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ABSTRACT

Are trade and capital mobility complements or substitutes? The standard Heckscher-Ohlin theory postulates that they are substitutes since trade integration invalidates the need for capital to flow to capital-scarce countries. On the other hand, in a recent paper, Antras and Caballero (2009) show that in a world with varying degrees of financial development, trade and capital mobility become complements since trade integration increases the return to capital in less financially developed economies. In our paper, we provide evidence for this complementarity between trade and financial flows of Germany, France, the U.K. – as source countries, and the Ottoman Empire – as a host country, over 1859-1913. Given the provisionistic view of the Empire during this period, only a surplus agricultural production was exported after the Ottoman army was fed. This allowed us to match the content of the Ottoman trade with the agricultural production and instrument trade with rainfalls to establish causality. We find that trade causes capital to flow from the North – the U.K., France and Germany, to the South – the Ottoman Empire. This result holds after accounting for the negative effect of the Ottoman default on financial flows. The complementarity between trade and capital flows gets weaker after the default only when the Ottoman Empire was made subject to a sanction in the form of financial control of the sovereign.

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1 Introduction

Classical trade theory predicts that trade and capital flows are substitutes as trade integration equalizes factor prices and eliminates the need for capital to flow towards capital scarce countries. In a recent paper, Antras and Caballero (2009) show that trade and capital flows are complements in less financially developed countries since trade integration increases the incentives for capital to flow into these economies. Other theories argue that a potential loss of gains from trade lowers the probability of default, increasing financial flows, the so-called "punishment hypothesis" (Rose and Spiegel, 2004; Wright, 2004).[1] Consistent with these predictions, the existing empirical literature mostly finds that trade and finance are positively correlated, where some researchers interpret this positive association as trade being a source of information for the host country enhancing capital flows (See Portes and Rey (2001) for such an interpretation and Obstfeld and Taylor (2004) for a review.)

Unfortunately, establishing a causal relationship between trade and financial flows has been difficult. The empirical literature suffers from an identification problem as trade and finance are simultaneously determined variables, and hence it is not clear how to interpret a positive correlation. The standard approach in cross-sectional research is to instrument trade with distance between the countries.[2] However, distance might not be an appropriate instrument since it can be a proxy for information flows, which could be a direct determinant of financial flows as shown by Portes and Rey (2001). The papers that exploit panel data do not employ an IV approach in general due to the difficulty of finding bilateral time-varying instruments. They rather try to account for unobserved heterogeneity thorough country fixed effects, which will help—but not solve completely—the problem of endogenity. There is also often an omitted variable bias due to inability to control for sovereign default episodes. In most cases this is simply due to data availability, where even if one can control for the actual default date, the time series data is not long enough to account fully for the episodes before and after the default.[3]

In this paper, we utilize a time-varying instrument and provide evidence that trade in goods causes trade in assets. Our innovation comes from the unique and unexploited historical data

[1]This latter literature builds on the reputation hypothesis of Bulow and Rogoff (1989).

[2]See Taylor and Wilson (2006).

[3]As shown by Mitchener and Weidenmier (2005), who employed a gravity model of trade, default is an important variable in determining bilateral trade patterns.

we use. We have a yearly panel data set for the period 1859–1913 that covers trade and financial flows between three source countries in the North—France, Germany, and the U.K.—and one host country in the South, the Ottoman Empire. The length of our time series allows us to cover both before and after the Ottoman default in 1876 and control for unobserved heterogeneity using country fixed effects. Most importantly, by matching the historical data on the content of Ottoman trade with the specifics of the Ottoman agricultural production, we are able to instrument trade with a unique instrument, time-varying historical rainfalls, to establish the direction of causality. As argued by Feyrer (2009), in order to measure the effect of trade on development, time varying instruments are needed so that we can control for unobserved country heterogeneity and address reverse causality at the same time. Both our OLS and IV results show that trade leads to more financial flows. This result holds conditional on the direct negative effect of default on financial flows.

Given the fact that our estimates are identified off of time variation, we can differentiate between several hypotheses that predict a positive association between trade and finance since each rely on different type of variation in the data. The information hypothesis, for example, is mainly a cross-sectional story, where if investors know more about a country because of the existing trade ties between the two countries, then the investor might invest more into that country. It does not rest on the idea that higher trade volume over time will give you more information. Our results are consistent both with the financial frictions hypothesis and the punishment hypothesis in the sense the existence of trade ties increases the return to capital and promotes capital flows to the financially underdeveloped economies since trade solves the misallocation of capital problem due to financing constraints. In the particular case of punishment hypothesis, more trade induces more financial flows due to the fact that increased trade over time serves as an implicit guarantee for the creditors, since potential loss of welfare from a larger trade volume lowers the probability of default. Both of these hypotheses will imply a time-series story instead of a cross-sectional story. The fact that we are finding a causal effect of trade in goods on trade in assets over time means these hypotheses are important. Our paper is the first paper, to the best of our knowledge, that provides causal evidence for the financial frictions and the reputation hypothesis in general as discussed in Antras and Caballero (2009), Wright (2004) and Mitchener and Weidenmier (2005).

To check for external validity and generalize our results beyond the Ottoman Empire, in the second part of the paper, we utilize data from Clemens and Williamson (2004) and investigate the reverse set up. Specifically, this second set of results considers British investments (the single source country) in 19 host countries during 1870–1914 for which we have also collected rainfall data to use as an instrument. The results are similar to the previous ones and assures us that our earlier results are not specific to the Ottoman Empire, though the unique historical setting of the Ottoman case provides clearer identification.

The rest of the paper proceeds as follows. Section 2 discusses the data. Section 3 presents the empirical specification and the results. Section 4 presents robustness results using British data. Section 5 concludes.

2 Data

The Ottoman Empire was one of the longest surviving empires. It stood at the crossroads of civilizations, stretching from Balkans to Egypt for 6 centuries prior to WWI. In the coarse of the 19th century, due to the increased integration with Europe, Ottomans undertook many reforms to attract more foreign capital. They switched to a new monetary system after the big inflation of 1844. Ottomans have borrowed heavily from Europe starting in 1854 to modernize the economy and finance the Russian wars together with the long-distance trade. For example, as Figure 1 shows, by 1875, only U.K. FDI constituted almost 2% of Ottoman GDP. Trade increased 15 fold between 1820–1914 and current account deficit widened, culminating into a financial crisis during 1875–1881. The Ottoman defaulted on their debt in 1876, when they had an external debt of 220 million pounds and when debt servicing was taking up half of their budget. The sharp decline in the U.K. FDI is visible in Figure 1 after the default.

In 1881, the Ottoman Public Debt Administration (OPDA) was set up, where foreign powers control the state revenue to manage the debt payments. This constitutes one of the biggest concessions in the history of international capital markets to gain back the lost reputation. In 1903, the creditors voluntarily restructured the remaining debt of the Ottoman Empire, partially reducing its size.

If we look at Figure 2, we would see that both private and public financial flows fell dramatically from all countries after the Empire defaulted in 1876. Indeed, for both France and the UK (there is no available pre-default data for Germany), the average level of FDI flows during 1877–1881 fell by more than 60%. For public financial flows, the results are even more dramatic – for the UK and Germany, they have decreased to nearly-zero levels. The establishment of the OPDA in 1881 helped the Ottoman Empire to regain its credibility. With the exception of FDI flows from the UK, which remain at the same low level, financial flows during 1882–1914 exceed those during 1877–1881.

A similar situation is observed in the goods market. The Ottoman's exports appeared to be significantly affected by the default: for all three countries, the level of exports from Ottoman empire declined during 1877–1881 when compared to 1859–1876. It seems that OPDA positively affected trade and by the beginning of the World War I, exports became comparable to, and sometimes even exceeded, the pre-default levels. With the exception of Germany, the dynamics of imports were relatively stable.

2.1 Data Sources and Descriptive Statistics

The data on private capital flows (FDI) from France, Germany, and the UK into the Empire are available for 1859–1913 period, and come from Pamuk (1987). Table 1 shows the descriptive statistics. The longest series for capital inflows is for the U.K., where data are available for the entire sample of 55 years. The magnitude of British investment flows into the Empire, however, was the smallest and constituted on average 386 thousand pounds sterling versus 1038 and 765 thousand pounds for France and Germany, respectively.[4] Government debt flow is constructed based on Pamuk (1987) data. These data are available for 1854–1914 and encompass major bonds issues, together with the date of emission, nominal value of bonds, and the (qualitative) description of the amount each major purchaser has acquired. To transform qualitative data into quantitative, we have assumed the following transformations as we document in Table 2.[5]

Exports and imports of goods from the Ottoman Empire into France, Germany and the U.K.

[4] Typically, if a series lacks 1 or 2 years of data, we replace them with the linear time averages of a preceding and a succeeding values. If, instead, it lacks 3 or more consecutive years of data, we leave it as is.

[5] For example, when the data shows that the Ottoman government has issued bonds valued at 3000 thousand pounds, and "nearly all were purchased by the UK," we have recorded that value as the UK public flow of $80\% \times 3000 = 2400$ thousand pounds. In case when a record shows that the purchases of some amount were done during several years (say, 5000 thousand sterling worth of bonds were sold in 1858–1859) we split sales equally between those years. If there are several sales in one year (as it is, say, in 1903), we sum the values together.

are the other central data in this study, which come from two different datasets: Pamuk (2003) and Pamuk (1987). The data in Pamuk (1987) is expressed in thousand British sterling, as the rest of the data we use, and does not require further conversion. We can see from Table 1 that Britain used to be the biggest trading partner of the Ottoman Empire, and used to purchase on average 4.6 million sterling worth of Empire's exports, while selling them about 7.6 million sterling worth of imports, on average. The smallest trade was between the Empire and Germany – only 1.1 million sterling worth of goods were exported, and 0.4 million sterling was imported by Germany. Unlike the UK and Germany, France was the only country (out of three) which has purchased more than it sold. Its own imports and exports to the Empire constituted 3.8 and 2.5 million sterling, respectively.

Gross Domestic Product of France, Germany, and the U.K. comes from Mitchell (1992). These data are expressed in local currencies, which we have converted into British Sterling using the "Gold Standard" exchange rates from Table 3. At that time, one sterling corresponded to a fixed 7.3223 grams of fine gold, and thus, we implicitly measure all the "monetary" variables in gold. GDP data for the Ottoman Empire comes from Clemens and Williamson (2004) dataset.

Population numbers for the Ottoman Empire come from Behar (1996) while the data on population of France, Germany and the U.K. come from the Maddison dataset. The data show that at the beginning of the sample in 1859, France was the biggest country among those three, with population of over 37 million. The smallest was the Great Britain with about 28 million in population. During 1859–1913, France, Germany and the Great Britain experienced drastic differences in population growth rates. By 1913, Germany's population increased by 85%, and it approached the WWI with more than 65 million people. Population of France and the U.K. in the middle of 1913 was 41 and 46 million, respectively.

3 Empirical Analysis

3.1 The Econometric Specification

We are looking to answer the question: Are trade and finance complements or substitutes? Hence, our benchmark specification is as follows:

$$\ln\left(\frac{FDI_{it}}{N_{it}}\right) = \alpha_i + \beta_1 \ln\left(\frac{EX_{it}}{N_{it}}\right) + \beta_2 OPDA_t + \beta_3 OPDA_t \times \ln\left(\frac{EX_{it}}{N_{it}}\right) + \gamma Z_{it} + \epsilon_{it} \quad (1)$$

The left hand side variable is gross capital inflows, defined as FDI, from the source countries (denoted as i), which are France, Germany and the UK, into the Ottoman Empire, without accounting for any investment made by the Ottoman Empire into these source countries. We do not have any information on the Ottoman outbound foreign investment, but our reading of the historical literature, however, seems to be suggesting that financial flows were mainly one-way into the Ottoman Empire. Trade is defined as Exports (EX), and together with FDI, they are normalized by population N_i of the source country.[6] $OPDA_t$ is a time dummy for the creation of the Ottoman Public Debt Administration (OPDA) in 1881; it equals 0 before 1881 and 1 after. The set of controls, Z_{it}, includes country-specific time trends, source countries' and Empire's GDP per capita, time dummies characterizing the effect of Empire's default on the foreign debt in 1876, and the Resettlement of the debt in 1903. To account for the possibility that the OPDA has affected the influence of trade on financial flows, we also include an interaction effect of trade with the OPDA. Thus, we expect β_1 to be positive and significant in the absence of this interaction effect of trade and finance are complements. We also expect the total effect, $\beta_1 + \beta_3$ to be positive but lower, hence β_3 to be negative if it is the case that establishing OPDA is enough for a lower probability of default and hence trade does not need to serve as a guarantee anymore.

[6]Even though both imports and exports data are available and it is arguably more common to define trade as the sum of the two, we define Trade as Exports to justify the exclusion restriction for the instrument.

3.2 Results: OLS

Trade and Private Capital Flows (FDI)

The results showing the log-log regression of private flows (FDI) on trade (defined as exports) are shown in Table 4. First, we see that Trade is typically significant, and the size of the coefficient varies from 0.311 to 0.468 which is in line with the rest of the literature (See Taylor and Wilson (2006)). Given the estimated elasticities, this result suggests that there is an increase in exports by 10%, that would be associated with an increase in private flows by roughly 4%. This result stays in place if we also allow for country-specific time trends, column (7).

To study the effect of the Ottoman Empire's default in 1876, we introduce a "Default" dummy, which equals 0 before 1876, and 1 thereafter. As was expected, by defaulting on its foreign debt, the Ottoman Empire discouraged further investment, reducing capital flows into the country. The point estimate of the coefficient of -1.471 means that foreign countries responded to default by decreasing private flows roughly by 73%.

In 1881, the Ottoman government decided to take actions toward repayment of the debt, and established a European-controlled organization, called the Ottoman Public Debt Administration (OPDA), designed to collect taxes that then were turned over to creditors. We take this event into account by introducing an "OPDA" time dummy, which is equal to 0 before 1880, and 1 after that. We look at two important effects of OPDA on flows. Column (3) of the table shows that the level effect of OPDA on financial flows was positive and significant. Right after establishment of the OPDA, financial flows increased by 171%, significantly mitigating the effect of the default. Indeed, if now we exclude the level effect, and instead introduce the interaction effect of OPDA and trade, we would see that the effect of trade on private flows has declined after establishment of the OPDA. If we take column (4) as a benchmark, that coefficient would amount for -0.266, reducing the effect of trade from 0.397 to 0.131. The intuition behind that result is simple: after introduction of the OPDA, there was no need for the trade relationship to keep serving as a guarantee for repayments of credit – that function was taken over by the OPDA itself. In column (5), when we use both level and interaction as it should be in order to avoid any omitted variables issue, interaction term turns out to be insignificant, while trade still having a positive significant effect.

Finally, in 1903, the creditors voluntarily restructured the remaining debt of the Ottoman Empire, partially reducing its size. We capture that effect by yet another time dummy, "Resettlement," which equals 1 after 1903. The point estimate of resettlement is 0.732, but it is insignificant.

Both source country GDP and host country GDP are included as controls. We can see that source country GDP is significant in some specifications, showing that as the UK, Germany and France became richer in terms of GDP per capita, they tended to invest more into the Empire. This effect, however, disappears as we add more controls. Investment, however, did not appear to be a function of host country – the Ottoman Empire – GDP, as it remains insignificant in all specifications.

To check our results for robustness, we perform one more estimation. Instead of normalizing variables by population, we scale them by GDP of a source country. These results can be found in Table A-1. The results are very similar in magnitude to those obtained before: the trade coefficient stays at the same level of 0.400 and is generally significant; all time dummies (Default, OPDA, and Resettlement) have consistent signs and magnitudes.

Trade and Public Capital Flows

Next, we utilize data on foreign purchases of Ottoman bonds by France, the U.K. and Germany, and look at the effect of trade on public flows. These results are presented in Table 5. As before, trade is proxied by exports, and variables are normalized by source countries populations.[7] The first striking result is that the trade coefficient is negative and highly significant, and is stable among various specifications. Its size is around 0.500 which is very similar to the effect of trade on private flows, however, here it works in opposite direction: higher trade volume is associated with lower public capital inflows. This result seem to suggest that indeed, private and public flows can be substitutes as argued by Lucas (2004). Using contemporaneous data, a recent study by Wei (2007) provides supporting evidence. In some specifications, it also seems to be the case that as countries get richer, they buy more of the Ottoman debt.

Unfortunately, for our sample period from 1859–1913, there is no data on public flows (i.e.

[7]If we normalize all the variables by source countries GDP, the results stay practically identical.

sales of government bonds) available between 1876 and 1881.[8] Therefore, it is not possible to separate the effects of the default (occured in 1876) and establishment of the OPDA (occured in 1881). Thus, we include only one control variable called "Default/OPDA" into the regression; the coefficient in front of it shows the joint effect of the two events. Its value, though being insignificantly different from zero, has a point estimate close to the net effect of default and OPDA on private flows. The same is true for the "Resettlement" dummy – it is positive, has the same size, but is not statistically significant. Allowing for country-specific time trends (column 5) does not influence the results.

3.3 IV Analysis

Rainfalls, Agricultural Production, and Trade

As we have argued in the introduction, the main problem in this literature is identification. There might be simultaneity between the capital inflows and trade, as it is possible that finance promotes trade. In general, researchers use distance between trading countries as an instrument for trade. The intuition is based on the well-known result of the gravity models that trade is inversely related to distance. This has become a stylized fact, which ensures a strong first stage of the IV regression. The caveat, though, is that distance might not be an excludable regressor from the capital flows equation. Indeed, Rose (2005), Portes and Rey (2004), Lane and Milesi-Ferretti (2008) and others successfully apply gravity framework to explain the movements of capital. Distance between the countries enters all their specifications, and is typically highly statistically significant. Therefore, using distance as an instrument might be problematic. In addition we want to stay in the panel framework using source country fixed effects and hence we need a time-varying instrument.

We instrument trade at time t with the amount of rainfalls at year t interacted with the content of trade. We start by specifying the linkage between trade and production. Then we argue why production is closely tied to weather conditions, and specifically the amount of rainfalls. Finally, we explain how the composition of exports into the UK, France, and Germany, as well as specialization of Empire's regions in different types of crops, allow us to construct the instrument.

[8] Alternatively, there might have been no sales of bonds during those years – we were not able to verify that.

The first step is to highlight the dependency between the level of exports and production. Excessive output in one particular year leads to a surplus of goods which are available for sale in and out of the country, causing exports to increase. This line of thought mainly comes from the "provisionistic" nature of Empire's policy. According to Genc (1987, 2000) there were three underlying principles for the Ottoman's development policies. These are provisionism, fiscalism and traditionalism. Provisionism is very important, especially from 16th to 19th century since during this period maintaining a large and consistent supply of goods in the urban economy and feeding the army was the priority. Provisionism determined state's production and trade policies and its relations with merchants. For example, imports were always good and exports were bad; foreign merchants favored over domestic ones; there were rigid price controls especially for the grain products.[9] The government policy at those times was aimed to primarily satisfy the needs of the Ottoman army. Therefore, the supply of exports was determined not only by the prices, but also by the yield in that particular year. If the yield is low, it had to go first towards satisfying the army needs; if instead it is high – the excess will be traded abroad.

As discussed in Pamuk and Williamson (2009), by the beginning of the second half of the 19th century, de-industrialization of the Ottoman Empire was practically complete. Labor and other resources were pulled out of industry, and agricultural production constituted the biggest part of the Ottoman Empire's GDP.[10] Altug, Filiztekin, and Pamuk (2008) state that "Mechanization of agriculture began [only] in the 1950s, making nature one of the most important determinants of people's well-being at those times," and Quataert (1994) adds that "Mechanized factory output was and remained relatively insignificant in the 19th century when compared with domestic and handicraft production."

Agricultural goods made up a significant share of Turkey's exports. Therefore, the amount of rainfalls could be considered as an important determinant of both domestic production and trade. Indeed, Donaldson (2009) for the case of India during 1861-1930 shows that "a one

[9]The second principle, fiscalism, aimed at increasing state's revenue given the wars and expenses of keeping a huge empire as a piece (reoccurring rebellions for example). Thus state collected a lot of taxes from a wide range of economic activities. Genc (2000) argues that state was viewing every economic activity as a source of tax. The third principle, traditionalism, served at keeping the existing relationships between the different groups at the society and between these groups and the state stable. Pamuk (2004) extends this view and argues that the rapid capital accumulation by merchants or any other groups such as urban guilds were never seen as a favorable thing given that this would destroy the existing order.

[10]For example, the share of industrial production in GDP in 1913 constituted only 13%. During 1880–1913, 80% of the labor force was employed in the agricultural sector (Altug, Filiztekin and Pamuk (2008)).

standard deviation increase in rainfall causes a 27 percent increase in agricultural productivity," thus affecting both quantity and quality of agricultural crop. For the case of grapes – one of the most important exports – Hellman (2004) gives an estimated 98 mm of water use per month to maximize quantity and quality of crop. This estimate is obtained for the most efficient modern drip irrigation system; for the furrow irrigation that historically was used in the Ottoman Empire, ideal water usage doubles to 196 mm. Another important agricultural product of the Empire is cotton. There is substantial evidence that "water deficit during critical growth stages can significantly reduce cotton yields" (Steger et al. (1998), Grimes et al. (1970)). For example, in the time of emergence (typically, in October) cotton fields require about 60 mm of monthly water usage. Water requirements increase during the next 5 months, reaching 255 mm a month in late February. Again, one of the main determinants of the yield of dryland (unirrigated) cotton are regular and predictable rainfalls. Similar patterns hold for other important agricultural export goods of the Ottoman Empire such as corn, grain, and olives. Dependency on rainfalls is especially important given that the development of irrigation systems occurred in Turkey only at the end of the 20th century (Food and Agricultural Organization of the United Nations (FAO) (2003)), which is outside the time frame we consider in this paper.

To measure the effect of rainfalls on various types of crops produced, including grain, grape, olives, cotton and others, is possible since the rainfall data is available on a region by region basis, and different regions specialize in different crops.

The area of modern-day Turkey amounts to 300,948 square miles, which equals 779,452 square kilometers. 265,931 square kilometers (a little more than one third) of those lands are used for agricultural purposes (TYS (2005)). In the past, a higher fraction of the land was used for agricultural production plus there was more land under the Ottoman Empire's boundaries. Nevertheless, we assume the specialization of regions in crops stays more or less the same given the geographical conditions. Historically and in modern day Turkey, different regions specialize in different agricultural production. Turkey consists of 80 administrative provinces, 12 statistical regions (SRE) and 7 geographical regions. The first 4 of the 7 regions have the names of the seas which are adjacent to them. Those regions are Black Sea Region, Marmara Region, Aegean Region, and Mediterranean Region. The other 3 regions are named according to their location in the Anatolia: Central Anatolia Region, Eastern Anatolia Region, Southeastern Anatolia Region.

In every region, agricultural land is typically split into two parts. The first part is cultivated field land. These lands are used to grow various types of grain (corn, wheat, barley, rye, etc), as well as cotton and tobacco. The second type is the area of fruit trees, olive trees, vineyards, vegetable gardens, and area reserved for tea plantations. For consistency, we call the first type of land "grain" land, and the second type "fruit and veggie" land. As shown in table 6, the share of "grain" land varies from 35% in the East Black Sea region, to high 99% in North East Anatolia.

An important assumption we make is that the shares of "grain" and "fruit and veggie" lands are roughly the same in the 1859–1913 and today. This allows us to generalize the modern land distribution to that in the late 19th, beginning of the 20th century.

The differences in the shares of "grain" and "fruit and veggie" lands inside each region, as well as the share of a region in the total country-wide production lead to different effects of rainfalls on yields of different types of crop in different regions. As an example, let there be an unusually extensive rain in the Aegean region, and abnormally dry weather in the Mediterranean region. Moreover, let the magnitude of these shocks be the same. We can conclude that first, this event would have a negligible effect on total "grain" production in the country. Indeed, if we look at Table 6, we can see that the area of positively affected "grain" land in the Aegean region equals $2,187$ thousand hectare, and it is fairy close to the negatively affected "grain" area in the Mediterranean region, which equals $2,132$ million hectare. Second, we expect whole country's output of "fruit and veggie" products to increase. The reason for that is that the "fruit and veggie" land in Aegean region is much bigger than that in the Mediterranean region (828 thousand hectares versus 490 thousand hectares). This simple thought experiment will constitute a basis for the construction of our instrument.

The historical precipitation dataset we employ in this study is assembled based on the "tree-ring" methodology – a technique proposed by A. E. Douglass in the 20th century. This methodology allows to relatively precisely recover the level of rainfalls during a "growing season" in each particular year centuries ago based on the wideness of age rings, where each ring corresponds to a certain calendar year. During draughts, rings are typically narrower, while extensive moisture results in wide rings. This data is not real-time historical data in the sense that it was not collected in the past, but instead, is being reconstructed nowadays.[11].

Analyzing tree-ring sites location maps in each study (the maps are available in the original studies), we are able to tie precipitation data series to different statistical regions (SRE), which are listed on Figure 3. Historical precipitation time series for North-West and South-Central regions of Turkey (TR8 and TR5) were constructed by Akkemik et al. (2007) and Akkemik and Aras (2007) respectively, and the time span covered exceeds 300 years. North-West study area – Kastamonu-Pinarbasi and its vicinity – was located on the southern side of the Kure Mountains. This corresponds to TR8 statistical region. The South-Central sampling area was located in the upper and northern part of the Western Taurus Mountains in proximity to Konya, and corresponds to TR5 region. Griggs et al. (2007) dataset covers North Aegean (TR2), specifically, North-East Greece and North-West Turkey, and goes back by 900 years. The authors reconstruct (May-June) precipitation based on analysis of oak tree rings. North-West of Turkey under consideration corresponded to TR2 statistical region. Touchan et al. (2003) build the dataset which reconstructing Southwestern Turkey (TR6) Spring (May-June) precipitations. Their data start in 1776, and the sites were located in the TR3 statistical region. Finally, Touchan et al. (2007) is an extensive reconstruction of precipitations in Eastern-Mediterranean Region for the last 600 years. This study covers not only Turkey, but also other countries in the region. Majority of sites located in Turkey are concentrated in TR3 and the West half of TR6. As the data does not allow to separate TR6 precipitations from TR3 precipitation, we decided to use this series as the best available proxy for the amount of rainfalls in the TR6 region. Because rainfall data are not available for other territories of the Empire, in further discussion we will consider only this subset of regions (TR2, TR3, TR5, TR6, and TR8).

To identify whether there was unusually rainy weather or unusually dry weather in a region $j (j = 1..J)$, in other words, whether there was a positive or negative shock dr_{jt} to agricultural production in year t in region j, we proceed as follows. First, we measure the percentage deviation of yearly precipitations r_{jt} in a region j during year t from their average values over

[11]The data on yearly precipitation rates in various regions of the Empire are publicly available for download at http://www.ncdc.noaa.gov/paleo/recons.html. As a robustness check, we compare reconstructed precipitation data to "true" historical data, provided by the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, and available for download at their website. Unfortunately, the time span this dataset covers is too short to be used in this study, and therefore, it is mainly used to check the "tree-ring" contemporaneous dataset for possible invalidity. The data between both datasets match well.

the time period under consideration (1859–1913):

$$dr_{jt} = \log(r_{jt}) - \log\left(\frac{1}{T}\sum_{t=1859}^{1913} r_{jt}\right) \tag{2}$$

where t indexes years, and T, the sample length, is 54. Positive values of this statistic would indicate that in a year t, region j experienced high amount of rainfalls, which most likely have resulted in high yield. Having this index and knowing the distribution of land between the "grain" and "fruit and veggie" land in each region allows us to construct a variable, which reflects the country-wide "grain" and "fruit and veggie" production shocks as a result of a unique rain map over the Ottoman Empire in year t. Let L_j be the agricultural area of region j. It is split into two parts: "grain" land L_j^g and "fruit and veggie" land $L_j^{f\&v}$, and $L_j = L_j^g + L_j^{f\&v}$. We can define S_j as the share of "grain" land in the total agricultural area of state j

$$S_j = \frac{L_j^g}{L_j} \tag{3}$$

Then the country-wide output shock to "grain" production P_t^g and the output shock to the "fruit and veggie" production $P_t^{f\&v}$ at year t would be the average of the regional shocks, weighted by the share of their area in total area:

$$P_t^g = \frac{\sum_{j=1}^J L_j^g \times dr_{jt}}{\sum_{j=1}^J L_j^g} = \frac{\sum_{j=1}^J S_j L_j \times dr_{jt}}{\sum_{j=1}^J S_j L_j} \tag{4}$$

$$P_t^{f\&v} = \frac{\sum_{j=1}^J L_j^{f\&v} \times dr_{jt}}{\sum_{j=1}^J L_j^{f\&v}} = \frac{\sum_{j=1}^J (1-S_j) L_j \times dr_{jt}}{\sum_{j=1}^J (1-S_j) L_j} \tag{5}$$

This set of indices describes the deviations in production of both types of agricultural outputs as a function of the amount *and* location of rainfalls in Turkey. This gives us the time series variation in our instrument.

The best way to illustrate this formula is to go over an example. Suppose, we know that some year t was especially rainy. Specifically, the percentage deviation from the usual level of precipitations was 10% for the West Marmara region, 20% for Aegean and 6% for West Anatolia. All other regions experienced usual level of rainfalls. What can we say about the deviations of grain and fruit and vegetable production from their average values? The answer depends on the size of a region L_j and its agricultural specialization S_j. The values of L_j and S_j come from Table 6, and they are equal to {1,736; 87%}, {3,010; 73%} and {4,221; 96%} for the West Marmara, Aegean and West Anatolia regions, respectively. To find country-wide shock to the production of "grain" and "fruits and vegetables", we need to use Eq. 4 and Eq. 5. After substituting the values, we get $P_t^g = \frac{0.10\times1{,}510+0.20\times2{,}187+0.06\times4{,}050}{13{,}846} = 6.00 \times 10^{-2}$ and $P_t^{f\&v} = \frac{0.10\times226+0.20\times828+0.06\times171}{1{,}971} = 10.07 \times 10^{-2}$. These numbers mean that in year t, production of grain has experienced a positive shock of 6%, while production of fruits and vegetables has experienced a positive shock of 10%. Different rain patterns from year to year cause a time variation of production.

Our next step is to introduce cross sectional variation (from one trading partner to another) to our instrument. We are able to do this by relying on the fact that the composition of exports differs for Germany, France, and the U.K.

Pamuk and Williamson (2009) argue that the Ottoman Empire, while importing manufactures, specialized in the export of primary products, such as, wheat, wool, raisins plus figs, tobacco, opium and raw silk. As is evident from Table 7, agricultural products (grain, fruit and vegetable) constituted about 50% of exports to both Germany and the U.K. For France, this share makes up 22%. We speculate that the reason for this is that unlike Germany and the U.K., France used to purchase high volumes of raw silk. Its share constantly made up more than 30% of France imports, falling to 18.3% only in 1880–1882, right after the default (Pamuk (2003)).

The differences in exports bundles allow us to obtain cross sectional variation of our instrument. Let m index the country, where $m = \{\text{France}, \text{Germany}, \text{U.K.}\}$. And let $\overrightarrow{\theta}_m = (\theta_m^g, \theta_m^{f\&v}, \theta_m^0)$ represent the decomposition of exports of country m into "Grain", "Fruit and Vegetables" and "Other" according to Table 7. We construct the variable "Rainfalls," R_{mt}, which reflects the effect of rainfalls onto exports into country m, and thus is able to instrument Exports:

$$R_{mt} = \theta_m^g P_t^g + \theta_m^{f\&v} P_t^{f\&v} \tag{6}$$

where as usual, "g" and "$f\&v$" denote "grain" and "fruit and vegetable" production, respectively, and the values of shocks to outputs P_t^g and $P_t^{f\&v}$ are defined according to Eq. 4 and Eq. 5.

3.4 IV Results

The first stage regression of Trade on Rainfalls as well as the 2SLS results of the effect of Trade (measured as Exports) on Private flows are presented in Tables 8 and 9. There, Trade variable for France and the U.K. is instrumented by the amount of rainfalls in various regions of Ottoman Empire as described above. The first stage regression proves that indeed, rainfalls were a significant determinant of exports: the value of the coefficient is around 0.350, significant at the 5% level. The result is not does not depend on whether or not we allow for country-specific time trends.[12]

Comparison of OLS and 2SLS results from Tables 4 and 9 does not show a well-defined pattern – depending on a specification, the 2SLS estimates can be higher or lower than OLS estimates. Their values, however, are statistically identical. 2SLS results show a strong causal effect of rainfallson FDI through trade. Similar qualitative results are obtained if instead of the effect of trade on private flows, we look at the effect of trade on public flows, as shown in Table 10. The effect of trade on public flows is still negative as in the OLS regressions. Here, the instrumented trade coefficients usually slightly exceed those obtained using OLS, which is an indication of a possible measurement problem in the OLS; the difference, however, is never statistically significant. The value of the trade coefficients as well as the effects of other variables on public trade are in accord with previous results.

4 Robustness Analysis: The Case of the U.K

So far we have looked at the dependency between Trade and Financial Flows from multiple source countries into one host country – the Ottoman Empire – before the WWI. For robustness we also analyze the reverse case and study the dependency between Trade and Financial Flows

[12]Germany's trade was not a function of the weather, but instead was determined by political reasons towards the end of our sample since while France and the U.K. fought against the Ottomans in the WWI, Germany was their ally. Hence we do our IV both with and without Germany. We get weaker first stage results for Germany compared to France and the U.K. as shown in Table 8. If we estimate a 2SLS regression over France and the UK, while omitting Germany, the results stay qualitatively the same.

out of one source country – the United Kingdom – into multiple host countries over the same pre-WWI time period. The choice of the UK among other alternatives was dictated both by the fact that before 1914, Britain was both the World's main creditor and a major trading nation and also by availability of the Clemens and Williamson (2004) data set on financial flows that is used by many other researchers. In particular, Taylor and Wilson (2006) raise a similar question as we do by asking whether "hegemons sent larger capital flows to the countries with whom they traded more." There are, however, some important differences between their study and ours. First, we look at a slightly different subset of countries. Second, we augment the financial flows data with annual trade data as oppose to their 5-year averages, since we want to preserve our rich panel structure. Third, Taylor and Wilson define Trade as the sum of UK Imports and Exports, while we use only UK Imports.[13] And finally we have country fixed effects due to our panel dimension, which will allow us to control for country level heterogeneity and utilize our time-varying rainfall instrument.

4.1 The Econometric Specification

Our benchmark specification is as follows:

$$\ln\left(\frac{FDI_{it}}{N_{it}}\right) = \alpha_i + \beta \ln\left(\frac{EX_{it}}{N_{it}}\right) + \phi Size_{it} + \gamma Z_{it} + \epsilon_{it} \quad (7)$$

The left hand side variable, FDI, is private capital outflow from the source country, the UK, into different host countries i, and the right hand side variable is trade, defined as country i's exports into the UK, EX; both FDI and EX are normalized by population of the host country, N_i. $Size_{it}$ controls for size effects, $\ln\left(\frac{GDP_{it}}{N_{it}}\right)$ and $\ln\left(\frac{GDP_{it}}{N_{it}}\right)^2$, similar to Taylor and Wilson (2006), and Z_{it} includes include country-specific time trends, time dummies, host countries' level of urbanization, a dummy for being on the gold standard and a dummy for being engaged in a war.

[13] As in the Ottoman Empire case, we proxy Trade by UK Imports to country i, which is also country i Exports in the UK, to make our instrument both relevant and excludable.

4.2 Data and Descriptive Statistics

To be able to analyze the effect of Britain financial flows on it's trade with partner countries, we have combined several existing datasets into one. Our goal was to obtain a dataset that would contain data on financial flows from Britain into its partner countries (and serves as our main LHS variable), data on bilateral trade between Britain and partner countries (our main RHS variable), and the amount of rainfalls in partner countries that would serve as an instrument, allowing to establish causality.

The first part of our dataset comes from Clemens and Williamson (2004) who have collected data on Britain private and public financial flows into 34 host countries during 1865-1914. The dataset also contains various other control variables that could be important in determining both trade and finance. Financial flows are measured in current British pounds, which we first convert into 1990 GBP using the series of deflator from O'Donoghue (2004) and then into 1990 USD by usign the 1990 GBP/USD exchange rate of 0.5632. Other variables we use from this dataset are GDP – already in 1990 USD, War – a dummy variable that equals 1 if the country was involved in an interstate war in which Great Britain was not a combatant in that year, Urbanization – the fraction of people living in agglomerations of 100,000 or more, and Gold Standard – a dummy variable equal 1 if the country was on the Gold Standard. See Clemens and Williamson (2004) for details.

The second part of our dataset comes from Barbieri, Keshk, and Pollins (2008) who have collected and made publicly available a dyadic trade (both exports and imports) dataset that covers 1870-2006. The dataset is very extensive, and contains 735,847 country pair/year entries. We are using the latest version of the dataset, 2.01, which is available for download at http://correlatesofwar.org. Trade data is measured in millions of current USD. To make this data comparable to Clemens and Williamson figures, we have transformed it into 1990 USD using the reconstructed historical US CPI series, available at http://oregonstate.edu/cla/polisci/faculty-research/sahr/cv2009.xls. Barbieri, Keshk, and Pollins point out that whenever trade data were not observed, they have never replaced it with a zero nor have they averaged it using a preceding and succeeding values; instead, they have coded it as "missing." To make finance data comparable, we also treat zeros in the finance data series as missing observations. As our ultimate goal is to instrument trade between the UK and country i in year t with the amount of rainfalls in country i in year t, we are only interested in one part of the trade dataset – "UK imports from country i" (which is, of course, "country i exports" from from country i's perspective).

Finally, the third part of our dataset comes from Mitchell's "Historical statistics" series that we have used to collect rainfall data. First rainfall records date back to 1700s, and for the majority of countries, the data are available starting in mid-1800. Originally, the data is available on a city-by-city basis. Thus, for some countries, there are multiple cities with rainfall data. For example, for Brazil, there is data for Curitiba, Recife, Rio de Janeiro, and Sao Paolo. However, there are also countries for which data is available for only one city, e.g.: Venezuela's Caracas. From "Historical statistics: The Americas," we have collected data for Mexico, Costa Rica, Cuba, Colombia, Brazil, Chile, Uruguay, Argentina, Venezuela, Ecuador, Bolivia, Australia, Hawaii, New Zealand, Canada, and USA, while data for Greece, Serbia, Belgium, Romania, Denmark, Netherlands, Switzerland, Finland, Portugal, Spain, Austria-Hungary, Norway, Germany, Ukraine, England, France, Italy, Russia, Sweden, and Poland are taken from "Historical statistics: Europe."

For each country, we construct a "rainfalls" index that is positive when rainfalls are above average, and negative otherwise. To do this, we follow the same logic as in the Ottoman case: For each city, we find the percentage deviation of year t precipitations from the average, calculated over 1850-1914. To obtain the rainfall index for countries for which we have data on multiple cities, we calculate a simple average of all city-specific indices for each year t.

As our dataset has to include the data on finance, trade, and rainfalls all at once, it incorporates only a small common subset of countries and years, covered in all constitutive datasets. Thus, our final dataset is available for 1870-1914 for the following countries: Argentina, Austria-Hungary, Brazil, Chile, Colombia, Denmark, France, Germany, Greece, Italy, Mexico, Norway, Portugal, Russia, Spain, Sweden, United States, and Uruguay. Table 11 shows descriptive statistics.

4.3 Results: OLS

The results showing the log-log regression of UK Private Flows (FDI) on Trade, defined as exports from the host countries into the UK, are presented in Table 12. Similar to the Ottoman case, each regression includes country fixed effects. We see that Trade enters each specification significantly, and the size of the coefficient varies from 0.408 to 0.441 which is in line with our results for the Ottoman Empire.[14] Given the estimated elasticities, this result means that as Trade increases by 10%, that would likely cause an increase in Private flows by roughly 4.2%.

Following Taylor and Wilson (2006), we have included size controls into our regressions, however they appear to be insignificant. The only other significant variable, "war," shows that as a country was entering a war, the U.K. financial flows into that country were falling roughly by 47%. Other control variables, Urbanization and Gold Standard, have the expected signs, but are not statistically significant.[15]

4.4 Results: IV

Our next step is to instrument trade (measured as UK imports from country i) with the amount of rainfalls in country i (that likely creates a positive shock to agricultural production and thus allows the surplus to be exported abroad into the UK). This idea rests on the assumption that a considerable share of trade consisted of agricultural products, which likely was the case in the 18th century.

We start by assessing performance of rainfalls as an instrument for country i exports. We have already seen that rainfalls significantly affected exports in the Ottoman Empire case. Having a panel dataset for multiple countries located in different regions of the world allows testing this conclusion more generally.

Unlike before, where rainfalls were ex-post *estimated* over the "growing season," here, rainfalls data are historically *recorded* over a "calendar year." As the growing season typically starts in late Summer – early Fall, one "growing season" is affected by rainfalls in year t as well as rainfalls in year $t-1$. Thus, we would be instrumenting exports with both $Rainfalls_t$ and $Rainfalls_{t-1}$.

To test relevancy of our instrument, we estimate first stage regressions that correspond to

[14]This coefficient is also close to Taylor and Wilson (2006) estimate of 0.397 from a comparable specification with additional controls. Their model is estimated over a comparable sample of countries and time span, but does not include country fixed effects due to its cross-sectional nature.

[15]When we tried estimating the regression replacing Private Capital flows with Public flows, the Trade coefficients became negative and insignificant in all specifications. If we, instead, define Exports and Capital Flows in levels, as opposed to logs, the point estimate becomes positive, but still stays insignificant. This result is different from Taylor and Wilson (2006), who obtain a positive coefficient of 0.965 for the effect of trade on public flows, significant at the 1% level.

previously obtained OLS results. Estimation results are presented in Table 13, column (1). We can see that lagged Rainfalls is significant across the specifications, and the cumulative effect of rainfalls is about 0.13 meaning that when Rainfalls increase by 10 percent, Exports increase by about 1.3 percent. Thus, we can proceed to IV estimation. We show the results of 2SLS estimation in column (2). Trade variable is instrumented by the amount of rainfalls in country i as described above. The effect is positive and significant. Comparison of 2SLS and OLS results from Table 12 reveals the standard pattern observed in 2SLS regressions when the attenuation bias caused by the measurement error is significant: all Trade coefficients in each specification are lower in OLS case than their counterparts in the 2SLS case. Even though their values are statistically identical, the point estimate differ in about 5 times, and show that when Trade goes up by 10%, Private Capital flows increase by about 20%.[16,17] The rest of the controls coefficients, as the Urbanization and the War dummy, also somewhat increase in the magnitude; their qualitative interpretation, however, stays the same as in the OLS case.

[16] This result is very similar to Taylor and Wilson (2006), whose cross-sectional 2SLS estimate of the Trade coefficient equals 1.924, and also exceeds its OLS estimate in $1.924/0.397 = 4.85$ times.

[17] Similar pattern is observed when we estimate a 2SLS regression with Public Capital flows as the left hand side variable. The point estimates rise in several times, but remain insignificantly different from zero regardless of whether we estimate the regression in logs or in levels. Thus, we fail to find any statistically significant dependency between public flows and trade for our sample of countries and time span.

5 Conclusion

In the light of the recent global crisis, economists turn to various historical episodes for lessons.[18] This paper investigates the causal effect of trade on financial flows using a historical experiment from the Ottoman Empire to pin down the identification. The use of the historical dataset is essential not only to justify the case for our instrument but also to be able to control for the default episodes, which is an important variable that affects the relationship between trade and finance.

We find that trade in goods causes trade in assets. We also find that this effect gets weaker after the default if the defaulter gives the control of its fiscal sources to the creditors to pay off its debt. Thus, our results can help us to differentiate among different models that try to justify the complementarity between trade and finance. Trade increases the return to capital in a world with financial underdevelopment and trade acts as "de-facto" lender-of-last-resort. These results are robust to cases when there is one lender and multiple borrowers, as well as when there are several lenders and only one borrower.

[18] See Reinhart and Rogoff (2009).

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Table 1: Descriptive Statistics, by Country

Variable	Units of Measurement	# of Obs	Mean	Std. Dev.	Min	Max
		France				
GDP	British Sterling, $\times 10^6$	55	1137.10	272.21	706.34	1965.43
FDI	British Sterling, $\times 10^3$	41	1038.28	1541.60	40.00	9233.00
Debt	British Sterling, $\times 10^3$	38	4701.65	6907.44	0.00	28000.00
Ottoman Imports from France	British Sterling, $\times 10^3$	40	2485.67	484.06	1579.00	3558.64
Ottoman Exports into France	British Sterling, $\times 10^3$	40	3769.51	586.80	2317.83	4916.00
Population	$\times 10^6$	55	39.47	1.26	37.24	41.46
		UK				
GDP	British Sterling, $\times 10^6$	55	1401.04	405.29	761.00	2354.00
FDI	British Sterling, $\times 10^3$	55	386.15	429.64	25.00	2107.00
Debt	British Sterling, $\times 10^3$	38	1768.96	2270.94	0.00	10000.00
Ottoman Imports from the UK	British Sterling, $\times 10^3$	40	7621.05	1471.72	3429.00	9930.26
Ottoman Exports into the UK	British Sterling, $\times 10^3$	40	4584.91	999.21	2485.35	6341.49
Population	$\times 10^6$	55	36.63	5.18	28.66	45.64
		Germany				
GDP	British Sterling, $\times 10^6$	55	1259.98	633.49	431.60	2782.56
FDI	British Sterling, $\times 10^3$	26	765.56	760.95	90.00	3400.00
Debt	British Sterling, $\times 10^3$	38	1404.07	1964.87	0.00	10560.00
Ottoman Imports from Germany	British Sterling, $\times 10^3$	40	1111.97	1388.10	22.71	4664.09
Ottoman Exports into Germany	British Sterling, $\times 10^3$	40	425.38	509.79	0.05	1461.50
Population	$\times 10^6$	55	47.50	8.69	35.63	65.05
		Ottoman Empire				
GDP	British Sterling, $\times 10^6$	49	153.27	36.70	73.97	208.64
Population	$\times 10^6$	55	16.54	3.10	10.17	21.89

Notes: FDI denotes average Private Capital Inflows from source countries (France, Germany and the UK) into the Ottoman Empire during 1859–1913. Data comes frim Pamuk (1987), Table A3.3 "Funds flows arising from direct foreign investment in the Ottoman Empire, 1859-1913". Debt denotes government debt flows constructed based on Pamuk (1987) data, page 74, Table 4.4 "Ottoman bond issues and major purchasers, 1854-1914. Qualitative measure is transformed into a quantitative measure; see Table 2. Exports and Imports are average values of goods exported from and imported into the Ottoman Empire from France, Germany and the U.K. over 1859–1913, from Pamuk (2003) Table 7.5 and Pamuk (1987) Table 2.3. All values in Pamuk (2003) are originally expressed in Turkish golden lira, and they are converted to British sterlings using Gold Standard exchange rates from Table 3. Source country GDPs come from Mitchell (1992) Table J1 on Page 889 "National Accounts Total". The table includes data on GDP for France and the U.K., and the NNP data for Germany. NNP figures for Germany were converted into GDP following the procedure described in Maddison (1991). Ottoman GDP data is from Clemens and Williamson (2004) dataset. Population figures for the Ottoman Empire are from Behar (1996). The data on population of France, Germany and the U.K. come from the Maddison dataset.

Table 2: Correspondence of Qualitative and Quantitative Measures of Ottoman Bond Purchases

Term used in the book	Percentage Value
All	100
Approximately 90%	90
Nearly all	80
Approximately 3/4	75
1 Country	70
2 countries / each	40
3 countries / each	30
Approximately 1/4	25
Less than 1/4	20
“?”	10
None	0

Notes: This table is used to transform Pamuk (1987) page 74, Table 4.4 “Ottoman bond issues and major purchasers, 1854–1914” into numerical values. Major creditors are B=Britain, F=France, G=Germany, A=Austria, I=Italy. If no info is available about the rest of purchases, we distribute them equally among the rest of the countries. E.g.: the record shows that in 1962 “Nearly all” bonds valued 8,000 thousand pounds sterling were purchased by B. This is transformed into Britain=80 percent, France=Germany=Austria=Italy=5 percent. In sterling amount, this corresponds to Britain=6,400, France=Germany=400.

Table 3: Gold Standard Exchange Rates

Country	France	United Kingdom	Germany	Ottoman Empire
Currency	Franc	Pound Sterling	Mark	Gold Lira
Adopted	04/07/1803	05/01/1821	12/04/1871	01/05/1844
Abandoned	08/05/1914	08/06/1914	08/04/1914	08/03/1914
Grams of Fine Gold	0.2903	7.3224	0.3584	6.6152
Sterling Exchange Rate	25.2215	1.0000	20.4290	1.1069
Dollar Exchange Rate	5.1827	0.2055	4.1979	0.2275

Notes: These data come from Global Financial Data, and available for download at http://www.globalfinancialdata.com/gh/GHC_XRates.xls

Table 4: Ottoman Trade and Private Flows: 1859–1913

	Dependent Variable: Private Flows per capita						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Trade per capita	0.448***	0.434**	0.311*	0.397**	0.340*	0.393**	0.468*
	(0.165)	(0.17)	(0.164)	(0.193)	(0.183)	(0.182)	(0.156)
Source GDP per capita	1.122*	1.183*	0.513	1.301*	0.852	-0.810	-0.635
	(0.649)	(0.655)	(0.671)	(0.674)	(0.807)	(1.584)	(3.031)
Host GDP per capita	1.268	1.889	1.642	1.532	1.540	1.985	1.791
	(1.216)	(1.267)	(1.255)	(1.264)	(1.266)	(1.283)	(2.177)
Default		-1.471***	-2.255***	-1.874***	-2.165***	-2.374***	-1.757
		(0.451)	(0.693)	(0.523)	(0.710)	(0.774)	(1.257)
OPDA			0.999*		0.593	0.713	
			(0.557)		(0.742)	(0.801)	
Trade × OPDA				-0.266*	-0.151	-0.109	-0.296*
				(0.137)	(0.154)	(0.161)	(0.078)
Resettlement						0.732	
						(0.506)	
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	No	No	No	No	No	No	No
Country Time Trends	No	No	No	No	No	No	Yes
R-Square	0.238	0.251	0.294	0.294	0.301	0.319	0.331
Sample size	87	87	87	87	87	87	87

Notes: Trade is defined as Exports. All variables but time dummies are in log's. Both Flows and Trade are normalized by Population of the Source country. Default is a time dummy variable equals 1 after 1876 after the default of the Ottoman Empire. OPDA is a time dummy variable variable equals 1 after 1880 which indicates establishment of the Ottoman Public Debt Administration (OPDA). Resettlement is a time dummy variable equals 1 after 1903 when the Ottoman external debt was significantly decreased after negotiations with creditors. For the specifications without country time trends, Trade variable for each country was detrended prior to estimation. ***, **, * and # stay for significance at the 1, 5, 10 and 15 percent level. All standard errors are clustered by country.

Table 5: Ottoman Trade and Public Flows: 1859–1913

	Dependent Variable: Public Flows per capita				
	(1)	(2)	(3)	(4)	(5)
Trade per capita	-0.504**	-0.520***	-0.516***	-0.468**	-0.446*
	(0.245)	(0.183)	(0.181)	(0.190)	(0.124)
Source GDP per capita		1.259**	1.527**	-0.376	2.814
		(0.572)	(0.580)	(2.247)	(2.522)
Host GDP per capita		-1.404	-0.345	0.874	-0.654
		(1.154)	(1.575)	(2.386)	(1.846)
Default/OPDA			-0.892	-1.163	-1.326
			(0.746)	(0.968)	(2.030)
Resettlement				0.908	
				(1.050)	
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	No	No	No	No
Country Time Trends	No	No	No	No	Yes
R-Square	0.638	0.419	0.430	0.443	0.425
Sample size	60	57	57	57	57

Notes: Trade is defined as Exports. All variables but time dummies are in log's. Both Flows and Trade are normalized by population of the Source country. Resettlement is a time dummy variable equals 1 after 1903 when the Ottoman external debt was significantly decreased after negotiations with creditors. As there are no data on government flows between 1876 (Default) and 1881 (OPDA), they are not separately identifyable, and Default/OPDA (a time dummy variable that equals 1 after 1881) shows their joint effect. For the specifications without country time trends, Trade variable for each country was detrended prior to estimation. ***, **, * and # stay for significance at the 1, 5, 10 and 15 percent level. All standard errors are clustered by country.

Table 6: Agricultural Land of Turkey by Statistical Region (SRE), as of 2004.

	Agricultural Land by SRE, thousand Hectare			
Region	Total Land	Cultivated Field Area	Area of fruit trees, olive trees, vineyards, vegetable gardens, and area reserved for tea plantation	Share of Cultivated Land in Total Land, %
	L_j	"Grain Land"	"Fruit and Veggie Land"	S_j
Istanbul	83	76	7	92
Marmara				
West Marmara	1,736	1,510	226	87
East Marmara	1,564	1,226	338	78
Aegean	3,010	2,187	828	73
Mediterranean	2,623	2,132	490	81
Black Sea				
West Black Sea	2,251	1,996	256	87
East Black Sea	736	259	476	35
Anatolia				
West Anatolia	4,221	4,050	171	96
Central Anatolia	4,003	3,872	131	97
North East Anatolia	1,461	1,443	18	99
Central East Anatolia	1,451	1,328	123	92
South East Anatolia	3,453	3,992	461	87
Total	26,593	23,066	3,526	87

Notes: The data come from Turkey's Statistical Yearbook, 2005. Table 11.11 at page 177. See Data Appendix for details.

Table 7: Ottoman Decomposition of Exports: 1880–1912

	Decomposition of Exports, %		
	France	U.K.	Germany
Grain produce	12.0	25.5	29.5
Fruit and vegetable produce	16.4	22.4	25.2
Other	71.6	52.4	45.3
Total	100.0	100.0	100.0

Notes: "Grain" produce include corn, wheat, barley, rye. Also, we included cotton into this category, because cotton is typically rotated with the grain. "Fruit and vegetable" produce include grape, fig, unspecified fruits and vegetables, vine, olive oil, acorn, hazelnuts and peanuts. "Other" include animal products such as sheep, goat and lamb wool, leather, silk and several minor categories. Shares data comes from Pamuk (2003), page 62, Table 7.2. For the UK and France, the percentage shares are the averages over 1860-1862, 1880-82, 1900-02 and 1910-12; for Germany, we take averages over 1880-82, 1890-1892, 1900-02 and 1910-12.

Table 8: First Stage Regressions of Ottoman Trade on Rainfalls

	Dependent Variable: Trade per capita			
	France the UK		Germany	
	(1)	(2)	(3)	(4)
Rainfalls	0.361**	0.340**	-1.683	-1.716
	(0.150)	(0.148)	(1.347)	(1.396)
Source GDP per capita	0.121	-0.259	-0.199	0.959
	(0.182)	(0.272)	(2.087)	(6.401)
Host GDP per capita	0.057	0.146	-0.933	-1.051
	(0.197)	(0.200)	(1.867)	(2.015)
Default	-0.616***	-0.701***		
	(0.153)	(0.162)		
OPDA	0.324***	0.226***		
	(0.052)	(0.074)		
Resettlement	-0.112*	-0.160**	-1.853**	-1.868**
	(0.065)	(0.072)	(0.810)	(0.836)
Country Fixed Effects	Yes	Yes	Yes	Yes
Time Effects	No	No	No	No
Country Time Trends	No	Yes	No	Yes
R-Square	0.700	0.718	0.620	0.736
Sample size	64	64	23	23

Notes: Trade is defined as Exports. All variables but time dummies and Rainfalls are in log's. Trade is normalized by Population of the Source country. Default is a time dummy variable equals 1 after 1876 after the default of the Ottoman Empire. OPDA is a time dummy variable variable equals 1 after 1880 which indicates establishment of the Ottoman Public Debt Administration (OPDA). Resettlement is a time dummy variable equals 1 after 1903 when the Ottoman external debt was significantly decreased after negotiations with creditors. For the specifications without country time trends, Trade variable for each country was detrended prior to estimation. ***, **, * and # stay for significance at the 1, 5, 10 and 15 percent level. All standard errors are clustered by country.

Table 9: 2SLS: Ottoman Trade and Private Flows: 1859–1913

	Dependent Variable: Private Flows per capita				
	(1)	(2)	(3)	(4)	(5)
Trade per capita	0.412**	0.367**	0.356**	0.412**	0.351***
	(0.161)	(0.160)	(0.167)	(0.171)	(0.021)
Source GDP per capita	1.073*	0.596	0.588	-1.142	
	(0.635)	(0.666)	(0.672)	(1.351)	
Host GDP per capita	1.272	0.824	1.638	2.094	
	(1.217)	(1.307)	(1.252)	(1.258)	
Default		0.765	0.972*	0.986	1.326#
		(0.535)	(0.562)	(0.599)	(0.521)
OPDA			-2.220***	-2.429***	-0.993
			(0.695)	(0.750)	(0.514)
Resettlement				0.799*	0.927
				(0.476)	(0.469)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Time Effects	No	No	No	No	No
Country Time Trends	No	No	No	No	Yes
R-Square	0.238	0.266	0.294	0.316	0.343
Sample size	87	87	87	87	88

Notes: Trade is defined as Exports. All variables but time dummies are in log's. For France and the UK, trade is instrumented by the amount of rainfalls; for Germany, no instrument is used (see text). Both Flows and Trade are normalized by Population of the Source country. Default is a time dummy variable equals 1 after 1876 after the default of the Ottoman Empire. OPDA is a time dummy variable variable equals 1 after 1880 which indicates establishment of the Ottoman Public Debt Administration (OPDA). Resettlement is a time dummy variable equals 1 after 1903 when the Ottoman external debt was significantly decreased after negotiations with creditors. For the specifications without country time trends, Trade variable for each country was detrended prior to estimation. ***, **, * and # stay for the significance at the 1, 5, 10 and 15 percent level. All standard errors are clustered by country.

Table 10: 2SLS: Ottoman Trade and Public Flows: 1859–1913

	Dependent Variable: Public Flows per capita				
	(1)	(2)	(3)	(4)	(5)
Trade per capita	-0.558**	-0.565***	-0.551***	-0.525***	-0.467*
	(0.257)	(0.186)	(0.185)	(0.192)	(0.109)
Source GDP per capita		1.194**	1.474**	-0.360	2.790
		(0.593)	(0.597)	(2.261)	(2.463)
Host GDP per capita		-1.377	-0.326	0.840	-0.645
		(1.161)	(1.576)	(2.391)	(1.826)
Default/OPDA			-0.890	-1.145	-1.366
			(0.750)	(0.972)	(1.993)
Resettlement				0.862	
				(1.063)	
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	No	No	No	No
Country Time Trends	No	No	No	No	Yes
R-Square	0.638	0.419	0.430	0.442	0.425
Sample size	60	57	57	57	57

Notes: Trade is defined as Exports. All variables but time dummies are in log's. For France and the UK, trade is instrumented by the amount of rainfalls; for Germany, no instrument is used (see text). Both Flows and Trade are normalized by Population of the Source country. Resettlement is a time dummy variable equals 1 after 1903 when the Ottoman external debt was significantly decreased after negotiations with creditors. As there are no data on government flows between 1876 (Default) and 1881 (OPDA), they are not separately identifyable, and Default/OPDA (a time dummy variable that equals 1 after 1881) shows their joint effect. For the specifications without country time trends, Trade variable for each country was detrended prior to estimation. ***, **, * and # stay for significance at the 1, 5, 10 and 15 percent level. All standard errors are clustered by country.

Table 11: Descriptive Statistics, U.K. Finance and Trading Partners, 1870–1914

Variable	Units of Measurement	# of Obs	Mean	Std. Dev.	Min	Max
UK Private capital flow (FDI) into country i	1990 USD, $\times 10^6$	718	190.10	531.60	0.00	4995.00
UK Public capital flow into country i	1990 USD, $\times 10^6$	718	61.75	165.58	0.00	1469.8
Country i GDP	1990 USD, $\times 10^6$	718	51800.00	77500.00	1230.00	516000.00
Country i population	$\times 10^6$	718	25.30	30.60	0.55	156.00
Country i exports into the UK	1990 USD, $\times 10^6$	718	1100.00	1790.00	9.17	10500.00

Notes: Private and Public capital flows from the U.K. into host countries, War and Gold Standard dummies, Population and Urbanization come from Clemens and Williamson (2004). Trade is proxied by host countries' exports into the U.K. (U.K. imports), and that data comes from Barbieri, Keshk, and Pollins (2008).

Table 12: UK Trade and Private Flows: 1870–1914

	Dependent Variable: Private Flows per capita				
	(1)	(2)	(3)	(4)	(5)
Trade per capita	0.441*	0.430*	0.408*	0.413*	0.416*
	(0.213)	(0.214)	(0.228)	(0.231)	(0.227)
Host GDP per capita		25.946	24.445	26.335	26.374
		(25.665)	(24.154)	(23.533)	(23.373)
Host GDP per capita squared		-1.636	-1.550	-1.679	-1.681
		(1.643)	(1.545)	(1.503)	(1.490)
Gold Standard			0.207	0.171	0.171
			(0.247)	(0.258)	(0.263)
Urbanization				5.700	5.321
				(4.947)	(4.863)
War					-0.436**
					(0.198)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes
Country Time Trends	Yes	Yes	Yes	Yes	Yes
R-Square	0.738	0.763	0.764	0.764	0.764
Sample size	584	584	584	584	583

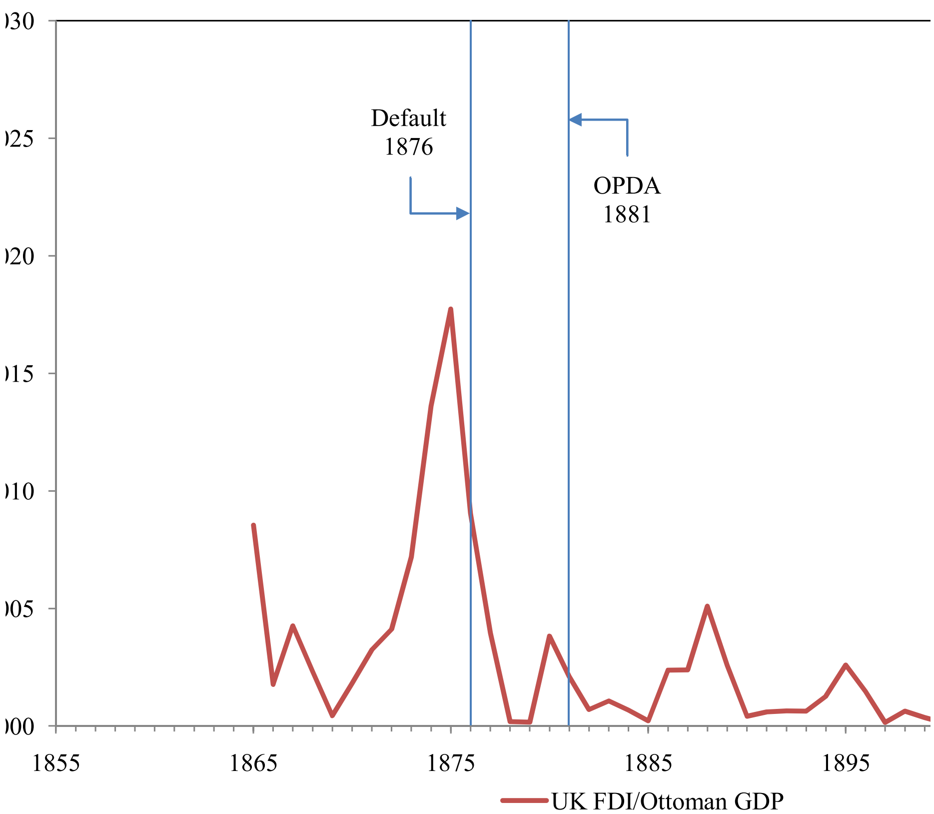
Notes: Trade is defined as Exports from country i into the UK (alternatively: UK imports), normalized by population of country i. All variables but urbanization and dummies are in log's. Both Flows and Trade are normalized by the Population of the host country. Each specification includes time dummies, country-specific time trends and fixed effects. ***, **, *, and # stay for significance at the 1, 5, 10, and 15 percent level. All standard errors are clustered by country.

Table 13: First and Second Stage Regressions of UK Trade, Rainfalls and Private Flows

Dependent Variable	Trade	Private Flows
	1st Stage	2nd Stage
	(1)	(2)
Lagged Rainfalls	0.133**	
	(0.058)	
Rainfalls	0.002	
	(0.063)	
Trade		2.049*
		(1.1170)
Host GDP per capita	-3.717	31.811
	(3.607)	(30.094)
Host GDP per capita squared	0.273	-2.097
	(0.241)	(1.917)
Gold Standard	0.213***	-0.139
	(0.052)	(0.358)
Urbanization	-1.346	7.113
	(1.823)	(10.307)
War	0.020	-0.468**
	(0.075)	(0.206)
Country Fixed Effects	Yes	Yes
Time Effects	Yes	Yes
Country Time Trends	Yes	Yes
R-Square	0.951	0.697
Sample size	581	581

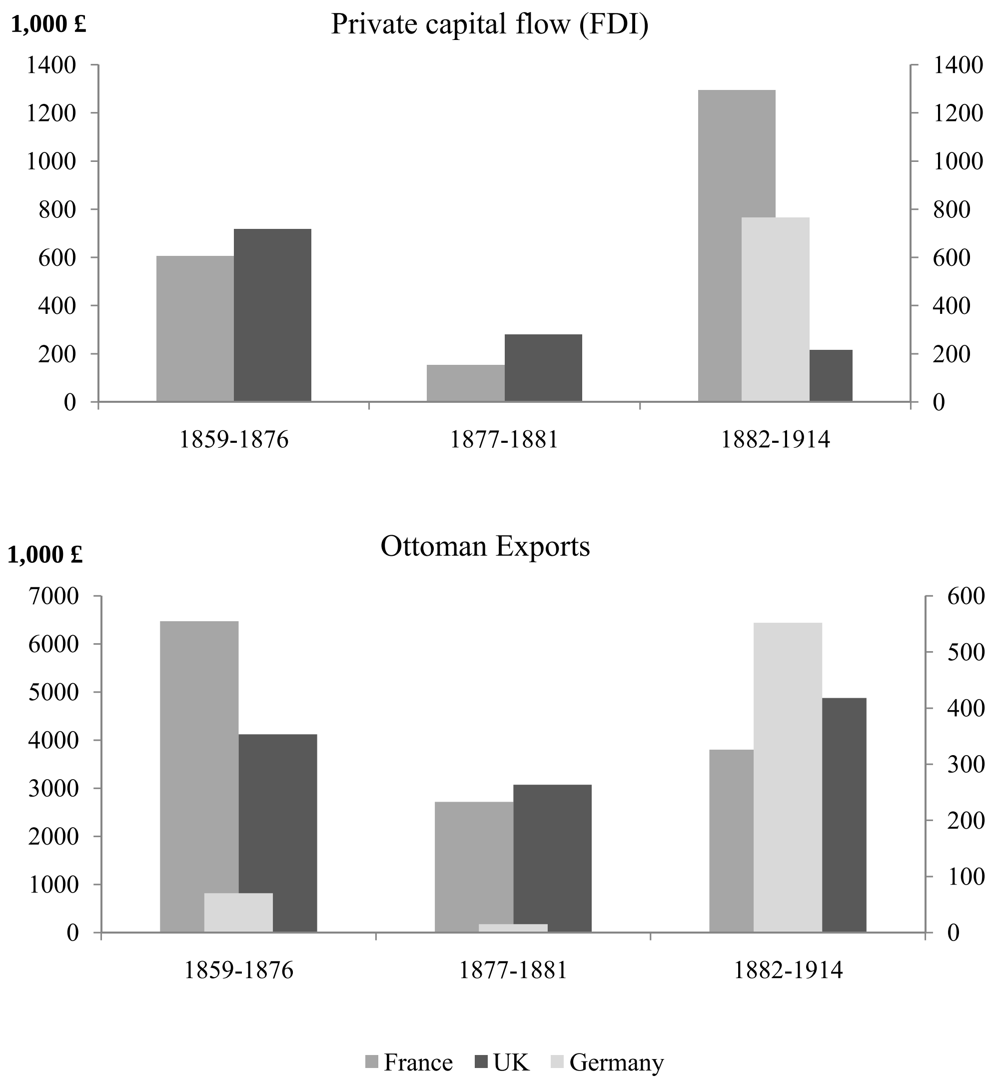
Notes: Trade is defined as Exports from country i into the UK (alternatively: UK imports), normalized by population of country i. All variables but urbanization and dummies are in log's. Each specification includes time dummies, country-specific time trends and fixed effects. ***, **, *, and # stay for significance at the 1, 5, 10, and 15 percent level. All standard errors are clustered by country.

Figure 1: The share of UK FDI in Ottoman Empire GDP over 1859–1913



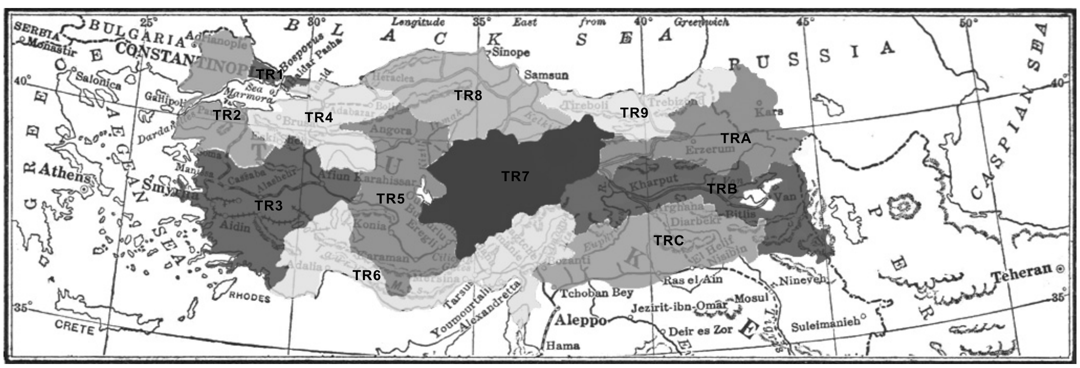
Notes: “Default” indicates default of the Ottoman Empire in 1876. “OPDA” indicates establishment of the Ottoman Public Debt Administration (OPDA) in 1881.

Figure 2: Private capital inflow (FDI) and Exports of the Ottoman Empire during 1859–1913



Notes: All variables are measured in thousand sterling. The UK and France are plotted on the left vertical axes; Germany is plotted on the right vertical axes.

Figure 3: Statistical regions of Turkey with long-term rainfall data



Notes: The figure shows the location of the statistical regions (SRE). TR1-Istanbul, TR2-West Marmara, TR3-Aegean, TR4-East Marmara, TR5-West Anatolia, TR6-Mediterranean, TR7-Central Anatolia, TR8-West Black Sea, TR9-East Black Sea, TRA-North East Anatolia, TRB-Central East Anatolia, TRC-South East Anatolia. Names of the statistical regions and their tags accord to TSY(2005), page 413 "Classification of statistical regions (SRE)". Long-term rainfall data is available for TR2 statistical region (Griggs et al. (2007)), TR3 region (Touchan et al. (2003)), TR5 region (Akkemik and Aras (2007)), TR6 region (Touchan et al. (2007)), and TR8 region (Akkemik et al. (2007)).

Table A-1: Ottoman Trade and Private Flows: 1859–1913 (Normalization: GDP)

	Dependent Variable: Private Flows/GDP					
	(1)	(2)	(3)	(4)	(5)	(6)
Trade/GDP	0.457**	0.441**	0.310*	0.369**	0.364*	0.422**
	(0.175)	(0.180)	(0.167)	(0.182)	(0.199)	(0.198)
Source GDP per capita	0.457	0.503	-0.277	0.021	-0.007	-1.607
	(0.710)	(0.713)	(0.704)	(0.700)	(0.842)	(1.540)
Host GDP per capita	1.303	1.922	1.662	1.555	1.559	2.014
	(1.216)	(1.269)	(1.257)	(1.254)	(1.266)	(1.281)
Default		-1.469***	-2.269***	-2.171***	-2.185***	-2.389***
		(0.455)	(0.693)	(0.616)	(0.709)	(0.768)
OPDA			1.016*		0.076	0.337
			(0.555)		(1.140)	(1.213)
Trade × OPDA				-0.163**	-0.153	-0.111
				(0.078)	(0.150)	(0.155)
Resettlement						0.744
						(0.507)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	No	No	No	No	No	No
Country Time Trends	No	No	No	No	No	No
R-Square	0.294	0.285	0.347	0.353	0.353	0.370
Sample size	87	87	87	87	87	87

Notes: Trade is defined as Exports. All variables but time dummies are in log's. Both Flows and Trade are normalized by the GDP of the Source country. Default is a time dummy variable equals 1 after 1876 after the default of the Ottoman Empire. OPDA is a time dummy variable variable equals 1 after 1880 which indicates establishment of the Ottoman Public Debt Administration (OPDA). Resettlement is a time dummy variable equals 1 after 1903 when the Ottoman external debt was significantly decreased after negotiations with creditors. For the specifications without country time trends, Trade variable for each country was detrended prior to estimation. ***, **, * and # stay for significance at the 1, 5, 10 and 15 percent level. All standard errors are clustered by country.

A Ottoman Variables, Data and Sources

- **Area of agricultural regions in Ottoman Empire**: We look at the contemporary 2004 data due to unavailability of the historical series[19]. Therefore, we proxy the historical distribution of the agricultural lands with the modern one. All data come from TSY (2005), specifically, page 170 and Table 11.11 on page 177. The table contains data on total agricultural land, cultivated agricultural land (which is divided into the sown and fallow land), vegetable gardens land, and the area of fruit trees, olive trees, vineyards and area reserved for tea plantation in all statistical regions (SRE) of Turkey. The SREs are: Istanbul, West Marmara, Aegean, East Marmara, West Anatolia, Mediterranean, Central Anatolia, West Black Sea, East Black Sea, North East Anatolia, Central East Anatolia, and South East Anatolia (refer to Figure 3). We combine 2 types of the cultivated land – sown and fallow – into 1 category "grain land", and we combine both vegetable gardens land and the area of fruit trees, olive trees, vineyards and area reserved for tea plantation into "fruit and veggie" land. The results are presented in Table 6. The principal difference between these 2 Villa (1993)types of land is that they are relatively stable over time, without migrating one into another. The reason is that while "fruit and veggie" land contains mainly perennial plants, "grain" land is repeatedly cultivated, typically each year.

- **Exports and Imports**: Exports and imports of goods from the Ottoman Empire into France, Germany and the U.K. are the other central data in this study, which come from two different datasets. First part of the data is available in Pamuk (2003). The data covers 1878–1913, which is shorter than the time span for which we have capital inflows data for, and thus it does not cover the pre-default period from 1859–1876. Additional data on earlier time period (starting in 1860) were taken from Pamuk (1987). These data show 3-year average values of imports and exports of the Empire for several periods, specifically, 1860–1862, 1870–1872, and 1900–1902, allowing to extend Pamuk (2003) data back to 1878. In our final data set, we have a total of 120 yearly observation for all 3 countries over 1859–1913.

[19]There were 7 agricultural censuses in Turkey, but the first one was conducted only in 1927 (TSY (2005)), while we consider the time period between 1859-1913

The data in Pamuk (1987) is expressed in thousand British sterling, as the rest of the data we use, and does not require further conversion. All values in Pamuk (2003), however, are expressed in Turkish golden lira, and we have converted them to British sterling using Gold Standard exchange rates from Table 3. At that time, one sterling corresponded to a fixed 7.3223 grams of fine gold, and thus, we implicitly measure all the "monetary" variables in gold.

- **GDP**: Gross Domestic Product of France, Germany, and the U.K. comes from Mitchell's (1992) "International Historical Statistics" and this is the primary measure of GDP we use throughout the paper.[20] These data are expressed in local currencies, which we have converted into British Sterling using the "Gold Standard" exchange rates from Table 3.

  GDP data for the Ottoman Empire comes from Clemens and Williamson (2004) dataset. Originally, GDP in the dataset is expressed in 1990 US Dollars, while the rest of the data we use is in British sterling during "Gold standard." To convert 1990 USD into British sterling, we first converted them to 1913 "Gold standard" USD by using the CPI deflator (CPI 1913=9.8, CPI 1990=127.4), and then converted them into Sterling using dollar-pound sterling exchange rate during "Gold standard" $USD/L = 4.8665$ (refer to Table 3 for details).

- **Gold Standard Exchange rates**: Cross-currency exchange rates during the Gold Standard come from the "Global Financial Data", and are available at http://www.globalfindata.com/gh/GHCXRates.xls. The data contains information on exchange rates of 54 countries, including France, Germany, Great Britain and the Ottoman Empire. It has the date a country adopted gold standard, abandoned it and restored. Also it contains currency/gold and currency/silver exchange rates.

[20] The second set of GDPs we are using to check for robustness comes from Jones and Obstfeld (1997). Its structure is the following. For the case of France, GDP data from 1850 to 1900 are from Levy-Leboyer and Bourguignon (1985) Table A-III, series 1, pages 329-332, "Produit interieur brut, millions de francs courants." Data from 1901 to 1944 are from Villa (1993), page 459, series PIBQ, "Production Interieure Brute en valuer - en gros francs courants." The NNP for Germany comes from Hoffman (1965), Table 248, pages 825-826 and it was raised by 8.4% to approximate GDP. And finally, the authors use 2 sources to construct the GDP series for the United Kingdom: from 1850 to 1869, data are from Mitchell (1988), Table. 5, page 831-832, "Gross domestic product at market prices." Data from 1870 to 1944 are from Feinstein (1972), Table 3, pages T10-T11, "gross domestic product at market prices." The dataset is available for download at the NBER website at http://www.nber.org/databases/jonesobstfeld/.

- **FDI**: FDI inflows from source countries into Ottoman Empire. The data are available from 1859–1913. The source of these data is Pamuk (1987). Specifically, we use Table A3.3 "Funds flows arising from direct foreign investment in the Ottoman Empire, 1859-1913". The data are in British pounds sterlings, and no conversion was needed. The table contains data for France, Germany and the UK for three categories: Capital Inflows, Repatriated Capital and Profit Transfers. By "repatriated capital" the author refers to "either the resale of a direct foreign investment in the Empire to investors from another country and the return of the initial investment to its country of origin (with incoming capital appearing under "Capital Inflows") or the repayment by a firm operating inside the Empire of its outstanding bonds being held in Europe". Pages 62-64 of the book discuss this in more details.

  At our knowledge, these are the only data available on private capital inflows into Ottoman Empire for that time period.[21]

- **Ottoman government debt**: Government debt flow is constructed based on Pamuk (1987) data. These data are available for 1854–1914 and encompass major bonds issues, together with the date of emission, nominal value of bonds, and the (qualitative) description of the amount each major purchaser has acquired. One of the challenges was to transform qualitative data into quantitative. For that purpose, we have assumed the following transformations as we document in Table 2. For example, when the data shows that the Ottoman government has issued bonds valued at 3000 thousand pounds, and "nearly all were purchased by the UK," we have recorded that value as the UK public flow of $80\% \times 3000 = 2400$ thousand pounds. In case when a record shows that the purchases of some amount were done during several years (say, 5000 thousand sterling worth of bonds were sold in 1858–1859) we split sales equally between those years. If there are several sales in one year (as it is, say, in 1903), we sum the values together.

- **OPDA**: Dummy variable which indicates establishment of the Ottoman Public Debt administration (OPDA), which was created in December, 1881 and provided foreign control over the national debt. The variable equals 0 in 1978-1880 and 1 in 1881-1914.

[21] Clemens and Williamson (2003) and Taylor and Wilson (2006) use the dataset on financial flows from a single source country, Britain, to 34 countries (one of which is Turkey) for slightly later time period.

- **Resettlement**: Dummy variable which equals 1 after 1903 when the Ottoman debt was significantly reduced as a result of resettlement in 1903 (Pamuk (1987) Page 75).

- **Population**: Population numbers for the Ottoman Empire come from Behar (1996). Another source of Ottoman population data which we use for robustness control is Clemens and Williamson (2004). The data there is available for the entire time period, though it differs from Behar (1996). We believe the reason for the discrepancy is the fact that Clemens and Williamson exclude Egypt and European territories, while Behar (1996) takes them into account.

  The data on population of France, Germany and the U.K. come from the Maddison dataset. The data show that at the beginning of the sample in 1859, France was the biggest country among those three, with population of over 37 million. The smallest was the Great Britain with about 28 million in population. During 1859–1913, France, Germany and the Great Britain experienced drastic differences in population growth rates. By 1913, Germany's population increased by 85%, and it approached the WWI with more than 65 million people. Population of France and the U.K. in the middle of 1913 was 41 and 46 million, respectively.

- **Rainfalls**: There are two sources for the rainfall data we use. The first historical precipitation dataset is assembled based on the tree-ring methodology. The data are publicity available for download at http://www.ncdc.noaa.gov/paleo/recons.html. Precipitations time series for North-West and South-Central regions of Turkey were constructed by Akkemik et al. (2007) and Akkemik and Aras (2007b) respectively. Griggs et al. (2007) dataset covers North-West Turkey. Touchan et al. (2003) reconstructs Southwestern Turkey precipitation. Finally, Touchan et al. (2007) is the extensive reconstruction of precipitations in Eastern-Mediterranean Region.

  The second source of data is the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, and this dataset is available for download at their website. The data cover 70+ Turkish cities and villages from 1889 to 1902 (with intervals of missing data).