traded goods (i.e., wheat, rice, butter, olive oil, honey, soap, charcoal, wood, and chickpeas) for the years 1469 to 1914. Data for Ottoman Empire are from Pamuk’s (2000) extensive collection of Istanbul’s prices. The CPI for Istanbul, which Pamuk constructs using constant relative weights that reflect consumption patterns, includes both food and nonfood items (e.g., flour, rice, cooking oil, honey, mutton, chickpeas, olive oil, soap, wood, coal, nails).¹⁵ The data for the 19 European cities in our sample are from Allen

¹⁵Exact details on CPI construction and on the sources used are given by Pamuk (2000), who constructs Istanbul’s CPI by using archival evidence on the budgets of average urban consumers. In particular, the weight of food items is between 75% and 80%, and the commodity weights are based on each commodity’s share of the total expenditures reported in more than 6,000 account books of various *vakif* (pious foundations) and their kitchens.

(2001). European CPIs are constructed using similar baskets while allowing for differences in national consumption patterns; for example, wheat bread prices are used for Spain whereas rye bread prices are used for Poland. As in the Ottoman case, the CPIs include both food and nonfood items (bread, beans/peas, meat, butter/olive oil, cheese, eggs, beer/wine, soap, linen, candles, lamp oil, fuel).¹⁶ To facilitate comparisons, all data have been converted into grams of silver.

Our data set is the most comprehensive we could compile from available sources, but one must bear in mind that using yearly data has some limitations, due to the method of constructing annual data points, that have direct implications for the testing of market integration. In fact, annual data are not always based on the same number of monthly observations because the prices may not have been collected during the same month (or week)—deviations that reflect, for example, different harvest times. One downside of aggregating the data in this way is that it may yield imprecise estimates of the speed at which prices converge (as explained in Section 4.6 and discussed in Section 5.1). Although unable to check the original archival sources,¹⁷ we are confident that the data used in our analysis do not have unreasonably large standard deviations (see Table A1 in the Appendix).¹⁸ Finally, we remark that working with historical data raises the distinct possibility of measurement error. For all these reasons, our estimates may be less precise than those derived by studies that rely on modern data.

The price of goods is the most widespread unit of analysis in the market integration literature and is often used to test the so-called law of one price. For goods that are traded, observing price

¹⁶Allen (2001) constructs the European CPIs by examining many different sources of data on consumer budgets and by adjusting them for different cuisines and climates; that approach follows the lead of Brown and Hopkins (1956, 1981), Reher and Ballesteros (1993), Scholliers (1989), and Van der Wee (1978). For details, see Allen (2001, pp. 420–22).

¹⁷Pamuk (2000) takes the simple average of all available observations for a given year until 1860, after which monthly data are used. The pre-1860 data are from account books and price lists at the Ottoman archives in Istanbul. Pamuk also reports institutionally set prices (i.e., those in the Topkapi palace kitchen’s account books and the officially established price ceilings, the *narh*), but he gives greater weight to market prices—namely, the prices paid by soup kitchens and pious foundations. Allen’s (2001) data are compiled from a large set of different sources, each of which contained tables reporting annual averages.

¹⁸The empirical analysis is performed using the log transformation of the prices reported by Pamuk (2000) and Allen (2001).

trends or price differences between markets—and their evolution—enables inferences about the transmission of shocks across locations. When using the CPI, we are interested in testing for market integration in a broader sense; that is, we are testing for between-market convergence in overall price levels. The items included in the Ottoman and European CPIs are not identical, but they are certainly comparable and representative of an average income earner’s typical consumption basket.¹⁹ Furthermore, the vast majority of the goods used to construct these indices were traded (albeit irregularly in some cases) between the Ottoman Empire and Europe (Özmucur and Pamuk, 2007, p. 60). So even as using CPI data allows us to depict Ottoman–European economic linkages with broad strokes, we still focus on the behavior of specific markets when measuring the strength of the links involving key traded commodities. We view these two types of analysis as being complementary.

The data have been deposited in Open-ICPSR (2018) along with the Matlab code for estimation and inference.

4 Econometric Methodology

There is a rich literature on market integration in both historical and contemporary settings. The standard methods used to test for market integration include the simple computation of coefficients of variation, OLS regressions, and more advanced econometric techniques that focus on co-integration analysis.²⁰ The co-integration approach is often coupled with estimation of error correction models (ECMs) and the computation of half-lives.²¹ An alternative approach is founded on the study of price variation.²²

In this paper we focus on price co-movement and base our analysis on the computation of dy-

¹⁹That the European and Ottoman CPI components are not exact matches is confirmed by our results in this sense: it is *more* difficult to confirm our market integration hypothesis because the lack of convergence could be driven by that different basket composition and not by the absence of price transmission.

²⁰For example: Shiue and Keller (2007) test for market integration between China and western Europe before the Industrial Revolution; Keller and Shiue (2014) estimate the effect of the *Zollverein* (customs union) by examining the convergence of wheat prices across 40 German cities; and Özmucur and Pamuk (2007) study integration of the European commodity market between 1500 and 1800.

²¹See, for example, Brunt and Cannon (2014), Federico (2007), and Getnet et al. (2005).

²²See Uebele (2011) for an analysis of wheat market integration between European and US cities; for an investigation of grain market integration in the Baltic Sea region during the 19th century, see Andersson and Ljungberg (2015).

namic factor models within a state-space framework. More specifically, we propose a set of bivariate models to investigate the relationships between Istanbul and other European cities. This approach allows us to identify and isolate the interactions between any such city pair and is also parsimonious. As intimated in Sections 2 and 3, the analysis is based on measuring market integration in terms of price convergence.

Our framework incorporates three models. The first is the most general and represents no market integration. The second one is nested by the first one and referred to as weak market integration. The third one is nested by the second one and is labeled as strong market integration.

Prior to introducing the formal models, we establish some notation. There are two cities, $i = 1, 2$. The data correspond to the time span $t = 1, 2, \dots, T$. The log price in city i at time t is denoted by y_{it} , and y_{it}^* denotes missing observations.

4.1 *Univariate model*

We start by studying each series of log prices within a univariate framework. If two markets are not integrated then price changes across locations are not transmitted, from which it follows that there would not be any relationship between two time series of log prices.

Each city's log price series is partitioned into a stochastic trend, a stationary process, and a white noise. This subdivision is an application of the Beveridge–Nelson decomposition (Beveridge and Nelson, 1981). The stochastic trend represents the long-run expectation or a dynamic equilibrium state in a market.

The model can be written as the following system of equations:

$$y_{it} = \alpha_i + \beta_i f_{it} + \gamma_i g_{it} + e_{it}^y, \quad (1)$$

$$f_{it} = f_{i,t-1} + e_{it}^f, \quad (2)$$

$$g_{it} = \phi_i g_{i,t-1} + e_{it}^g \quad (3)$$

for $i = 1, 2$ with $e_{it}^y \sim N(0, \sigma_i^2)$. For identification purpose we assume that the error term $e_{it}^f \sim N(0, 1)$ and $e_{it}^g \sim N(0, 1)$ have standard normal distributions and that $\beta_i > 0$ and $\gamma_i > 0$. All errors $(e_{it}^y, e_{it}^f, e_{it}^g)$ are independent.

The intercept α_i incorporates transaction costs. The stochastic trend f_{it} is the dynamic factor with a constant loading β_i and follows a random walk process. The g_{it} is a stationary AR(1) process

with coefficient $\phi_i \in (0, 1)$ and loading γ_i . That process represents city-specific fluctuations related to business cycles or other short-run price changes around the long-run trend $\beta_i f_{it}$. The white noise error term e_{it}^y is associated with the measurement error or other high-frequency transitory shocks.

Our univariate model treats each city separately. If two markets are not integrated, then they do not have a common f_t or β_i : their log price dynamics are thus in line with the univariate model's prediction.

4.2 *Weak Model*

The weak model assumes that two time series in the previous univariate model share the same stochastic trend f_t but have different loading coefficients β_i . This approach is commonly used in the market integration literature featuring co-integration analysis (see e.g. Brunt and Cannon, 2014; Getnet et al., 2005). The common stochastic trend reflects the long-run relationship between prices and can be interpreted as a dynamic equilibrium; that interpretation is illustrated as follows:

$$y_{it} = \alpha_i + \beta_i f_t + \gamma_i g_{it} + e_{it}^y, \quad (4)$$

$$f_t = f_{t-1} + e_t^f, \quad (5)$$

$$g_{it} = \phi_i g_{i,t-1} + e_{it}^g. \quad (6)$$

With the exception of f_t , this *weak* model of market integration is equivalent to the univariate one. The only difference is that the weak model restricts $f_{1t} = f_{2t}$ in the univariate model. It is consistent with an error correction model because it preserves the long-run relationship between two dependent variables.

If the data support the weak model against the univariate model, then the two markets share the same stochastic trend and preserve a long-run dynamic equilibrium (as in an ECM). However, that equilibrium need not conform to the law of one price, because the prices may still diverge as $\beta_1 \neq \beta_2$ in general. The left panel of Figure A1 plots two simulated series from a weak model for a case in which it would be inappropriate to conclude that the two markets are integrated.²³

²³ When using levels instead of log price data, a divergence between two series may be interpreted as a change in transaction costs. However, if in the presence of a long time series as in our case, using levels is not appropriate due to both the likelihood of finding heteroskedasticity and to the fact that the price dynamics may not fit into any simple linear framework. Hence, unless the time series are short, using log price data

4.3 *Strong Model*

We now propose a strong model to represent the market integration hypothesis, under which two cities share not only the same stochastic trend but also the same loading coefficient. It is our preferred representation of market integration, which is embodied by price convergence and consistent with the prediction of the law of one price. The strong model is structurally nested in the weak model because we set the stochastic trend loadings β_i to be equal between two cities.

The strong model is written as follows:

$$y_{it} = \alpha_i + \beta f_t + \gamma_i g_{it} + e_{it}^y, \quad (7)$$

$$f_t = f_{t-1} + e_t^f, \quad (8)$$

$$g_{it} = \phi_i g_{i,t-1} + e_{it}^g \quad (9)$$

for $i = 1, 2$. Except for β , this model is equivalent to the weak model. The absolute value of the intercepts' difference, $|\alpha_1 - \alpha_2|$, represents trading costs. Therefore, as in the right panel of Figure A1, a strong model predicts that two log prices are parallel curves that allow for temporal deviations and noise. For the strong model to hold, any deviations originating in individual cities (i.e., g_{it} or e_{it}^y) would adjust back to zero.²⁴

4.4 *Bayesian Estimation*

The empirical estimation is based on the Bayesian method, which has several advantages for this paper. First of all, there are missing observations from each price series.²⁵ Rather than following the conventional method of simply interpolating those values, we treat them as probability distributions—in the same way that we model the parameters. This method, called “data augmentation” (Tanner and Wong, 1987), accounts for imputation uncertainty because the missing

is preferable.

²⁴Özmucur and Pamuk (2007) apply the same idea to a restricted ECM by requiring that the slope coefficient be equal to 1. Since these authors use price level data instead of log price data, their approach cannot be used to capture proportional transaction costs.

²⁵ In the original datasets by Pamuk (2000) and Allen (2001) the share of missing observations ranges between 0.22 per cent (CPI in Antwerp) and 91.14 per cent (rice in Krakow). In our estimation we use only the series with a maximum of 60 per cent missing values.

variables are randomly drawn from their posterior distribution.²⁶ Once we obtain a large number of random draws for the parameter space, the uncertainty related to the missing values can be integrated out numerically.

The second problematic aspect of our data set is that the number of overlapping observations across series is often not large, thereby exposing the empirical estimation to the small-sample problem—which is often encountered when using historical data.²⁷ Such problems become especially relevant when the full sample is divided into sub-periods for the purpose of analysing how market integration changes over time. Since small-sample properties are exact in the Bayesian framework, it follows that this type of estimation is preferable in our setting. For the empirical estimation, we use only those series for which a maximum of 60% of the focal two cities’ values do *not* overlap. The proportion of non-overlapping observations is calculated for each commodity during each computational period.²⁸

It is also worth noting that, we treat all models as having an equal likelihood of being true a priori—that is, we do not test a null hypothesis versus the alternative. As a result, each of the three models’ respective posterior probabilities reflects the data evidence for (or against) market integration. We estimate the models using Markov chain Monte Carlo techniques, as detailed in the Appendix.

4.5 *Measurement of Market Integration*

We report the posterior probabilities of models as a coherent measure of market integration. For each pair of cities—among which Istanbul is always included—the prior probabilities of the univariate, weak, and strong models are the same. We use M_i to denote model i , where $i = \{\text{uni, weak, strong}\}$, and the associated prior probabilities P are

$$P(M_{\text{uni}}) = P(M_{\text{weak}}) = P(M_{\text{strong}}) = \frac{1}{3}.$$

The posterior probability of a model is calculated by applying Bayes’ rule. For example, (recall

²⁶One can think of this method as an EM algorithm.

²⁷We define *overlapping observations* as occurring when price data are available for two cities at the same time t .

²⁸By construction, then, each univariate series can consist of no more than 60% missing values.

that Y represents the data), the posterior probability of the strong model is

$$\begin{aligned}
P(M_{\text{strong}} | Y) &= \frac{P(M_{\text{strong}}, Y)}{P(Y)} \\
&= \frac{P(M_{\text{strong}})p(Y | M_{\text{strong}})}{P(M_{\text{uni}})p(Y | M_{\text{uni}}) + P(M_{\text{weak}})p(Y | M_{\text{weak}}) + P(M_{\text{strong}})p(Y | M_{\text{strong}})} \\
&= \frac{p(Y | M_{\text{strong}})}{p(Y | M_{\text{uni}}) + p(Y | M_{\text{weak}}) + p(Y | M_{\text{strong}})}.
\end{aligned}$$

The last of these equations embodies the principle of equality across the three models' prior probabilities. The interpretation of a model's posterior probability is intuitive. So if $P(M_{\text{strong}} | Y) = 0.9$, for instance, then we can say (after observing the data) that the probability of the two focal markets being integrated is 90%.

To explain our methodological choices to readers who are not familiar with Bayesian inference, we offer an *ad hoc* example to clarify how it differs from a classical testing approach.²⁹ Suppose that we test the null hypothesis H_0 of observing the weak model M_{weak} against the alternative H_1 of observing the univariate model M_{uni} , choosing 5% as the significance level at which the null should be rejected. This standard requires that the weak model be rejected if its probability is below 5%, but conflicting conclusions could follow if the null and alternative hypotheses were switched. For example, if one hypothesis has probability 30% and an alternative hypothesis has probability 70%, then *neither* can be rejected.

In this paper, we utilize the posterior probabilities of models as statistical guidance for inference on market integration. A higher probability of the *strong* model means that the data support market integration. A higher probability of the *weak* model indicates that two markets do have a long-run relationship but do not obey to the law of one price; and a higher probability of the *univariate* model shows that two markets are independent. Instead of specifying a rejection rule, this approach yields a full picture of the data-based evidence for each model. Thus models are treated symmetrically, and there is no inferential conflict.

²⁹The Bayesian and classical method have fundamental differences in their respective philosophies of inference.

In practice, however, we could always find some numerical similarities—for example, a density interval and a confidence interval. Although they have different interpretations, the results are comparable and usually point to similar conclusions.

4.6 Half-lives

In all our models, the city-specific fluctuation g_{it} has a stationary AR(1) representation. Hence it also has a well-defined half-life, which is calculated as the posterior mean of $\ln(0.5)/\ln(|\phi_i|)$. For a city i , this half-life represents how long it takes to halve the gap between its current price level and the equilibrium price. Since the interpretation is similar to that of the half-life in an ECM, which measures the speed of convergence, it can be interpreted as a measure of market efficiency. Half-lives with small values correspond to markets that are more efficient, because such values reflect a more rapid price convergence.

When the data frequency is annual, it can be challenging to calculate half-lives because commodity prices usually take not years but rather months or even just weeks to achieve an equilibrium. This difficulty arises also in our historical setting. Taylor (2001) shows in particular that half-life estimates based on yearly data are upward biased. One straightforward way of tackling this problem would be to replace low-frequency with high-frequency data, but that approach is not feasible in our case. The underlying bias of the yearly data could, alternatively, be corrected by using Taylor’s suggested strategy as follows. Let $\hat{H}$ be the half-life estimate using yearly data and let L be the period over which the “averaging” applies;³⁰ we can then compute the true half-life H by solving

$$\hat{H} = \frac{L \ln(2)}{\ln \left(\frac{L(1-2^{-2/H})-2^{1-1/H}(1-2^{-L/H})}{2^{-1/H}(1-2^{-L/H})^2} \right)}.$$

We have followed this procedure to adjust the half-life, on a monthly basis.

5 Results

We start by presenting the results on market integration between Istanbul and each European city for the entire 1469–1914 period. Then, to investigate changes in integration patterns over time, we split the sample into five sub-periods—for which the posterior probabilities are reported in Tables A2–A40. The particular subsample divisions were guided by how the CPI was constructed, which in turn was motivated by the Ottoman Empire’s underlying economic and monetary trends (as suggested by Pamuk, 2004, p. 468). These divisions are also in line with the periodization of Ottoman European commercial relations employed by Stoianovich (1974, p. 62).³¹ In each of Tables

³⁰If the annual data is averaged using monthly (weekly) data, then L is equal to 12 (to 52).

³¹We follow Chib (1998) in developing a model to test for the presence of univariate structural breaks. We

A2–A40, column 2 gives the share of missing data; columns 3–8 report the posterior probability for our three models of market integration (no integration, weak integration, and strong integration).

A complementary and intuitive way of looking at the results is provided by the posterior probability of models illustrated in Figure 1–4. The bars in each figure represent the posterior probability of observing each model; these figures also report the number of overlapping and total observations.³² To clarify the presentation, we plot the posterior probabilities only for some selected goods (see Appendix Figures A2–A9 for the full results). Because the share of non-overlapping observations always exceeds 60% during the first (1469–1585) sub-period, we do not report those results. As mentioned in Section 4, to interpret our findings we use the posterior probabilities as statistical guidance. Thus, although we do not specify a strict rejection criterion, the following “rule of thumb” is used to indicate the strong model’s dominance over the other two: $P(M_{\text{strong}} | Y) \geq 0.8$. If this rule is satisfied then we consider the two markets to be integrated. We remark that these results can only confirm (or disprove) the *existence* of market integration; the *extent* of any such integration is addressed in Section 5.1.

Our findings generally favour the strong integration hypothesis for most time periods and for a large number of commodities and cities. Overall, then, this analysis offers support for the hypothesis that broad and persistent market linkages existed between the Ottoman and European economies over the centuries—a finding that indicates a long-lasting relationship of mutual influence. In addition, we observe some heterogeneity in terms of time, geography, and commodity types. Our most striking result is the decline of integration during the 19th century.

The empirical analysis based on commodity prices offers stronger evidence of price pass-through than does the analysis using CPI data. This result is not surprising given that the CPIs were not then apply that model to the CPI data because they are the least compromised by missing values. In this way, we establish three results: structural breaks exist, but the number of breaks is not the same for each city; there is no clear evidence of simultaneous structural breaks; and missing values lead to the “detection” of nonexistent structural breaks. Hence we conclude that, in order to obtain results that are robust to model misspecification, it is preferable to follow the subsample breaks suggested by the literature. Details about the method of inference and the univariate factor model that allows for structural breaks are given in Section E of the Appendix.

³²For example, Figure 1 shows that—of the 68 observations that constitute Krakow’s series of olive oil prices—55 observations overlap with those for the corresponding Istanbul series.

constructed using identical baskets across countries; they were intended to capture the transmission of price changes across markets only at the aggregate level. Nevertheless, we still find some support for integration when CPI data are used. For example, the full-sample findings suggest that markets were integrated (over the very long run) between Istanbul and two important trade partners in the Mediterranean region—Napoli and Madrid—as well as with respect to Leipzig and Lwow, which were linked to the Ottoman capital via the land route (see Figure A3). That we can observe a process of long-run price transmission involving cities along both of these commercial routes suggests that these ways of exchanging goods between the two regions were significant and also complementary. Our CPI-based findings also indicate that the 1691–1768 sub-period was the one in which price transmission was most widespread (Figure A2). For those years, our data support the existence of strong market integration between Istanbul and five regions that were located either on the sea route or the land route: Augsburg, Lwow, Munich, Napoli, and northern Italy.³³ In the preceding (1586–1690) and following (1769–1843) sub-periods, we observe strong market integration with, respectively, Napoli and Madrid. This finding reflects that, for centuries, the Mediterranean was the route most widely used to exchange goods between the Ottoman Empire and southern Europe. It also indicates that trade between Europe and the Levant³⁴ resisted the Cape route’s opening and even increased at the end of the 16th century (Davis, 1970, p. 202).

The analysis based on commodity markets similarly gives widespread support to the strong integration models; Table 1 summarizes our findings across time, goods, and locations. As a “snapshot” of these results, the table indicates which markets were integrated and which were not, where integration is defined as $P(M_{\text{strong}} \mid Y) \geq 0.8$.³⁵ As in Table 1, here we summarize the results according to historical periods, type of commodities traded, and location; for the latter purpose, Europe is divided into four macro-regions. Broadly speaking, these regions reflect a division along the major trade routes: northwestern Europe (Amsterdam, Antwerp, London, Paris), which was linked to Istanbul via the Mediterranean and the Atlantic; central Europe (Augsburg, Munich, Leipzig, Strasbourg) and eastern Europe (Gdansk, Krakow, Lwow, Warsaw), which were connected to the Ottoman Empire via the land routes; and southern Europe (Florence, Madrid, Milan, Napoli,

³³“Northern Italy” is a composite of average prices in Florence, Milan, and Venice.

³⁴The area bounded by Mesopotamia, the Arabian Desert, and the Mediterranean Sea.

³⁵Empty cells in the table mean either that data are not available for specific periods, commodities, and cities or that there were an insufficient number of overlapping observations.

northern Italy, Valencia), which traded predominantly via the Mediterranean.

When focusing on the time dimension, we find that commodity market integration persisted from the 16th century to the first half of the 19th century but declined thereafter. The historical phase that witnessed the most widespread economic linkages spanned the years 1586 to 1843 (sub-periods 2–4); for these years, the strong integration model is favored for most of our sample’s commodities and cities. However, we also observe that the share of integrated cities declines slightly over time: from 72% during 1586–1690 to 61% during 1691–1768 and to 59% during 1769–1843.³⁶ This share decreases still further in the last sub-period (1844–1914), which mirrors a weakening of bilateral linkages during the second half of the 19th century for the commodity prices in our data set.³⁷ This result is surprising when one considers that, during the second half of the 19th century, the Ottoman Empire’s trade with Europe intensified—spurred on by improvements in transport infrastructure and reductions in trade costs due to the first wave of globalization. That half-century also saw an increase in the commercialization of Ottoman agriculture and in its agricultural exports. We shall discuss the interpretation of these results in Section 6.

Results on the spatial patterns of integration are summarized in Figure 5. In northwestern Europe we find evidence of price convergence between 1586 and 1843 for a variety of commodities: chickpeas, butter, wheat, soap, charcoal, olive oil, and wood.³⁸ We find similar patterns in central Europe, as our results indicate price transmission with respect to Ottoman markets between 1586 and 1843 for a wide set of commodities. The third sub-period (1691–1768) saw the largest number of integrated markets in Augsburg, Leipzig, and Munich, and integration with Strasbourg increased during the next sub-period (1769–1843). For eastern European cities, we find the largest share of integrated markets in the period from 1586 to 1690.³⁹ Turning now to southern Europe, we

³⁶The shares are calculated as follows: for 1586–1690 we have price data for 25 commodities and cities, of which 18 are integrated with Istanbul; the corresponding numbers are 33 out of 54 for 1691–1768 and 22 out of 37 for 1769–1843.

³⁷Of this period’s data for 17 cities and commodities, only the data for wheat (in four cities) support the strong integration model.

³⁸The share of integrated markets in Antwerp was unchanged during this period. For Amsterdam and Paris, however, the periods with the largest number of linked markets were (respectively) 1691–1768 and 1769–1843—with integration increasing over time. All London markets for which data are available (butter, wheat, olive oil) were integrated with Istanbul during the third sub-period (1691–1768).

³⁹This region exhibits some heterogeneity: only Gdansk’s markets were integrated for three consecutive sub-

find clear evidence supporting the strong model in sub-periods 2 and 3, with Napoli exhibiting the strongest linkages in the region. Yet we also observe a decline in the average share of integrated markets in the following century (1691–1843).⁴⁰

When looking at specific commodities, we find that grains and especially wheat had strong and geographically widespread patterns of integration (Figures 3 and 4). Wheat price data are available for the 1691–1843 period for 13 cities; of these, 10 (all) were integrated with the Ottoman capital during 1691–1768 (1769–1843).⁴¹ In the rice market (see Figure 2), there was price convergence between Istanbul and Augsburg (but not in Milan and Valencia) during 1585–1690; however, convergence was observed between 1769 and 1843 in all the cities for which we have data (Milan, Strasbourg, Warsaw). Links in the olive oil market were also strong for a large set of cities that were integrated with Istanbul between 1585 and 1843; the only exception was Milan in the second sub-period (see Figure 1). Data on soap prices are less abundant: they start in 1691 and are available for only four cities (Amsterdam, Leipzig, Milan, Paris); even so, these prices exhibit strong integration patterns between 1691 and 1843 (Figure A8). Wood prices cover only the 1691–1768 period (Figure A9), in which the strong model dominates the others in all areas (Augsburg, Gdansk, Madrid, northern Italy, Paris, Warsaw). Istanbul’s chickpea markets are integrated with all cities during 1586–1690, but integration declines rapidly in the following periods (Figure A6). Finally, we uncover less robust evidence for integration in the butter, charcoal, and honey markets; see (respectively) Figures A4, A5, and A7.

5.1 *Market efficiency*

The findings presented so far in this section allow us to understand whether two markets were periods (from 1586 to 1843)—thus behaving similarly to most cities in central and northwestern Europe—with the largest share in the 1769–1843 sub-period. We also find evidence of price pass-through between Lwow and Istanbul’s markets for butter and chickpeas during 1586–1690 and, from 1586 to 1768, for the only Krakow commodity markets (i.e., chickpeas and olive oil) for which data are available. Data on Warsaw’s commodity prices are available only for 1691–1843, when most of the commodities evidence support for our strong integration hypothesis.

⁴⁰We find no evidence that either Napoli’s or northern Italy’s commodities markets were integrated with Istanbul’s during this period.

⁴¹In contrast, for the period 1844–1914 we find evidence of wheat price co-movement for only four of eight cities.

integrated as well as how market integration changed over time. Here we assess the efficiency of integrated markets by looking at half-lives, which indicate how sudden price deviations from equilibrium (due to short-run shocks) were “cleared”. Figures 6–8 illustrate the half-lives of all integrated commodities between 1586 and 1843 (for full results, see Appendix Tables A41–A50).⁴² In the figures and tables both, we report two half-lives that represent the speed of convergence to equilibrium of, respectively, Istanbul’s prices and those of the paired European city. Comparing the two half-lives allows us to identify each market’s leading city—in other words, the location that reached the equilibrium path most rapidly. So if the price adjustment in a specific Istanbul market is faster than that of its European counterpart (i.e., if the former prices exhibited a smaller half-life), then the Istanbul market is more efficient and has less price dispersion.

Our estimates reveal that the speed of price convergence ranged from quickly adjusting markets, such as Istanbul–Augsburg rice (subsample 2) and Istanbul–Napoli wheat (subsample 3), to markets that adjusted more slowly, such as Istanbul–Antwerp charcoal (subsample 3) and Istanbul–Augsburg wood (subsample 3). Furthermore, our results indicate that the price pass-through required less than a month for 27% of the commodities; its speed ranged between one and two months for 22% of them, between three and six months for 25% of them, and more than six months for the remaining 27% to achieve equilibrium.⁴³ We observe that no market emerged as the clear leader: Istanbul’s speed of convergence was quicker for 59.1% of the sample (across time and goods)—in particular, for wood, butter, olive oil, honey, and rice as well as in subsamples 2 and 3.⁴⁴ Finally, Istanbul’s half-lives were on average smaller than those of Amsterdam, Augsburg, Krakow, London, Lwow, Madrid, Milano, Munich, Napoli, Valencia, and Warsaw but larger than those of Antwerp,

⁴²We computed the half-lives also of non-integrated markets. As expected, their values are much larger than those of integrated markets, which reflects their lower efficiency. Although unreported here, these values are available from the authors upon request.

⁴³About 10% of the commodity prices took more than a year to converge to equilibrium, a result that is likely to be caused from our use of annual data and from the high number of missing observations in the specific series. Both factors lead to estimation uncertainty and, as such, reflect a clear limitation of our data.

⁴⁴In the chickpeas and soap markets, the speed of convergence was similar for Istanbul and its paired European city whereas the latter had more efficient wheat and charcoal markets. Results for the full sample suggest similar half-lives, although the European cities in subsamples 4 and 5 had (on average) a faster speed of convergence.

Firenze, Gdansk, Leipzig, Paris, and Vienna. Thus, these half-life estimates reinforce our market integration findings and yield a more detailed picture of the mutual influences among European and Ottoman markets. The estimates also suggest that the Ottoman Empire and Europe were both market-oriented economies whose institutions facilitated a similarly high level of allocative efficiency.⁴⁵

5.2 Robustness checks

We further substantiate our results by performing three robustness checks, as described next. First, we propose an alternative specification for the city-specific factor g_{it} . Following Uebele (2011), we model g_{it} not as an AR(1) process but rather as an AR(8) process so as to account for the possibility of fluctuations due to the business cycle. This modeling strategy is consistent also with Burns and Mitchell (1946), who suggest the use of eight lags to adjust for business cycles when yearly data are used. Results of these tests are reported in the last three columns of Appendix Tables A2–A40; they are qualitatively similar to those derived from our baseline specification, which supports the strong integration model for most goods, periods, and locations.

Second, we perform the empirical analysis while changing the number of missing or non-overlapping observations; again, all our baseline results continue to hold.⁴⁶ Finally, we use different thresholds at which the strong model is presumed to dominate the other models. More specifically, we choose a stricter criterion for assessing two markets as being integrated: $P(M_{\text{strong}} | Y) = 0.9$. Although using this more restrictive rule reduces the number of integrated commodities, we do not observe any period- or city-specific pattern. In subsample 2, for example, the goods for which the strong model’s probability is between 80% and 89% vary from butter in London, Lwow, and Napoli to chickpeas in Antwerp and Krakow to honey in Valencia; thus no particular traded item or geographic location drives these results. In some cases our findings are identical under the two criteria; examples include the CPI and rice in sub-period 2, chickpeas in sub-period 3, and (in the full sample) soap in sub-periods 3 and 4. In general, then, using the 90% threshold would not change our overall conclusions on integration. Of course, adopting a *less* stringent criterion—such as $P(M_{\text{strong}} | Y) = 0.7$ —would lead to even greater support for the strong integration hypothesis.

⁴⁵Our findings are in line with those of Shiue and Keller (2007), who compare market integration in China and western Europe; those authors argue that both regions had efficient allocative institutions.

⁴⁶These untabulated results also are available upon request.

Third, for each model $\times$ city $\times$ commodity $\times$ subsample estimation we check the prior sensitivity by further applying two extra priors—one loose and the other tight—when computing the models’ posterior probabilities. Our baseline results are robust to this procedural modification. (See Section D of the Appendix for details on eliciting the priors.)

5.3 *Validity of results*

In this section, we consider two important threats to the validity of our findings. First we test for whether Istanbul prices are representative of the Ottoman Empire, thereby ensuring that our analysis is not biased by factors that are specific only to the Empire’s capital. For this purpose, we estimate the extent of market integration between Istanbul and other Middle Eastern cities for which price data are available: Bursa, Cairo, Damascus, Edirne, and Konya.⁴⁷ Second, we test for whether Europe’s periphery—as represented by Krakow and Madrid—was more integrated with Europe’s core than it was with Istanbul. One could argue that a relatively weaker Istanbul–Europe price co-movement goes a long way toward explaining Bosker et al.’s (2012) reported result of *no* significant economic interaction between the growth of Islamic and Christian cities.

Our results on the extent of market integration within the Middle East are presented in Figure 9 and in Appendix Tables A51–A68. Overall, they establish the existence of strong market integration for most commodities and time periods. At the same time, we can observe heterogeneity across cities and goods: all Edirne markets co-moved with Istanbul; in Cairo and Bursa, 83% and 77% (respectively) of goods were integrated with the Ottoman capital; yet market linkages in Damascus and Konya were weaker (there 44% and 50%, respectively, of the markets were integrated). With regard to commodities, we find that wheat was the most integrated market (the strong model’s probability is 92% for all city pairs and time periods)—followed by rice (80%), honey (78%), chick-peas (75%), olive oil (56%), and soap (50%). In thus documenting the existence of tight links across Middle Eastern commodity markets, these results strengthen our core findings.

Appendix Tables A69–A101 illustrate Krakow’s and Madrid’s patterns of integration with core European cities: Amsterdam, Antwerp, London, and Paris. The results show that these core cities’ integration with these two peripheralas before cities was quite similar (indeed, slightly lower) than was the former cities’ integration with Istanbul: 43% of Krakow’s and 63% of Madrid’s markets

⁴⁷The price data we use here are from Pamuk (2000).

were integrated with Europe’s core (across sub-periods and commodities), on average, whereas the corresponding share for the Ottoman capital was 65%. Our finding that Istanbul was no less integrated with Europe’s core markets than were the Continent’s “marginal” cities confirms the strength of economic relations between the two regions. Thus we can rule out weaker trade linkages as the driver of Bosker et al.’s (2012) claim that there was no mutual influence between Middle Eastern and European urban development.⁴⁸

6 Patterns and drivers of market integration

Our empirical analysis has delivered four key findings, which can be framed by looking at market integration in terms of time, geography, and commodity types. First, the historical period during which the strong model of integration is most definitively supported by the data was from the 17th century to the mid-19th century. Second, over these approximately 250 years we observe an evolution in the patterns of integration across locations—one that reflects a gradual and partial shift from the dominant role played by southern and eastern European markets in their connection with Istanbul to the increased predominance of central and northwestern European markets. Third, we find evidence of price convergence for most commodities in our sample; this convergence persisted over time and across a wide swath of regions, especially with respect to the markets for wheat, olive oil, and soap. Fourth, for most goods in our sample we observe a decline in price convergence starting in the second half of the 19th century.

How can we explain these findings? We believe that our results supporting integration are likely to reflect both the patterns and intensity of commercial exchange between Europe and Istanbul. However, we are unable to document the volume of trade flows between Europe and the Ottoman Empire because (i) aggregate trade statistics are not available for the 1450–1800 period and (ii) annual data about trade transactions of specific commodities are fragmentary. We therefore rely on the large body of historical literature that describes the intensity of commercial interconnectedness between these two regions.⁴⁹ Most importantly, this literature provides evidence that the commodities in our sample competed with imports—a necessary condition for price changes to be transmitted

⁴⁸Yet these authors plausibly argue that their results are driven by border cities, which were more likely to engage in war.

⁴⁹See, for example, Abulafia (2011), Barkan (1975), Berov (1974), Bulut (2001), Çizakça (1985), McGowan (1981), and Wallerstein (1979).

across locations.⁵⁰

Berov (1974), among others, reports a list of items traded among the Balkans, the Empire, and Europe between the 16th and the early 19th centuries; thus active competition—between Istanbul and various European cities—has been thoroughly documented for basic food items and raw materials. McGowan (1981, pp. 1–3) explains how, between the 16th and 18th centuries, the patterns of trade between Europe and the Ottoman Empire mirrored regional specialization in production and hence differences in relative factor prices. Europe was able to access supplies of cheaper Ottoman products during the pre-industrial era of high population growth. Such demographic pressures, which were especially strong in northwestern Europe, altered land-to-labor ratios (and prices) and thereby increased the need for unprocessed commodities, usually food and fiber.⁵¹ That increased need represented the key link in Ottoman–European trade, through which large quantities of land-intensive Ottoman commodities were exported to Europe in exchange for processed goods or coin (i.e., following the principle of comparative advantage).

There is indeed extensive evidence that, despite some fluctuation, trade between Europe and the Ottoman Empire from 1500 to 1800 was active and heterogeneous, which reflected increasing levels of commercialization in both regions.⁵² As mentioned in Section 2 (footnote 12), trade transactions had been regulated by the principle of capitulation (*ahidname*) since 1500. This principle amounted to a type of amnesty formally granted by the head of the Islamic community to non-Muslim nations (Inalcik and Quataert, 1994, p. 189). The capitulations essentially guaranteed that foreigners could travel and trade freely throughout the Empire; in return, the Ottomans expected similar guarantees for their own traders—a quid pro quo arrangement for the parties’ mutual advantage.⁵³ Other important factors facilitating trade with Europe were the de facto minimum tariffs and overall

⁵⁰For instance, McGowan (1981, pp. 3–5) explains that population pressures in Europe led to an increase in the demand for primary goods that could not be satisfied by the domestic supply, which led to an increase in imports from the Ottoman Empire. See also Stoianovich (1974).

⁵¹The conditions driving the increased population growth in 16th-century Europe entailed an insufficiency of land to sustain prevailing consumption patterns, which led in turn to increased imports from the Levant.

⁵²See, for example, Inalcik and Quataert (1994) and Stoianovich (1974).

⁵³Ottoman traders belonging to non-Muslim minorities (Jews, Greeks, and Armenians) thrived in many European cities such as Ancona, Lwow, and Venice. In fact, Ottoman Muslim merchants in Venice were given their own *Fondaco dei Turci* in 1592.

protectionist measures instituted by the Empire (Inalcik and Quataert, 1994).

The Ottoman Empire exported to Europe primarily agricultural produce (wheat, rice, olive oil) and raw materials (silk, wool, mohair), in addition to a limited number of manufactures, while importing mainly cloth and such raw materials as tin and lead.⁵⁴ European traders competed with Ottoman merchant networks for the exports of manufactured goods, especially textiles (Inalcik and Quataert, 1994, p. 480). Competition for control of the Mediterranean was quite lively, and even more intense were the rivalries between English and Venetian merchants in the 16th century and between English, Dutch, and French traders in the 17th century. The existence of such a competitive environment, in conjunction with the capitulation agreements, facilitated the process of price transmission between Ottoman and European markets (Inalcik and Quataert, 1994, p. 482).⁵⁵

Our empirical analysis reveals some geographic variation in the share of integrated commodity markets. This variation reflects that the weight and relative importance of the Ottoman Empire's main trading partners—England, France, the Habsburg Empire, the Italian city states, and the Netherlands—varied throughout the centuries because of changes in economic and geopolitical supremacy. The Ottoman Empire's most active trade relationship at the beginning of our study period was with Venice, followed by Genoa and Florence. The Venetian and the Genoese were also the main middlemen for Levantine products in northwestern Europe and Spain, which may help explain our market integration findings for those parts of Europe (see Map 1 for an illustration of the sea routes connecting the Ottoman Empire to Europe). The rise and fall from prominence of the Italian traders, replaced first by the Dutch and English and then by the French (McGowan, 1981, p. 15), is broadly captured by our results.

The Mediterranean was not always the preferred choice for transport, and it was often complemented by the land route connecting the Empire to eastern and central Europe via the Danube and Transylvania. These roads were actively used in the 17th century by Rumelian traders who bought and sold Ottoman and European goods. Land-based trade thrived during this period thanks to the spread of large trade fairs in the Balkans, such as those hosted by Uzundjova and Plovdiv (Mc-

⁵⁴For instance, Middle Eastern raw silk exports to England between 1621 and 1721 increased by 275% while silk exports to the Low Countries also rose considerably (Çizakça, 1985, p. 357). Between the periods 1621–1634 and 1663–1669, exports of mohair yarn to England rose by 400% (Davis, 1970).

⁵⁵See Çizakça (1985, p. 364) for details on Ottoman–European competition in the textile sector.

Gowan, 1981; Stoianovich, 1974). In fact, our results show that the majority of eastern European markets were integrated with the Ottoman capital during the 17th and 18th centuries.

Beyond Transylvania, the caravan routes that connected the Empire to the Austrian border flourished during the 18th century, when decreasing mercantile activities in the Mediterranean shifted the commercial exchange of Ottoman–British goods by the way of Vienna (Inalcik and Quataert, 1994, p. 486). This land-based trade was further facilitated by the growing importance of the fairs held in Leipzig, which were most active starting in the early 1700s, and of those in Komorn and Rusciuk on the Danube (Stoianovich, 1974, p. 98). An alternative way to exchange goods with Europe was via Dubrovnik, a hub used for both maritime trade via the Adriatic and overland trade via the Balkans (Inalcik and Quataert, 1994, pp. 510–11).⁵⁶ The active use of overland transit and the Dubrovnik alternative underlie our broad findings of integration in the central European cities of Augsburg, Leipzig, Strasbourg, and Vienna; these cities were especially during the 1691–1768 period.

Our results show also that the commodity market linkages of Amsterdam, Antwerp, and London with Istanbul strengthened between the late 17th century and the first decades of the 19th century.⁵⁷ England’s direct contact with the Empire started at the time of the Ottoman–Venetian war (1570–1573), and it was strengthened by the provision of full capitulatory privileges in May 1580 (Inalcik and Quataert, 1994) and the founding of the Levant Company in 1581 (Willan, 1955). After displacing the Venetians from the Mediterranean in the early 17th century, English trade relations with the Porte (i.e., the Empire’s central government) remained intense until the first half of the 18th century.⁵⁸ Trade with the Dutch also increased after 1570, spurred by the creation in 1582 of a Turkish “nation” of merchants in Antwerp and by the granting of capitulations in 1612. Consolidation of the Dutch commercial position in the Levant continued until the late 1700s (Van der Wee, 2013, p. 257).⁵⁹ The 18th century saw a shift in the Empire’s trade partners: England was replaced

⁵⁶Dubrovnik was a tributary state of the Ottoman Empire; trade in this state was controlled by Italian-speaking merchants of Slav background, who enjoyed special privileges within the Ottoman territory.

⁵⁷The share of commodities that were integrated between these northwestern European cities and Istanbul was 72%, on average, during 1691–1760.

⁵⁸Ottoman–British trade was based on the English exporting tin, lead, and woolen cloth while importing spices, raw materials, and various foodstuffs—mostly currants, olive oil, and wine (Brenner, 1972).

⁵⁹The Ottomans supplied the Dutch with cotton, yarn, leather, honey, and beeswax in exchange for lead,

by France as major destination of Ottoman exports and a supplier of textiles.⁶⁰ Our results capture the increased importance of the French markets by showing increased integration between Paris and Istanbul between the periods 1691–1760 and 1761–1843.⁶¹

When we focus on specific commodities, evidence of price convergence for a wide range of goods reflects the active competition between European and Ottoman markets. Among the various foodstuffs exported from the Ottoman territories, wheat deserves special attention because it was the main traded foodstuff—in terms of value and quantity—over long periods of time (Braudel, 1995; McGowan, 1981, pp. 32–38). It is not possible to make generalizations about the levels of European–Ottoman wheat trade, since these were not regularly recorded; yet we do know that English and Dutch ships were used to import Ottoman wheat and rice throughout the 17th and 18th centuries and that also the land route was often used to trade grains, sometimes in defiance of the Sultan’s prohibition against exporting outside the Empire (Fekete and Káldy-Nagy, 1962). In addition to cereals, other important Ottoman exports to Europe between 1500 and 1800 were olive oil and its byproduct, soap (Stoianovich, 1974). Thus the supply of Ottoman oil was connected not only with European demand for direct consumption but also with the production needs of soap factories.⁶² That oil and soap were competing imports emerges from a series of records of French consuls in the Levant, who often opposed the establishment of Ottoman soap manufacturing because they feared a decline in domestic production and export (Grenville, 1965).

We find that this integration process, which persisted until the first half of the 19th century, slowed down considerably during the last 70 years of the Ottoman Empire—despite the intensification of the two regions’ trade linkages due to technological progress associated with the first wave of globalization.⁶³ We propose three possible explanations, which are neither mutually exclusive nor jointly exhaustive, for these findings. Namely, they could be driven by: the type of commodities used

tin, iron, and steel.

⁶⁰France’s status as leading trade partner was facilitated by the 1740 trade agreement, under which imported French goods were assessed a customs rate of only 3%—the lowest that was applicable to foreigners (Inalcik and Quataert, 1994, p. 728).

⁶¹The commodities most integrated were wood (1691–1760) and soap and wheat (1761–1843).

⁶²For example, the decline in 1788 of labor employed by the Marseille soap factories was followed by reduced Ottoman oil exports in 1789.

⁶³Total exports from the Ottoman Empire to Europe increased by a factor of 5 between 1840 and 1913 Pamuk (1987, p. 83).

in the analysis; the relatively small sample size; and/or the impact of war, especially the Empire's territorial fragmentation. Although we emphasize that other factors could well have played a role in the decline of market integration, our discussion here is limited to elaborating on the hypotheses just suggested.

During the first wave of globalization, the import of European manufactures continued to rise steadily and was matched by the export of certain Ottoman agricultural goods: predominantly high-value-added industrial crops. Thus the composition of Ottoman commodity exports to Europe shifted toward a larger proportion of raw materials to supply Europe's industrializing economies. The Empire's participation in this period's global market was shaped by an intensification of agricultural commercialization and by a related change in the composition of its agricultural output (Owen, 1993). In particular, commercialization was associated with a rise in the production of raw materials (e.g., cotton, wool, opium, tobacco) as the Empire sought to satisfy greater demand from European markets. The existing qualitative literature, which describes market integration between the two regions strengthening in the 19th century, explicitly refers to such commodities (Kasaba, 1988).⁶⁴ Because our data set does not include the prices of raw materials, we are unfortunately not able to test such statements empirically. We remark, however, that production of the non-industrial crops in our sample was relatively less affected by this epoch's changes in the international division of labor. As the effects of the second Industrial Revolution spread globally, leading both to a dramatic reduction in transaction costs and an expansion of trade, Europe started importing from a larger set of countries those goods that in preceding centuries were vital elements of commercial exchange with the Ottoman Empire—for example, cereals, soap, and olive oil. This change led to a shift in the Empire's relative comparative advantage, which had shaped bilateral relations with Europe during the pre-industrial era. Such dynamics are likely to have driven our findings of lower market integration during 1844–1914: because our sample's commodities were not a part of the increases in commercialization and trade flows with Europe, they cannot reflect the two regions' greater integration.

Another reason for our finding of less integration during 1844–1914 might be that our samples of cities and commodities are smaller than the corresponding samples used for other time periods and

⁶⁴This greater integration is confirmed by a quantitative analysis of co-integration between Ottoman and British cotton markets (Panza, 2013).

hence may be less indicative of the actual intensity of Ottoman–European trade relations. Recall from Section 5 (footnote 37) that we have price data for only 17 city pairs as compared with 25 for the period 1585–1690, 54 pairs for 1691–1768, and 36 pairs for 1769–1843. Yet one must bear in mind that our results are not driven by cities or goods that were generally less integrated. In fact, Table 1 illustrates that the non-integrated cities during sub-period 5 were Amsterdam, Antwerp, London, Lwow, Milan, and Vienna. Among these cities, only Lwow exhibited low integration (just 33% of its markets were integrated) during sub-periods 2–4, while London and Vienna were highly integrated and Amsterdam’s ranking was higher than the average.⁶⁵ Commodities for which the strong model’s probability is less than 80% are butter, chickpeas, soap, rice, and wheat (in four cities). These markets nonetheless exhibit relatively high levels of co-movement in the previous sub-periods, during which the share of integrated cities was 88% for soap, 85% for wheat, 83% for rice, 48% for chickpeas and 41% for butter. The values reported in this paragraph confirm that our results for 1844–1914 are not driven by particular cities or commodities. It is likely, though, that the results are affected by both internal and bilateral conflict—as detailed in the next section.

6.1 *Effect of conflict on integration*

Although our empirical analysis reveals that there were persistent economic ties between Europe and the Ottoman Empire over the period 1469–1914, their relations during that time were shaped also by conflict. The Empire looked westward for territorial expansion, especially during its period of military dominance (until the Treaty of Karlowitz in 1699), and made extensive territorial gains on the Continent (Iyigun, 2008). The Ottoman–European wars were a struggle not only for geopolitical supremacy but also between two rival faiths. Indeed, the religious divide between the two regions was often the cause of violent confrontations and is widely regarded as a major barrier to their interaction (Bosker et al., 2012, p. 1423). The Empire engaged in conflicts also with non-European states as well as domestically, both of which may have indirectly affected bilateral trade.

To what extent did conflict disrupt market integration between Europe and Istanbul—and how did that disruption change over the centuries? To measure the effect of war on commodity price

⁶⁵In cities for which sub-period-5 prices are available, the share of integrated commodity markets during sub-periods 2–4 were as follows: 100% in Vienna and Munich, 83% in London, 80% in Krakow, 67% in Amsterdam, 60% in Paris, 57% in Milan and northern Italy, 57% in Warsaw, 50% in Antwerp, and 33% in Lwow.

transmission, we perform the following regression:

$$\begin{aligned}
P(\text{strong})_{itc} = & \alpha_1 + \beta(OE-EU_war_{it}) + \gamma(OE_war_t) \\
& + \Psi X_i + \delta_i + \delta_t + \delta_c + \epsilon_{itc}.
\end{aligned}
\tag{10}$$

Here $P(\text{strong})_{itc}$ represents the posterior probability of the strong model for commodity c in city i at time t ; $OE-EU_war$ denotes the number of wars between city i and the Ottoman Empire; OE_war is a dummy variable set to 1 for years during which the Ottoman Empire was engaged in a non-European war, including domestic conflicts (and set to 0 otherwise); and δ_i , δ_t , and δ_c are (respectively) city-, time-, and commodity-specific effects. The vector X_i contains a set of control variables: *Sea_route*, a dummy set to 1 if the main trade route between Istanbul and city i was via either the Mediterranean or the Atlantic (and set to 0 otherwise); *Distance*, the geographic distance (in thousands of kilometers) between Istanbul and city i ;⁶⁶ and $OE-EU_casualties$ and $OE_casualties$ denote the number (in thousands) of casualties suffered during, respectively, Ottoman–European wars and the Empire’s non-European wars. After running a baseline regression devoted to estimating the coefficients β and γ , we allow those coefficients to have subsample-specific effects so that we can assess how, over time, war affected integration. For that purpose we interact $OE-EU_war$ and OE_war with time dummies that correspond to our subsample divisions.

To identify the number of wars between each sample city and the Ottoman Empire, we utilize Brecke’s *Conflict Catalog*, a compilation of all violent conflicts that have occurred between 1400 and the present; it provides information on the number of wars, their duration, and the number of casualties.⁶⁷ Summing up, while casualty data yield a better representation of conflict intensity, it is important to recognize that these figures are less precise and may underestimate total fatalities. Furthermore, casualty data are available for only a limited amount of conflicts and so using them reduces our sample size. Figure A10 illustrates that conflicts between the Empire and our sample of cities were frequent throughout the periods studied—although it should be noted that not all cities were directly involved in wars with the Empire.⁶⁸

⁶⁶Distance data are from Geobytes (<http://geobytes.com/get-city-details-api/>).

⁶⁷The *Catalog* (<http://www.cgeh.nl/data>) records all violent conflicts with at least 32 battle deaths.

⁶⁸For example, there were no conflicts between the Porte and Augsburg, Leipzig, or Valencia during the

The regression results are presented in Table 2, where columns I–IV report OLS estimates and columns I–VIII report Poisson pseudo maximum likelihood (PPML) estimates; standard errors are clustered at the city and time (subsample) level. The estimates establish that market integration was not affected by war per se (see columns I and V). Yet the coefficient for European–Ottoman wars becomes negative and significant when we control for the number of casualties, suggesting that conflict *intensity* reduced the extent of price convergence between Istanbul and Europe (columns II and VI). More specifically, one additional war reduced the strong model’s posterior probability by 1.7%–2%.⁶⁹ The regressions incorporating time-specific effects show that both European and non-European (including domestic) conflict reduced market integration for subsample 5 (i.e., during 1844–1914). This negative effect of conflict on price co-movement plausibly accounts for our finding that Ottoman–European market integration declined during the second half of the 19th century. It was this period that witnessed the Empire’s territorial fragmentation—starting with the loss of its European provinces, which included Albania, the Balkans, Bessarabia, Bulgaria, Crete, Cyprus, Greece, Macedonia, and the Danubian principalities of Moldavia and Wallachia (Inalcik and Quataert, 1994, pp. 766–68). These developments proved to be extremely costly in that the state withdrew from its wealthiest, most fertile, and most populous provinces; moreover, the territorial losses not only weakened and sometimes severed centuries-old economic ties (Inalcik and Quataert, 1994, p. 768) but also effectively increased the distance from the Empire’s boundaries to any given city in Europe. During the Ottoman Empire’s final years, other major conflicts that further contributed to weakening its political and economic structure were the “Young Turks” revolution, the Armenian genocide, and the rise of independence movements in its Middle Eastern provinces.⁷⁰

7 Conclusion

Our study of integration between Europe and the Ottoman Empire shows that the intensity of links between these two regions’ markets varied across time, location, and commodity type. Exploiting a rich data set that covers 20 cities, nine commodities, and nearly five centuries, we provide new

1469–1914 period.

⁶⁹In the PPML regressions, the formula used to compute the effect of a coefficient is $(e^\beta - 1) \times 100$.

⁷⁰See Rogan (2015, pp. 1–52) for a thorough analysis of the Empire’s conflict history from 1900 to World War I.

empirical evidence on the nature and extent of market connections between these two key players in the international economy. By employing Bayesian inference to compute dynamic factor models, we overcome several shortcomings in the type of historical data on which our analysis relies and thereby offer the first comprehensive empirical study of price transmission between Istanbul and a large set of European cities.

Our findings are important because they provide a rigorous empirical interpretation of evolving economic linkages between two regions that were relatively advanced in the pre-industrial period. The results reported here also offer a new perspective on the influential notion that Europe became industrialized because of exceptionally well-functioning markets that provided appropriate incentives (North, 1981). Our findings point to similar levels of allocative efficiency between market institutions—in terms of similar price pass-through speeds, as measured by the half-lives—and indicate that Ottoman and European market performance was roughly comparable even during the decades of industrialization. We conclude that strong market performance might be a necessary but not a sufficient condition for industrialization to occur.

Whereas these results contrast with Bosker et al.'s (2012) arguments for the *lack* of interdependence between Europe and the Islamic world, they do accord with the predominantly qualitative historical literature on the economic relations between these two regions. We believe that the long-lasting integration patterns between Europe and the Ottoman Empire through the early 19th century—as emphasized in Ottoman–European historiography and confirmed by our analysis—reflect a continuous yet evolving relationship of commercial exchange that was strong enough to resist the disruptive forces of political antagonism and conflict. This exchange was predominantly shaped by an east-to-west flow of primary goods that was stimulated by increasing (especially western) European demand from the 16th century onward. Thus Europe's rising needs attracted considerable quantities of agricultural exports, mostly food and fiber, much of which came from the Levant.⁷¹

Despite fluctuations in volume and content, Ottoman products continued to penetrate and influence pre-industrial European markets, due to their import-competing nature. That the price of Ottoman products were competitive with their European counterparts reflected the Empire's

⁷¹The Baltic shores were also key supplier of grain (mainly rye) to western Europe between the 16th and the 18th centuries.

relative factor endowment: its more extensive land frontier offered a cost advantage, given Europe's increasing population and decreasing availability of marginal lands. Such patterns of specialization, which linked Ottoman and European markets and enabled price transmission to occur and persist over the centuries, changed considerably with the first wave of globalization. During the second half of the 19th century, increased Ottoman production and export of industrial raw materials (e.g., silk, cotton, wool) altered the composition of the Empire's exports to Europe. The reduced importance of such traditionally traded items as olive oil, soap, and cereals—in conjunction with the negative effect of conflict with Europe and within the Empire itself—is the most likely explanation for a weakening of price transmission between the two regions.

References

- Abulafia, D. (2011). *The Mediterranean in history*. Getty Publications.
- Allen, R. C. (2001). The great divergence in european wages and prices from the middle ages to the first world war. *Explorations in economic history* 38(4), 411–447.
- Andersson, F. N. and J. Ljungberg (2015). Grain market integration in the baltic sea region in the nineteenth century. *The Journal of Economic History* 75(03), 749–790.
- Barkan, O. (1975). The price revolution of the sixteenth century: a turning point in the economic history of the Near East. *International Journal of Middle East* 6(1), 3–28.
- Berov, L. (1974). Changes in price conditions in trade between Turkey and Europe in the 16th-19th century. *Etudes Balkaniques* 3, 168–178.
- Beveridge, S. and C. R. Nelson (1981). A new approach to decomposition of economic time series into permanent and transitory components with particular attention to measurement of the business cycle. *Journal of Monetary economics* 7(2), 151–174.
- Bosker, M., E. Buringh, and J. L. van Zanden (2012). From Baghdad to London. *Review of Economics and Statistics* 95(4), 1418–1437.
- Braudel, F. (1995). *The Mediterranean and the Mediterranean world in the age of Philip II*. London: University of California Press.
- Brenner, R. (1972). The social basis of English commercial expansion, 1550-1650. *The Journal of Economic History*, 361–384.
- Brown, H. P. and S. Hopkins (1956). Seven centuries of the prices of consumables, compared with builders’ wage-rates. *Economica* 23(92), 296–314.
- Brown, H. P. and S. Hopkins (1981). *A Perspective of Wages and Prices*. London: Methuen.
- Brunt, L. and E. Cannon (2014). Measuring integration in the english wheat market, 1770–1820: New methods, new answers. *Explorations in Economic History* 52, 111–130.

- Bulut, M. (2001). *Ottoman-Dutch economic relations in the early modern period 1571-1699*. Hilversum: Uitgeverij Verloren.
- Burns, A. F. and W. C. Mitchell (1946). Measuring business cycles. *NBER Books*.
- Çizakça, M. (1985). Incorporation of the Middle East into the European World-Economy. *Review (Fernand Braudel Center)*, 353–377.
- Chib, S. (1998). Estimation and comparison of multiple change-point models. *Journal of Econometrics* 86(2), 221–241.
- Ciolek, T. M. (2005). Georeferenced data set (series 1 - routes): Chief trade routes in europe, levant and north africa 1300-1500 ce. *OWTRAD Dromographic Digital Data Archives*.
- Cleveland, W. (2004). *A history of the modern Middle East* (Third edit ed.). Cambridge MA [u.a.]: Westview Press.
- Davis, R. (1970). English imports from the Middle East, 1580-1780. In M. A. Cook (Ed.), *Studies in the Economic History of the Middle East*, Chapter English im, pp. 193–206. London: Oxford University Press.
- Federico, G. (2007). Market integration and market efficiency: the case of 19th century italy. *Explorations in Economic History* 44(2), 293–316.
- Federico, G. (2012). How much do we know about market integration in europe? *The Economic History Review* 65(2), 470–497.
- Fekete, L. and G. Káldy-Nagy (1962). *Rechnungsbücher Türkischer Finanzstellen in Buda (Ofen) 1550-1580*. Akadémiai Kiadó.
- Findlay, R. and K. H. O'Rourke (2007). *Power and plenty*. Trade, War, and the World Economy.
- Getnet, K., W. Verbeke, and J. Viaene (2005). Modeling spatial price transmission in the grain markets of ethiopia with an application of ardl approach to white teff. *Agricultural Economics* 33(3), 491–502.
- Grenville, H. (1965). *Observations sur l'état actuel de l'Empire Ottoman*. Ann Arbor: University of Michigan Press.

- Inalcik, H. and D. Quataert (1994). *An economic and social history of the Ottoman Empire, 1300-1914*. Cambridge: Cambridge University Press.
- Iyigun, M. (2008). Luther and Suleyman. *The Quarterly Journal of Economics*, 1465–1494.
- Kasaba, R. (1988). *The Ottoman Empire and the world economy: The nineteenth century*. SUNY Press.
- Keller, W. and C. H. Shiue (2014). Endogenous formation of free trade agreements: evidence from the zollverein’s impact on market integration. *The Journal of Economic History* 74(4), 1168–1204.
- Kuran, T. (2004). The economic ascent of the middle east’s religious minorities: the role of islamic legal pluralism. *The Journal of Legal Studies* 33(2), 475–515.
- Langer, W. (1935). *The Diplomacy of Imperialism. 2 vols*. New York.
- McGowan, B. (1981). *Economic life in Ottoman Europe: taxation, trade, and the struggle for land, 1600-1800*. Cambridge University Press.
- Moral-Benito, E. (2012). Determinants of economic growth: a bayesian panel data approach. *Review of Economics and Statistics* 94(2), 566–579.
- North, D. C. (1981). *Structure and change in economic history*. Norton.
- North, D. C. and R. P. Thomas (1973). *The rise of the western world: A new economic history*. Cambridge University Press.
- Open-ICPSR (2018). Data. <https://doi.org/10.3886/E106923V1>.
- O’Rourke, K. H. and J. G. Williamson (2002). When did globalisation begin? *European Review of Economic History* 6(1), 23–50.
- Owen, R. (1993). *The Middle East in the world economy, 1800-1914*. IB Tauris.
- Özmucur, S. and Ş. Pamuk (2007). Did European commodity prices converge during 1500-1800. In A. M. Hatton, Timothy J.; O’Rourke, Kevin; H.Taylor (Ed.), *The New Comparative Economic History: Essays in Honor of Jeffrey G. Williamson*, pp. 59–85. Cambridge MA: MIT Press.

- Pamuk, Ş. (1987). *The Ottoman Empire and European capitalism, 1820-1913: trade, investment, and production*. Cambridge University Press.
- Pamuk, Ş. (2000). *500 Years of prices and wages in Istanbul and other cities*. Istanbul: TC Babakanlk Devlet statistik Enstitüsü.
- Pamuk, Ş. (2001). The price revolution in the Ottoman empire reconsidered. *International Journal of Middle East Studies* 33(1), 69–89.
- Pamuk, Ş. (2004). Prices in the Ottoman Empire, 1469-1914. *International journal of middle east studies*, 451–468.
- Panza, L. (2013). Globalization and the near east: a study of cotton market integration in egypt and western anatolia. *The Journal of Economic History* 73(03), 847–872.
- Reher, D. S. and E. Ballesteros (1993). Precios y salarios en castilla la nueva: La construccion de un indice de salarios reales, 1501–1991. *Revista de Historia Económica-Journal of Iberian and Latin American Economic History* 11(1), 101–151.
- Rogan, E. (2015). *The Fall of the Ottomans: The Great War in the Middle East*. Basic Books.
- Scholliers, P. (1989). *Real wages in 19th and 20th century Europe: historical and comparative perspectives*. Berg Pub Limited.
- Shiue, C. and W. Keller (2007). Markets in china and europe on the eve of the industrial revolution. *American Economic Review* 97(4), 1189–1216.
- Stoianovich, T. (1974). Pour un modele du commerce du levant: economie concurrentielle et economie de bazar 1500-1800. *Bulletin de l' Association Internationale d'Etudes du Sud-Est Europeen* 12(2), 61–120.
- Tanner, M. A. and W. H. Wong (1987). The calculation of posterior distributions by data augmentation. *Journal of the American statistical Association* 82(398), 528–540.
- Taylor, A. M. (2001). Potential pitfalls for the purchasing-power-parity puzzle? sampling and specification biases in mean-reversion tests of the law of one price. *Econometrica* 69(2), 473–498.

- Uebele, M. (2011). National and international market integration in the 19th century: evidence from comovement. *Explorations in Economic History* 48(2), 226–242.
- Van der Wee, H. (1978). Prices and wages as development variables: a comparison between england and the southern netherlands, 1400–1700. In *Acta Historiae Neerlandicae*, pp. 58–78. Springer.
- Van der Wee, H. (2013). *The growth of the Antwerp market and the European economy: fourteenth-sixteenth centuries*. Springer Science & Business Media.
- Wallerstein, I. (1979). The Ottoman Empire and the capitalist world-economy: Some questions for research. *Review (Fernand Braudel Center)*, 389–398.
- Willan, T. (1955). Some aspects of English trade with the Levant in the sixteenth century. *English Historical Review*, 399–410.

Table 1: Results summary

	Butter				Charcoal		Chickpeas				Honey		Oil			Rice			Soap			Wheat			Wood	% integrated				
	Sub-sample																													goods
	2	3	4	5	3	4	2	3	4	5	2	3	4	2	3	4	2	4	5	3	4	5	3	4	5	3	by city			
Amsterdam	×	✓	×	×			✓	×	✓	×											✓		✓	✓	×		0.50			
Antwerp	×	×	×		✓		✓																✓	✓	×		0.43			
Augsburg							✓	×	×		×						✓							✓		✓	0.57			
Firenze																							✓				1.00			
Gdansk	×	×	×				✓	×															✓	✓		✓	0.50			
Krakow							✓	✓		×				✓	✓								✓	×	✓		0.71			
Leipzig	×	✓	×				✓	✓	×												×		✓				0.50			
London	✓	✓	×													✓							✓	✓	×		0.71			
Lwow	✓	×		×			✓			×																	0.40			
Madrid					×			×			✓	×		✓	×								✓	✓		✓	0.56			
Munich	✓	✓																					✓	✓	✓		1.00			
Napoli	✓								×														✓				0.67			
Northern Italy		✓	×		×							×	×		×	✓	✓	✓		✓	✓	×	×	✓		✓	0.53			
Paris					×																✓		×	✓	✓	✓	0.67			
Strasbourg		✓	×			✓		×	×						✓			✓					×	✓		✓	0.56			
Valencia					×						✓	✓		✓	✓		×						✓	✓			0.71			
Vienna		✓		×			✓			×									×				✓	✓	×		0.50			
Warsaw		✓			×				×			×							✓					✓	✓	✓	0.63			
% integrated goods by sample	0.5	0.73	0	0	0.17	1	1	0.29	0.17	0	0.67	0.25	0	1	0.67	1	0.67	1	0	1	0.75	0	0.77	0.92	0.50	1				

Notes: × and ✓ denote non integrated and integrated commodity markets, respectively. Two markets are defined as integrated when $P(M_{strong}|Y) \geq 80\%$.

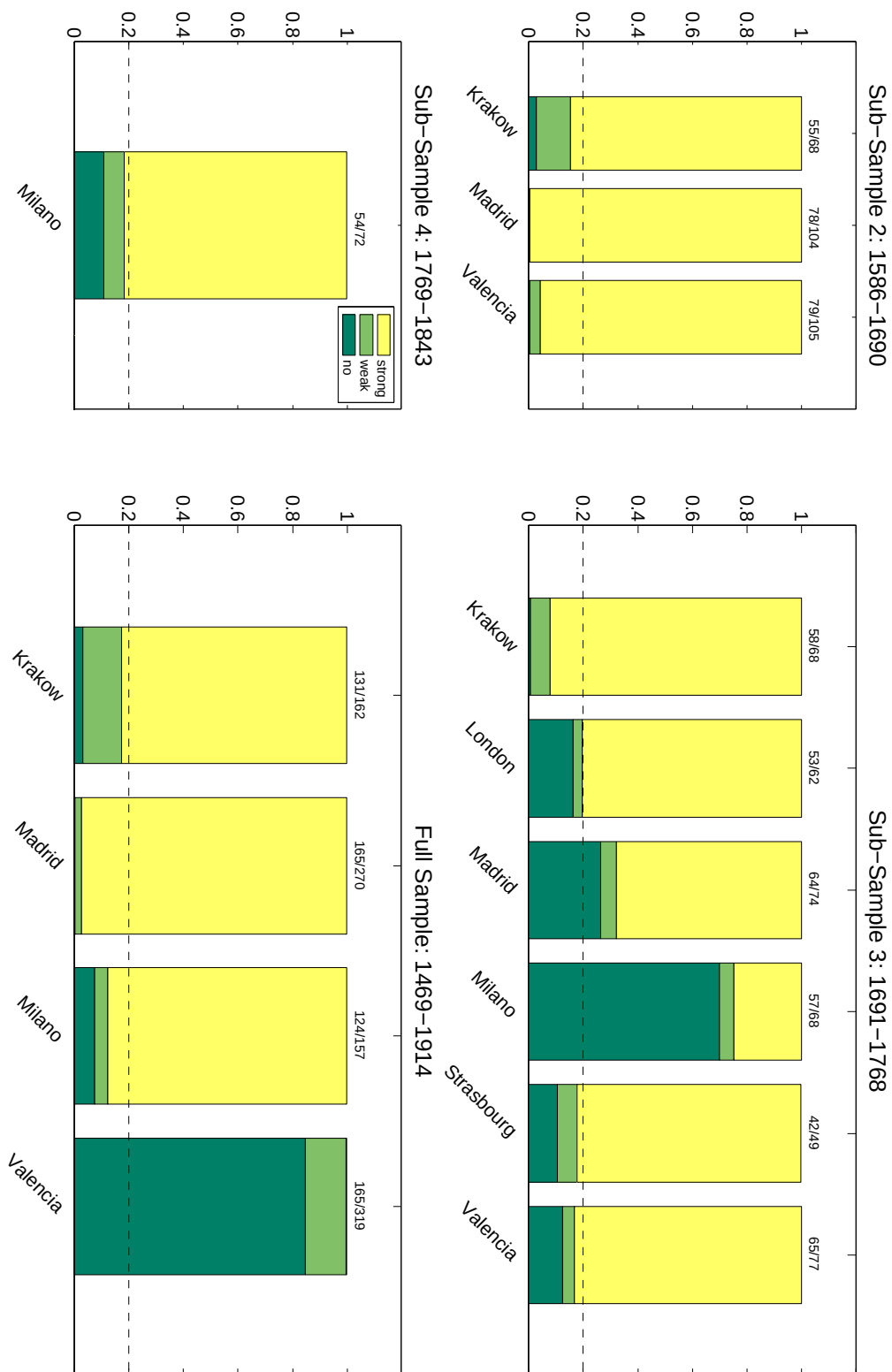
Table 2: The impact of war on integration

	OLS				PPML			
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
N. Eu-Ottoman wars	0.005 (0.007)	-0.017* (0.009)			0.007 (0.009)	-0.021* (0.011)		
N. Ottoman wars	0.000 (0.001)	0.001 (0.002)			0.000 (0.001)	0.001 (0.002)		
Eu-Ottoman war casualties		0.268 (0.160)				0.348 (0.189)		
Ottoman war casualties		-0.216*** (0.075)				-0.347*** (0.095)		
Distance	-0.002 (0.037)	0.012 (0.035)	-0.006 (0.039)	-0.009 (0.037)	-0.006 (0.047)	0.009 (0.041)	-0.013 (0.049)	-0.017 (0.046)
Sea route	-0.015 (0.044)	-0.066 (0.053)	-0.012 (0.040)	0.000 (0.045)	-0.019 (0.054)	-0.085 (0.055)	-0.015 (0.048)	0.001 (0.055)
Eu-Ottoman war x1496-1585			-0.004 (0.013)				-0.005 (0.017)	
Eu-Ottoman war x 15861690			0.003 (0.003)				0.005 (0.003)	
Eu-Ottoman war x 1691-1768			0.008 (0.007)				0.011 (0.009)	
Eu-Ottoman war x 1769-1843			0.000 (0.005)				0.000 (0.007)	
Eu-Ottoman war x1844-1914			-0.033*** (0.012)				-0.073*** (0.020)	
Ottoman war x1496-1585				0.045 (0.055)				0.061 (0.068)
Ottoman war x 15861690				0.03 (0.018)				0.039 (0.024)
Ottoman war x 1691-1768				0.014 (0.014)				0.019 (0.018)
Ottoman war x 1769-1843				0.008 (0.013)				0.01 (0.017)
Ottoman war x1844-1914				-0.032*** (0.012)				-0.070*** (0.019)
City FE	Y	Y	Y	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y	Y	Y	Y
Commodity FE	Y	Y	Y	Y	Y	Y	Y	Y
N	431	130	431	431	431	130	431	431

Notes: * p<0.05, ** p<0.01, *** p<0.001.

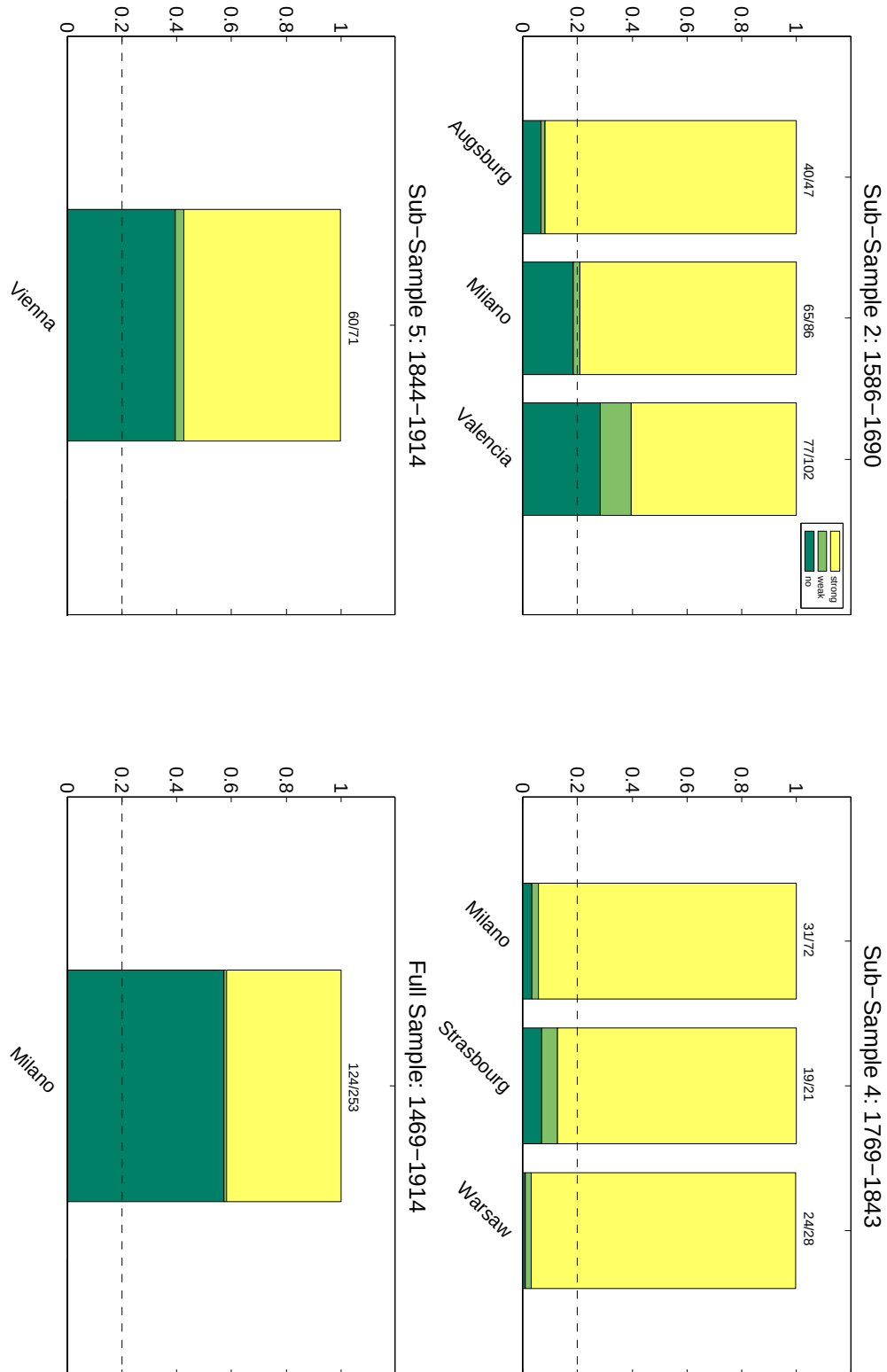
Columns I-IV report OLS estimates, columns V-VIII report poisson pseudo maximum likelihood (PPML) estimates. Standard errors are clustered at the city and time (subsample) level.

Figure 1: Posterior probabilities of strong, weak and no integration models: olive oil



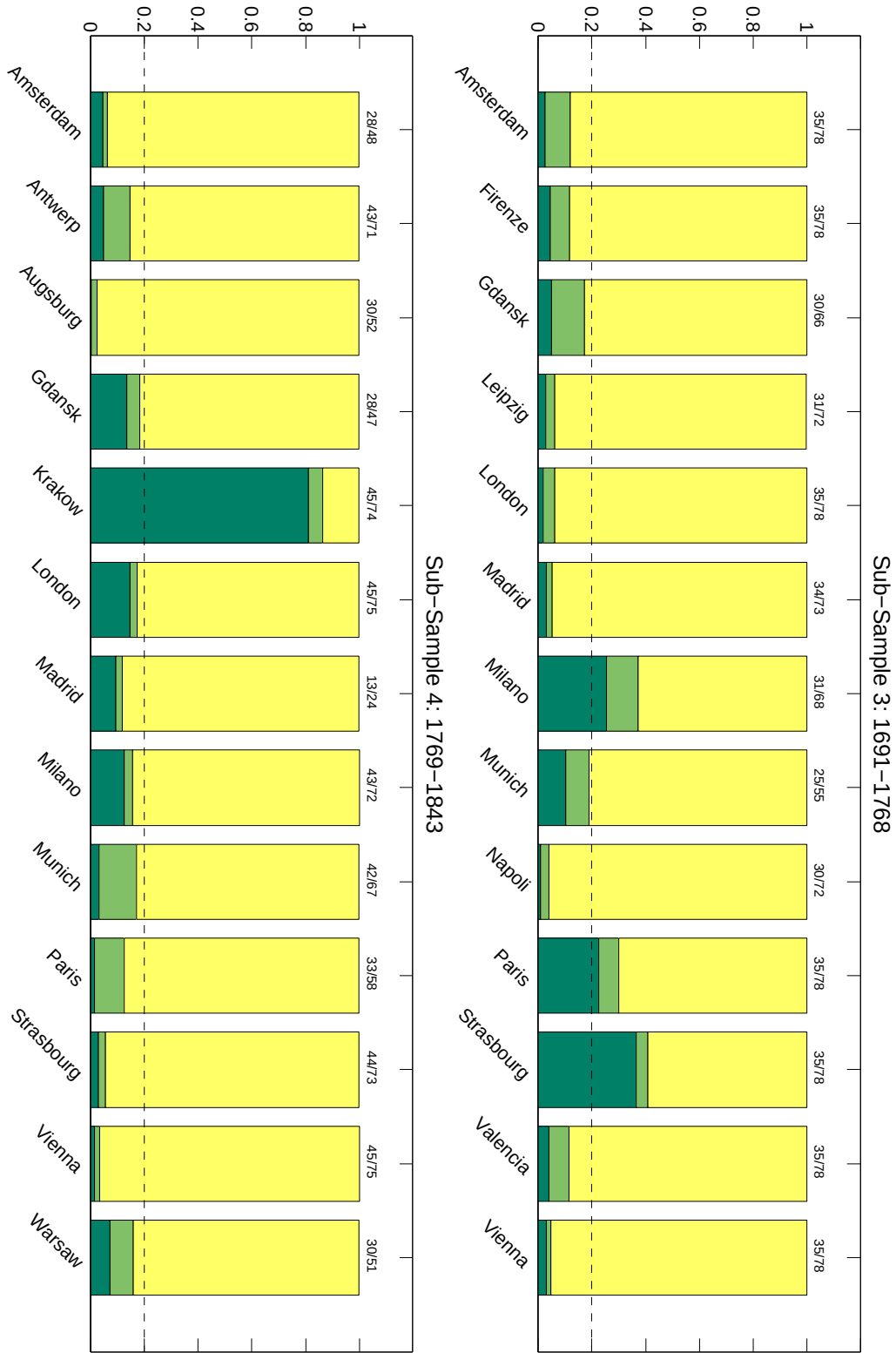
Note: The bars represent the posterior probability of observing each model; on top of each bar we report the number of overlapping over total observations. The dotted line indicates the 80% threshold used as guidance to determine the dominance of the strong model over the alternatives.

Figure 2: Posterior probabilities of strong, weak and no integration models: rice



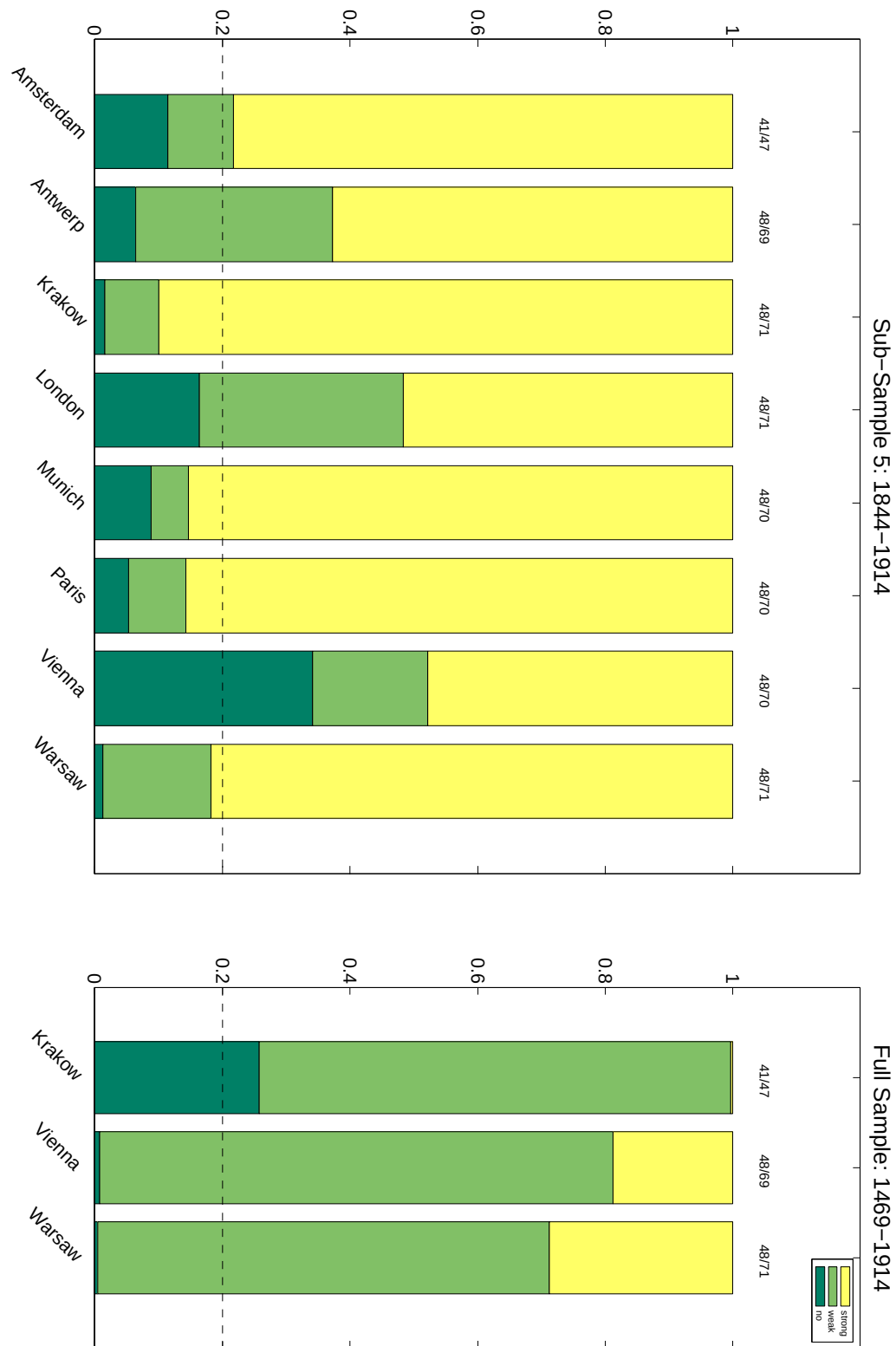
Notes: The bars represent the posterior probability of observing each model; on top of each bar we report the number of overlapping over total observations. The dotted line indicates the 80% threshold used as guidance to determine the dominance of the strong model over the alternatives.

Figure 3: Posterior probabilities of strong, weak and no integration models: wheat (sub-periods 3 and 4)



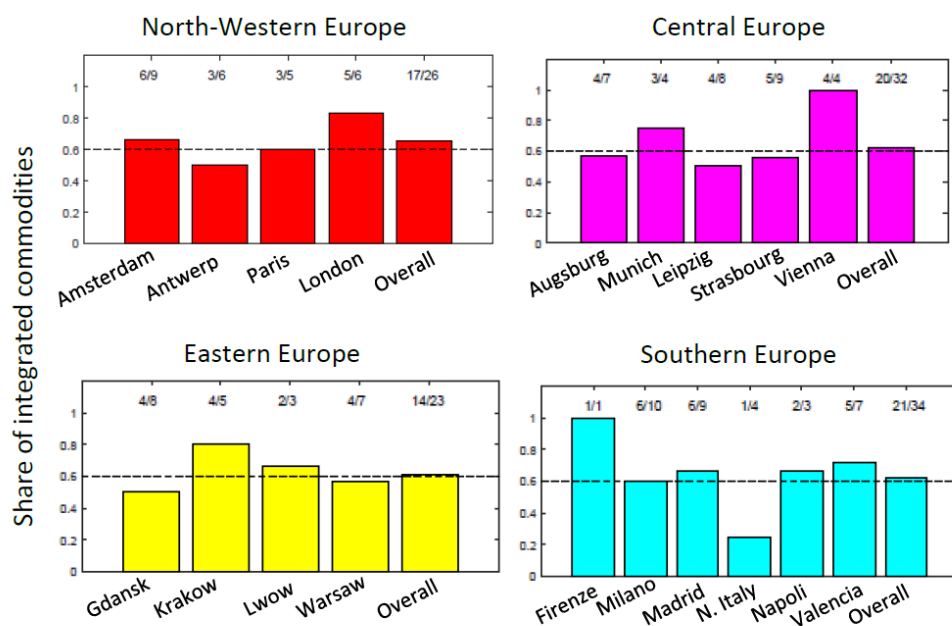
Notes: The bars represent the posterior probability of observing each model; on top of each bar we report the number of overlapping over total observations. The dotted line indicates the 80% threshold used as guidance to determine the dominance of the strong model over the alternatives.

Figure 4: Posterior probabilities of strong, weak and no integration models: wheat (sub-periods 5 and full sample)



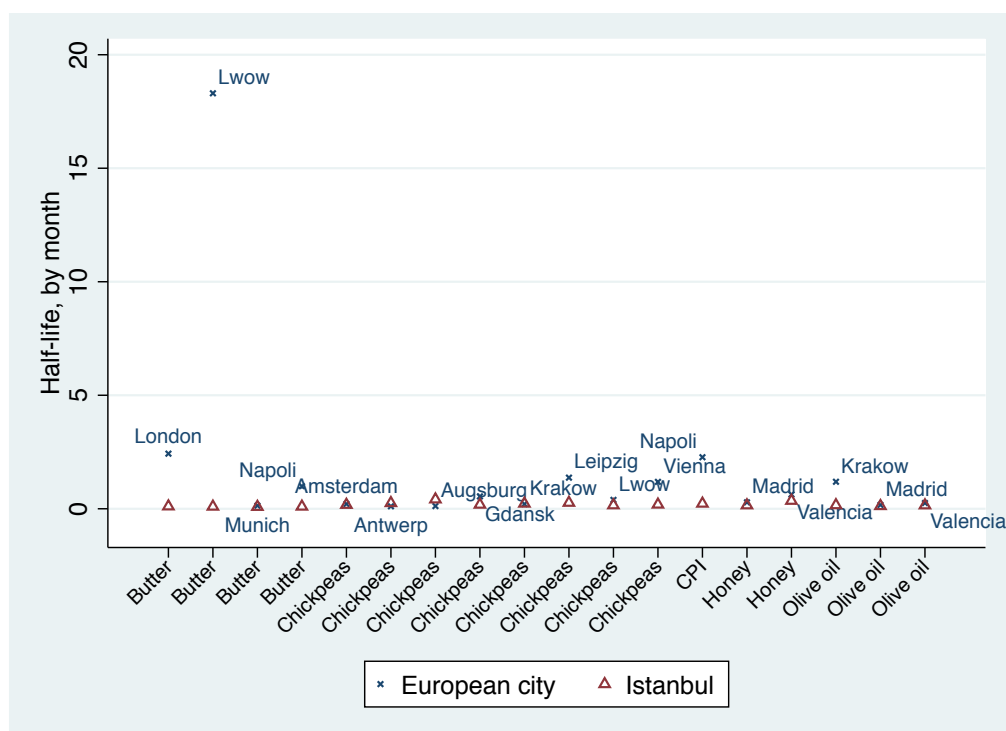
Notes: The bars represent the posterior probability of observing each model; on top of each bar we report the number of overlapping over total observations. The dotted line indicates the 80% threshold used as guidance to determine the dominance of the strong model over the alternatives.

Figure 5: Share of integrated commodity markets across regions.



Note: Each panel illustrates the share of commodities that favors the strong model. The values on top of each column indicate the number of integrated markets over total available markets.

Figure 6: Half-lives, 1586-1690, by month



Notes: The half-lives indicate the number of months needed for price deviations to return to equilibrium in each market. The monthly speed of convergence has been computed following Taylor (2001).

The figure consists of two scatter plots. The top plot shows the half-life of various commodities in European cities and Istanbul. The bottom plot shows the half-life of various commodities in European cities and Istanbul. The legend indicates that 'x' represents European cities and triangles represent Istanbul.

Top Plot: Half-life, by month

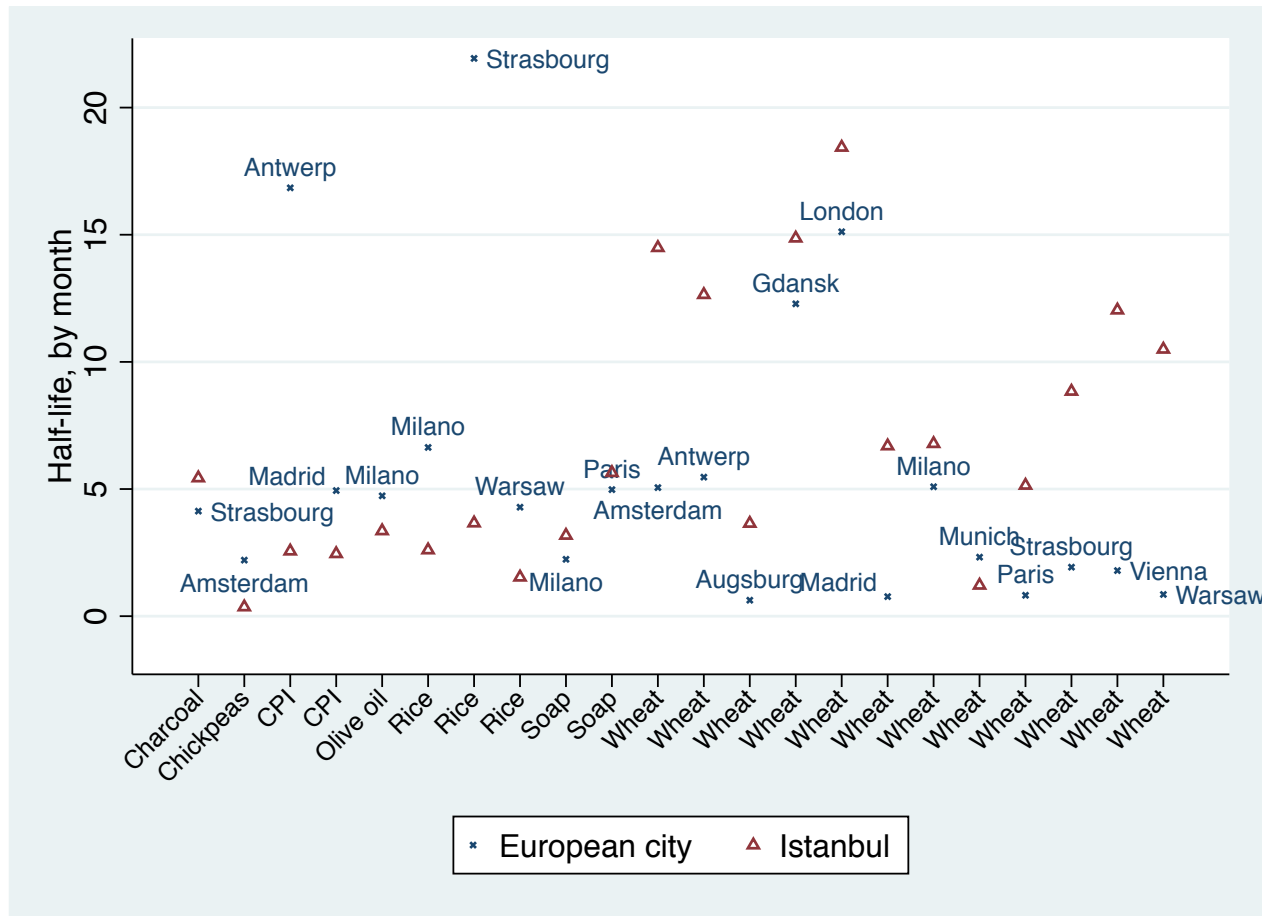
Commodity	European city (x)	Istanbul (triangle)
Butter	Amsterdam (20), London (15), Leipzig (0)	Leipzig (0)
Charcoal	Strasbourg (15), Vienna (10), Warsaw (10)	Warsaw (50)
Chickpeas	Cracow (10), Leipzig (0)	Cracow (0)
CPI	Cracow (10), Lwow (20), Napoli (20), Augsburg (10), Munich (0)	Munich (0)
Olive oil	Northern Italy (15), Krakow (10), Strasbourg (15), Valencia (0)	Valencia (0)

Bottom Plot: Half-life, by month

Commodity	European city (x)	Istanbul (triangle)
Soap	Milano (10), Amsterdam (15)	Amsterdam (0)
Wheat	Amsterdam (15), Gdansk (10), Firenze (5), Leipzig (0), London (5), Madrid (0), Munich (0), Napoli (0), Valencia (10), Vienna (5)	Amsterdam (0), Gdansk (0), London (0), Madrid (0), Munich (0), Napoli (0), Valencia (0), Vienna (0)
Wood	Gdansk (20), Northern Italy (10), Paris (5), Warsaw (0)	Warsaw (0)

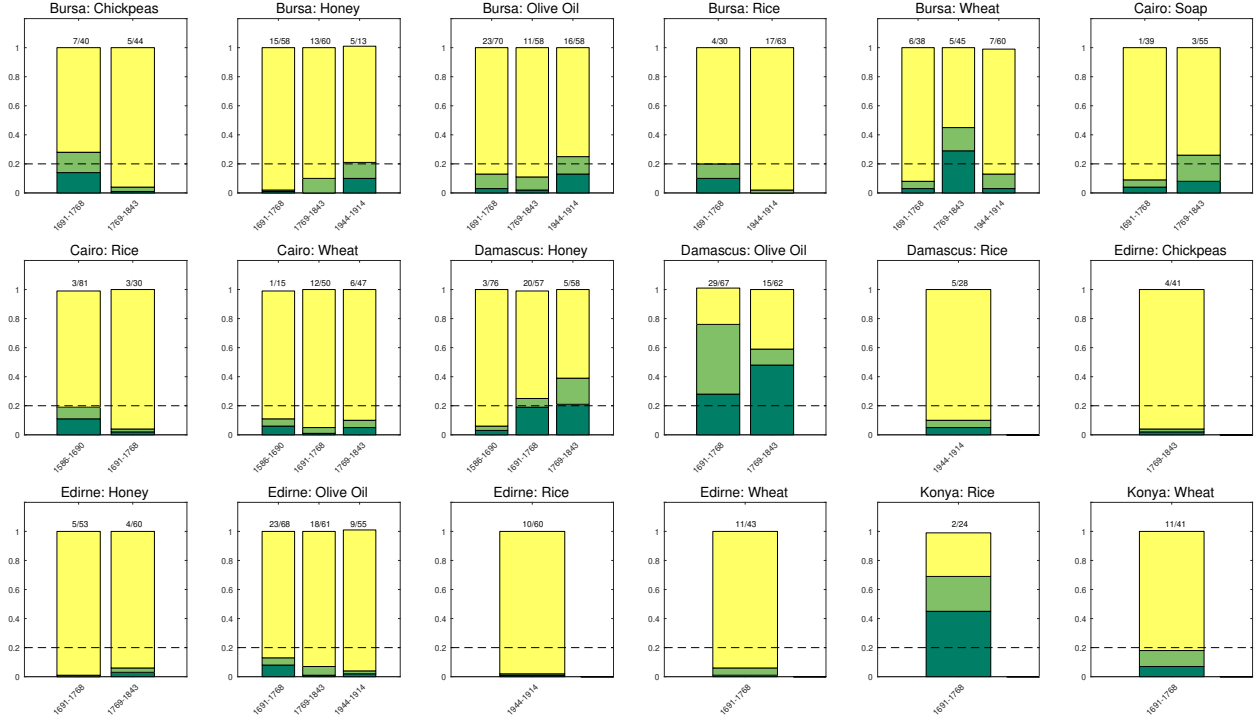
47

Figure 8: Half-lives, 1769-1843, by month



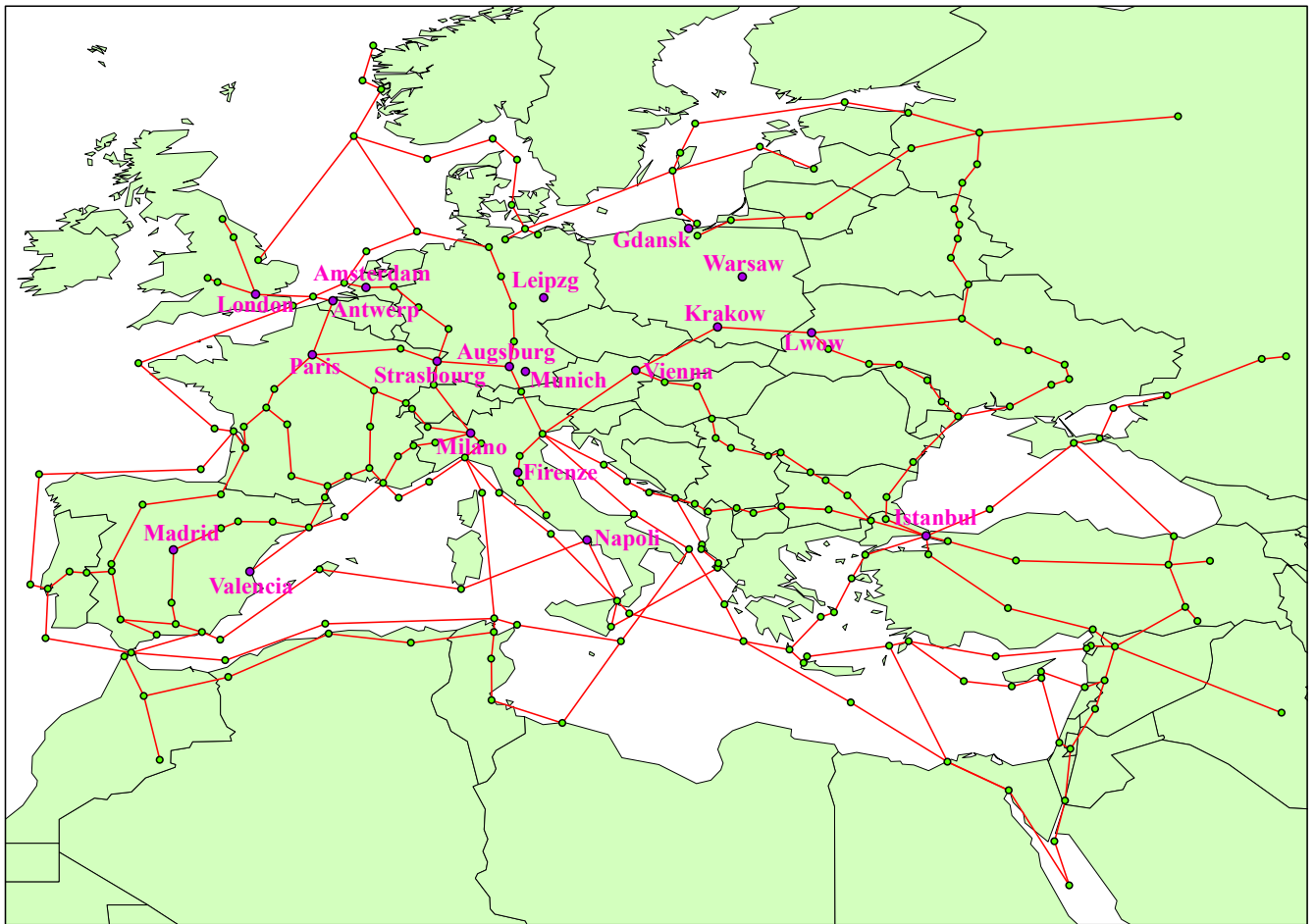
Notes: The half-lives indicate the number of months needed for price deviations to return to equilibrium in each market. The monthly speed of convergence has been computed following Taylor (2001).

Figure 9: Posterior probabilities of strong, weak and no integration models across cities of the Ottoman Empire



Notes: The bars represent the posterior probability of observing each model; on top of each bar we report the number of overlapping over total observations. The dotted line indicates the 80% threshold used as guidance to determine the dominance of the strong model over the alternatives.

Map 1: Trade routes between Europe and the Ottoman Empire



Source: Ciolek (2005)