NBER WORKING PAPER SERIES

DOES TRADE CAUSE CAPITAL TO FLOW? EVIDENCE FROM HISTORICAL RAINFALLS

Sebnem Kalemli-Ozcan
Alex Nikolsko-Rzhevskyy

Working Paper 16034
http://www.nber.org/papers/w16034

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
May 2010

We thank Michael Clemens, James Feyrer, Graciela Kaminsky, Christopher Meissner, Elias Papaioannou, Alan Taylor, Dietrich Vollrath for helpful discussions and comments, and Ünal Akkemik for help with historical tree-ring rainfalls data. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

Does Trade Cause Capital to Flow? Evidence from Historical Rainfalls
Sebnem Kalemli-Ozcan and Alex Nikolsko-Rzhevskyy
NBER Working Paper No. 16034
May 2010, Re vised April 2011
JEL No. F10,F30,F40,N10,N20,N70

ABSTRACT

Estimating the effect of trade on capital flows is difficult given the endogeneity problem. We use rainfall variation as an instrument for trade between Germany, France, the U.K. and the Ottoman Empire during 1859-1913. The provisionistic policy of the Empire during this period – only a surplus production was exported after the Ottoman army was fed – constitutes the basis of our identification strategy. Heavier rainfall than usual created a surplus agricultural production, which was exported under the provisionistic policy. We findthat one standard deviation in rainfalls from the mean lead to a 3.5 percent increase in Ottoman exports, which in turn causes a 10 percent increase in capital in flows, on average. We show that the effect of rainfall shocks on capital flows does not operate through income. Our results also hold after accounting for the negative effect of the Ottoman 1876 default on foreign investment and trade. These findings are supportive of trade theories predicting complementarity between trade and capital flows as a result of causality running from exports to foreign direct investment.

Sebnem Kalemli-Ozcan
University of Houston
Department of Economics
Houston, TX 77204
and NBER
sebnem.kalemli-ozcan@mail.uh.edu

Alex Nikolsko-Rzhevskyy
Department of Economics, FCBE
University of Memphis
Memphis, TN 38152
alexr.work@gmail.com

1 Introduction

The classical Heckscher-Ohlin-Mundell paradigm states 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. Introducing technological differences across countries, Kemp (1966) and Jones (1967) argue that trade and capital flows can be complements with full specialization of at least one country. Helpman and Razin (1978) show a similar result through a different mechanism under production uncertainty. Trade in assets can insure the production risk enabling specialization and promoting trade in goods. Both in Kemp-Jones and Helpman-Razin frameworks, causality runs from international capital flows to trade. Although direct empirical support for this channel has been absent, Kalemli-Ozcan, Sorensen, Yosha (2003) provides indirect evidence by showing regions with higher levels of risk sharing also have higher levels of industrial specialization.

In a recent paper, Antras and Caballero (2009) highlight a different mechanism, where the causality runs from trade to capital flows. They argue that in less financially developed countries trade integration increases the incentives for capital to flow into these economies. Their specific mechanism works through the existence of financial constraints that creates a misallocation of capital across sectors given the fact that some sectors are in need of higher external finance. Trade solves this misallocation problem. Although, no direct evidence has been brought upon this specific story, there is empirical work that shows a positive effect of trade on capital flows. Using a cross-sectional approach, Taylor and Wilson (2006) finds a positive effect of trade on financial flows, instrumenting trade with distance. Their interpretation is that trade decreases asymmetric information and hence enhances capital flows. However, as shown by Guiso et al. (2009), Portes and Rey (2001) and Aviat and Coeurdacier (2007), distance and other non time-varying gravity related factors determine both trade in assets and trade in goods and hence cannot be valid instruments for each of them.

Establishing a causal relationship between trade and financial flows is difficult. As implied by the various theoretical models causality can run both ways and hence it is not clear how to interpret a positive correlation. In addition there can be a serious omitted variable bias due to inability to control for common shocks such as financial crisis and/or sovereign default episodes, which will create a simultaneity problem in capital flow and trade patterns as shown by Mitchener and Weidenmier (2005). The existing empirical literature does not adequately address the endogeneity problem and fails to provide evidence for the effect of trade on capital flows. It is important to know the causal relationship between trade in goods and trade in assets since this inter-relation is one of the key features of globalization.

In this paper, we use exogenous variation in rainfall as an instrument for trade. We use a yearly panel data set for the period 1859–1913 that covers trade and financial flows (private and public) between three source countries in the North – France, Germany, and the U.K. – and one host country in the South, the Ottoman Empire. There is an extensive literature that uses weather shocks as an instrument for growth in GDP in agricultural economies without well-developed irrigation systems that rely on rain.[1] Our identification strategy is similar in the sense that it is based on temporary fluctuations in agricultural production caused by year-to-year changes in rainfall.[2] This strategy is very relevant for our case given our exclusion restriction that rainfall variation affects capital flows *only* through exports in the short-run. Our innovation comes from not only the fact that we are first to use the rainfall variation to predict the effect of trade on capital flows, but we also have a unique historical context that delivers our exclusion restriction.

Historians emphasize the fact that in late medieval and early modern periods, it is difficult to talk about the economic environment separate from the political and administrative one. The case of the Ottoman Empire is no exception to this rule. The leading concern of the Ottoman policy was the provisioning of the army, palace and the urban economy. The government wanted to assure a steady supply of goods for the armed forces, state officials and the major cities. This emphasis on provisioning created an important distinction between imports and exports. Imports were encouraged since they have added to the available good set in urban markets. Exports, on the other hand, were permitted *only* after the requirements of the domestic economy were met.[3] Pamuk and Williamson (2009) argue that these provisionistic views interacted with the increased integration of the Ottoman economy into the world markets during

[1]This literature goes back to Paxson (1992), who used weather variability to measure response of savings to temporary income fluctuations. See Schlenker and Roberts (2006), and Deschenes and Greenstone (2007) who focus on U.S. agricultural production.

[2]Miguel, Satyanath, and Sergenti (2004) uses yearly changes in rainfall to identify the effect of temporary growth on the likelihood of civil conflict in Africa.

[3]See Genc (1970) and Inalcik (1994) among others.

the 19th century and paved the way for the Ottoman de-industrialization process that has been completed circa 1850. The empire became an importer of manufactured goods and exporter of the *surplus* agricultural goods, such as cotton, grape, corn, grain, olives, raisins, and figs. Rain is very important for these agricultural products: a typical estimate found in the literature is that 1 standard deviation increase in rainfalls delivers a 30 percent increase in the production of agricultural goods.[4] Our final step involves mapping the regional production of these primary products with the rain patterns and also with the export bundles that U.K., France, and Germany were buying from the Ottomans. We use a historical precipitation dataset that is based on the "tree-ring" methodology. This methodology allows to recover the level of rainfalls during a growing season in each year centuries ago based on the wideness of the tree rings, where each ring corresponds to a calender year. During draughts, rings are narrower, while extensive moisture results in wider rings. To check the validity of the tree-ring methodology we compared our rainfall data constructed from tree-rings to real-time historical rain data from two different sources, obtaining a good match between the data sets.[5]

The following example will clarify the thought experiment behind the construction of the instrument. Suppose the percentage deviation in rainfalls in year t is 10 percent for region A and 20 percent for region B, and there was no deviation in rainfalls from the mean for the other regions of the empire. Also suppose, region B's land is distributed in a way that 70 percent is share of cultivation (grain products) and 30 percent is fruit and vegetable production. For region A, the distribution is 80/20 percent between grains and fruit and veggies. Then we can calculate a weighted average index of regional rainfall deviations given the land distribution of production to obtain the yearly rainfall shock to grains and fruit and veggies.[6] Next, to create country-time variation in the instrument, we combine this yearly product specific weather shock with the initial (first year in our sample) content of trade: Ottoman grain versus fruit and veggie exports into France, Germany, U.K. at the beginning of our sample.

This unique historical context constitutes the basis of our identification. It is not only the

[4]See Donaldson (2009).

[5]The first real-time historical data comes from National Oceanic and Atmospheric Administration, U.S. department of Commerce. The second one is from Ottoman Archives. Both sets are not available for all our regions and time periods and hence cannot be used in the regression analysis.

[6]Specifically, in this example, rainfall shock to grains=$0.2 * 0.7 + 0.1 * 0.8$ and rainfall shock to fruits and veggies=$0.2 * 0.3 + 0.1 * 0.2$

case that our instrument explains the variation in the main explanatory variable, Ottoman exports, but it is also excludable since rainfalls will affect investment by the northern countries into the empire only through exports in the short-run. The reasoning relies on the fact that we only use short-run fluctuations in rainfalls, which created a temporary surplus production, which was in turn exported given the provisionistic view. This is important especially in the context of standard dynamic open economy models that predict an effect of a productivity shock on country's capital inflows. But note that there is a clear distinction in these models between a temporary shock (such as yearly fluctuations in rainfalls) and a permanent one. In the case of a temporary shock, savings will increase with not much action on investment, resulting on net capital outflows.[7] Only in the case of a long-lived productivity increase there can be net capital inflows unrelated to exports violating our exclusion restriction. The length of our time series allows us not only to exploit time-series variation and control for unobserved heterogeneity using country fixed effects, but also makes it possible to include country specific trends that will account for any increasing investment by Northern countries into the Ottoman empire due to a long-lived productivity increase in the empire, if any.

Our main empirical findings are as follows. In the OLS specifications we find a positive correlation between Ottoman exports and capital inflows from U.K., France, and Germany. The point estimates imply a 10 percent increase in Ottoman exports into Northern countries being associated with a 5 percent increase in FDI from North to the Ottoman empire, both variables explained as a share of northern countries GDP. The reduced form estimates of FDI on our weighted rainfall index show a robust positive significant effect. Our first stage predicts a deviation of 10 percent in rainfalls from the mean (which approximately corresponds to one standard deviation in rainfalls from the mean) results in a 3 percent increase in Ottoman exports.[8] Finally, our second stage regressions deliver an effect of 3 to 15 percent increase in FDI as a result of a 3 percent increase in exports, depending on the specification. The second stage estimates are little higher then the OLS estimates, given the fact that OLS estimates are biased downwards

[7]During the coarse of the 19th century, capital flows were one way from the center to the periphery countries as argued by Obstfeld and Taylor (2004) and hence capital outflows were essentially zero. This is either because periphery countries were full colonies or they were not integrated fully into the world markets to invest their savings.

[8]See also Dell, Jones, and Olken (2008, 2009) who focus the effect of weather changes (temperature and precipitation) on GDP and exports and find large estimates in the case of exports.

due to the measurement error in export data. The economic impact of all these estimates are significant and reasonable.

Our results are consistent with the financial frictions hypothesis of Antras and Caballero (2009) in the sense that the existence of trade ties increases the return to capital and promotes capital flows to the financially underdeveloped economies. In their model, with trade integration, South (Ottomans) specializes in the unconstrained sector (agriculture) and becomes a net importer of the output of the financially dependent sector (manufacturing). This was indeed the case as argued by Pamuk and Williamson (2009) starting with the trade liberalization treaty of 1838.[9] Altug, Filiztekin, and Pamuk (2008) report that agriculture started being dependent on external finance only after 1950s when mechanization started, which is outside our sample period. In Antras-Caballero model, trade integration does not bring factor price equalization and raises the return to capital in the South. Given the depressed wages in the South and good price equalization, capitalists earn a higher return in the South. Hence trade solves the misallocation of capital problem due to financing constraints.

Complementarity between trade and capital flows can also arise in modified versions of Heckser-Ohlin-Mundell type frameworks as argued above. However, notice that in those models causality almost always runs from capital flows to trade, where comparative advantage is not driven by differences in capital-labor ratios but rather by other channels (see, Markusen, 1983). Our results robustly show that causality runs from trade integration to capital flows. This does not mean there is no effect of FDI on trade. In fact in a historical context there are many cases of significant investment by the core countries into the infrastructure of the periphery countries such as railroads, which ended up boosting the trade between the two. German-Ottoman strategic partnership for Berlin-Baghdad railroad is a case in point.[10] This is exactly why a strong identification strategy is necessary to see if the positive correlation between FDI and trade is solely driven by the effect of such infrastructure FDI on trade or rather there is also a significant causal impact of trade on FDI, which is the case as we show here.[11]

[9]This 1838 Anglo-Turkish Commercial Convention was not only viewed as the empire's transition to economic liberalism but also though of marking the "collapse" of Ottoman industry according to many historians (Issawi, 1982), especially the quildsmanship with the influx of cheap manufactured goods. Note that this treaty eliminates all duties and tariffs for foreign merchants while keeping in place an 8 percent internal customs duty for domestic merchants to transfer goods within the empire. Export duties are also raised. See Issawi, 1982.

[10]McMeekin (1994).

[11]Another possible interpretation of our findings is a lower degree of the asymmetric information as a result of

A valid threat to the identification is the possibility of omitted variable bias, where a third variable can drive both Ottoman exports to North and North's investment in the empire. Our instrumental variables strategy will be able to deal with this issue to a certain extent. Nevertheless, we use country and time fixed effects and country-specific trends together with controls for GDP and population differences, imports, and also Ottoman government debt. Most importantly we condition our results on the the direct negative effect of 1876 Ottoman default. As a result of default both trade and financial flows can go down regardless of the temporary shocks to trade caused by rainfalls. Our results are not only robust to controlling the default episode but also to the establishment of Ottoman Public Debt Administration (OPDA) in 1881. OPDA was established after the debt restructuring negotiations for the purpose of paying the creditors. We show that the positive effect of trade on flows weakened after the establishment of the OPDA. In this sense, our results are also consistent with the punishment hypothesis which is advanced by Wright (2004), Mitchener and Weidenmier (2005), and Rose and Spiegel (2004) that is based on reputation work of Bulow and Rogoff (1989). Here, 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.

The rest of the paper proceeds as follows. Section 2 lays out the historical and institutional context together with the data. Section 3 discusses the descriptive statistics. Section 4 presents the empirical specification, the results and the robustness analysis. Section 5 concludes.

2 Historical-Institutional Context and 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. Given the coverage of our data from 1859–1913, this paper focuses on the borders of the empire from 1830 until World War I, as shown in figure 1. These borders include northern Greece, Syria, Iraq and present-day Turkey, excluding Egypt and Libya.

increased trade, which in turn encourages foreign private investment. We think this is unlikely in the case of the Ottoman empire and the core European powers of the time given the Ottoman presence in Europe (military and economic) and numerous visits and extended stays by European merchants and diplomats in the empire since 1500s.

In light of the new evidence from the archives historians no longer think the Ottoman empire was in a state of a permanent decline beginning 16th century. It is now realized that Ottoman state was flexible and pragmatic and was able to adopt to the changing environment. Although 17th century was a period of crisis, 18th century has witnessed an expansion of trade and an increase in production. The empire was shrinking starting the middle of the 18th century due to territorial losses, but at the same time, during most of the 19th century empire become more linked to Europe via commercial and financial networks. The provisioning of the capital city, the armed forces and the urban areas, taxation, support, and regulation of long-distance trade, and maintaining a steady supply of money were among the main policy concerns of the state. Hence, government always intervened into economic affairs. Ottoman empire is not unique in this respect since the pursuit of similar policy goals led the emergence of powerful nation states in Europe and Asia (Tilly, 1975).

During our sample period, the world economy had witnessed an enormous expansion of trade between center and periphery countries. Thanks to the Industrial Revolution, European (center) countries became exporters of manufactured goods. These countries were selling their manufactured products to the third world (periphery) countries and at the same time they were buying primary products and raw materials from the periphery countries.

Among the periphery countries, China and the Ottoman empire had a unique place since they had a strong central bureaucracy and their governments had the upper hand in the struggle between the bureaucracy and the interest-groups such as merchants and export-oriented landlords (Genc (1987); Inalcik and Quataert (1994)). These countries were never colonized. In the case of the Ottoman empire, the sultans and state officials were aware of the critical role played by merchants. Long distance trade was very important for the provisioning of the empire. Foreign merchants were especially welcome since they brought goods that are not available in Ottoman lands and hence they were granted various privileges and concessions at the expense of domestic merchants. Historians argue that this is the primary reason why mercantilist ideas never took root in Ottoman lands. While the ideas of domestic merchants and producers were influential in development of mercantilism in Europe, the priorities of central bureaucracy dominated the economic thought in the Ottoman empire instead. The policy priority is such that only surplus agricultural production can be exported abroad after the army, palace and the urban markets were satiated. This provisionistic policy created a difference in the attitude of sultans towards foreign and domestic merchants, and hence between imports and exports (Genc (1987); Inalcik and Quataert (1994)). Trade between the Ottoman empire and the European countries has increased 15 fold between 1820–1914. However, given the provisionistic policy, the share of Ottoman exports did not exceed 6 to 8 percent of total production and 12 to 15 percent of agricultural production until 1910 (Pamuk (1987)). By 1910, 25 percent of the agricultural production was exported, whereas 80 percent of the manufactured goods are imported.

The 19th century is characterized by one-way capital flows from center European countries to periphery third world countries. Our data covers such one-way private capital flows (FDI) from France, Germany, and the UK into the Ottoman empire during 1859–1913 period. We also have data on exports from the Ottoman Empire into France, Germany and the U.K. and imports of the Ottoman empire from these three center countries. Both data come from Pamuk (2003) and Pamuk (1987) and they are expressed in British sterling. The top panel of figure 2 shows the total Ottoman exports and imports during our sample period, using data from Pamuk (1987). There was an eight-fold increase in imports and a quadrupling of exports, a pattern that led to accumulation of current account deficits. The sharp decline in both exports and imports after the default of 1876 is visible. The bottom panel in the same figure plots the same total exports series from the top panel together with exports to the U.K., France and Germany, where the latter constitutes almost half of the total exports.

The expansion of trade between center and periphery countries was followed by investment of European powers into the third world, in general. It was not only the case that European governments lent money to the periphery governments but also private foreign money flowed into the periphery countries. Some of this investment is in the form of foreign direct investment (FDI) to finance infrastructure such as railroads, with the aim to expand trade even more. The foreign investment was not solely concentrated in the infrastructure, however, and the case of the Ottoman empire was not different. As of 1888 while 33 percent of the total foreign investment from Europe in the Ottoman empire was in railroads, 31 percent was in banking, 9 percent was in utilities, 8 percent in commerce, 12 percent was in industry, and 5 percent was in mining, as shown in Pamuk (1987). Foreign investment in agricultural sector remained limited until the end of World War I.

The top panel of figure 3 shows the private investment (FDI) from U.K., France and Germany into the empire. Overall, France was the biggest investor followed by the U.K. and Germany. German investment did not start until after the signing of the strategic German-Ottoman partnership which also marks the start of the Berlin-Baghdad railroad construction in 1885. The bottom panel of the same figure shows the country by country decomposition of exports from the previous figure. Again exports into Germany in general is low compared to the U.K. and France and only slightly increased during the last three decades of our sample period that coincides with the increased FDI of Germany. Similar to exports and imports in the previous figure, there is a stark decline after 1876 in FDI, up to 60%, and then recovery. This is also true for exports by destination country as shown in the bottom panel. Both declines are due to the default of the Ottoman empire on its external debt in 1876.

In the coarse of the 19th century Ottomans undertook many reforms to modernize the economy. They needed foreign capital not only to finance this modernization effort but also to keep their growing fiscal deficit under control given the increased financing of Russian and Balkan wars. Ottomans have borrowed heavily from Europe during 1850s and 1860s. None of this can prevented the financial crisis of 1873 and the default of 1876 on the sovereign debt. As of 1876 the outstanding debt was 200 million pounds sterling and debt servicing was taking up half of the budget (Pamuk (1987)). After negotiations, the Ottoman Public Debt Administration (OPDA) was established in 1881 to exercise European Control over Ottoman finances and ensure debt payments. The outstanding debt was reduced half of its value in nominal terms during the debt restructuring negotiations. (Blaisdell, 1929). The OPDA helped to repair the lost reputation and hence the Ottoman state gained renewed access to the international capital markets. This constitutes one of the biggest concessions in the history of international capital markets to gain back the lost reputation.

3 Descriptive Statistics

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 0.39 million pounds sterling versus 1.04 and 0.77 million pounds for France and Germany, respectively.[12] We can also 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, with Ottoman exports being 3.8 and France imports being 2.5 million sterling, respectively. Overall, the empire was running a current account deficit against all these three countries in total, on average during our sample period.

Gross Domestic Product (GDP) of France, Germany, and the U.K. comes from Mitchell (1992). Mitchell (1992) and Maddison (1995) also give some GDP numbers for Turkey. We use the GDP data for the Ottoman Empire comes from Clemens and Williamson (2004), which is based on Pamuk's GDP estimates (later years' figures where data available from all sources match exactly). All the GDP data are expressed in local currencies, which we have converted into British Sterling using the "Gold Standard" exchange rates (see appendix table A-1). During our sample period, 1 sterling corresponded to a fixed 7.3223 grams of fine gold, and thus, we implicitly measure all the "monetary" variables in gold. As shown in table 1, the Ottoman empire is roughly 10 times poorer then the European countries.

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 (1995). Table 1 shows 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 only 41 and 46 million, respectively.

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

4 OLS Analysis

4.1 Empirical Specification

Our benchmark specification is as follows:

$$\ln\left(\frac{FDI_{it}}{GDP_{it}}\right) = \alpha_i + \lambda_{it} + \beta \ln\left(\frac{EXPORTS_{it}}{GDP_{it}}\right) + \gamma Z_{it} + \epsilon_{it} \tag{1}$$

where α_i is a country-fixed effect and λ_{it} is a country specific-trend. The left hand side variable is gross FDI inflows from the source countries (denoted as i), which are France, Germany and the UK, into the Ottoman Empire. $EXPORTS$ are Ottoman exports into these countries. Both FDI and EXPORTS are normalized by GDP of the source countries, GDP_i. The set of control variables, Z includes different time dummies such as a time dummy for the creation of the Ottoman Public Debt Administration (OPDA) in 1881, and other time dummies characterizing the effect of Empire's default on the foreign debt in 1876, and the Resettlement of the debt in 1903. Controls also includes source countries' and Empire's GDP per capita, population, imports, and Ottoman public debt.

4.2 Results

We report results from the OLS estimation of equation (1) in Table 2. In all the specifications, exports turn out to be positive and highly significant. None of the controls in columns (2) to (6) change the main result. The results are also economically significant, where a 10 percent increase in exports lead to 3-5 percent increase in FDI flows. We show results with and without country specific time trends, where both lead the same findings. Specifications with time fixed effects yield similar results but we prefer not to use time fixed effects since we want to estimate the effects of certain events such as default, establishment of OPDA and debt resettlement.[13]

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 (columns (1)-(4)). In 1881, the Ottoman government decided to take actions toward

[13] These results are available upon request.

repayment of the debt, and established a European-controlled organization, called the Ottoman Public Debt Administration (OPDA), designed to collect taxes which then were turned over to creditors. We take this event into account by introducing an "OPDA" time dummy, which is equal to 0 before 1881, and 1 after that. OPDA on its own does not seem to have a significant impact, although it enters positively in all the specifications, and significantly in column (4). 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. This dummy enters positively but the point estimate of resettlement is significant only in the last specification, column (6), when we also control for source and host country GDP per capita.

There is also the possibility the OPDA changed the nature of the relationship between exports and FDI. Hence in columns (5) and (6) we add the interaction term $Exports \times OPDA$ into the regression, we see that it is negative and significant, and equal about -0.200, while the main effect increases to roughly 0.500. This result means that there was a permanent change in the effect of exports on FDI: before 1881, the slope is about 0.500, while after 1881, it decreased down to about 0.300. One interpretation of this result might be the possibility that after introduction of the OPDA, there was less need for the trade relationship to keep serving as a guarantee for repayments of credit – that function was in part taken over by the OPDA itself.

For robustness we also normalize FDI and EXPORTS by population of source countries instead of their GDP. Note that there is no point in normalizing with Ottoman GDP and population since that will be a common factor among three source countries and be absorbed by the constant term. When we normalize by population of the source country the results are very similar in magnitude to those described below: the trade coefficient stays at the same level of 0.350 and is generally significant; all time dummies (Default, OPDA, and Resettlement) have consistent signs and magnitudes.[14] An alternative normalization would be to normalize by total exports and total FDI. Although we have total exports to all countries in addition to three we use, we do not have total FDI from all countries. In fact we have FDI only from the three countries we use, a limitation of our data set.

[14]These results are available upon request.

5 IV Analysis

5.1 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. Our instrumentation strategy relies on explaining trade with the yearly rainfall shocks. Below, we lay out our argument on the linkage between trade, production and weather conditions, specifically the amount of rainfalls. We explain in detail how the composition of exports into the U.K., France, and Germany, as well as specialization of Empire's regions in different types of crops, allow us to construct the instrument.

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.[15] As the government policy at those times was aimed to primarily satisfy the needs of the Ottoman army, 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.[16] 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."

[15] 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.

[16] 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)).

Agricultural goods made up a significant share of Ottoman 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 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 appendix table A-2, 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 A-2, 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.[17]

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 4. 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

[17]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. We did a similar match using another real time historical data set from the Ottoman archives.

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 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 55. 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 A-2, 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 $P_t^g = \frac{0.10 \times 1{,}510 + 0.20 \times 2{,}187 + 0.06 \times 4{,}050}{13{,}846} = 6.00 \times 10^{-2}$ and $P_t^{f\&v} = \frac{0.10 \times 226 + 0.20 \times 828 + 0.06 \times 171}{1{,}971} = 10.07 \times 10^{-2}$. 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 the 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 A-3, at the beginning of the sample, agricultural products (grain, fruit and vegetable) constituted about 70% of exports to both Germany and the U.K. For France, this share makes up 26%. 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 A-3. We construct the variable "Rainfalls," R_{mt}, which reflects the effect of rainfalls onto exports into country m, and thus is able to instrument for country-time varying 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).

5.2 Reduced Form and IV Results

The reduced form regression of France, Germany, and U.K. FDI on Rainfalls is shown in table 3. We have 114 observations here instead of 88 of OLS regressions since we have no missing data on rainfalls, where we do have missing data on exports. Regardless of the presence of country-specific time trends, Rainfalls is positive and highly significant, suggesting that there is a reduced form effect of rainfalls on FDI inflows. Note that we interacted rainfalls with OPDA to be consistent with the OLS regression and here too we see a weakening effect of rainfalls on FDI after the establishment of OPDA. The total effect is insignificant after the establishment of OPDA as expected since the link between trade and capital flows weakens after OPDA. This result strengthens the case of exclusion restriction since it supports the hypothesis that rainfalls effect on financial flows work through exports.[18]

The first stage regression of Exports on Rainfalls as well as the 2SLS results of the effect of Exports on FDI are presented in Table 4. The first stage regressions (the bottom panel) show that indeed, rainfalls were a significant determinant of exports: in specifications (1)-(3), the value of the coefficient is around 0.300, suggesting that an increase in the rainfall index by 12% (which corresponds to a one standard deviation in rainfalls from the mean) leads to a 3.5% increase in Ottoman exports to France and the U.K. The result does not depend on whether or not we allow for country-specific time trends. Figure 5 shows the partial plot for column 3; it is clear that the strong first stage relation is not driven by outliers.

The top panel of Table 4 shows the 2SLS results. We do obtain a poor first stage fit for Germany when we do it country by country and hence we show results without Germany in columns (4) and (5). As argued before, Germany's trade was most likely not a function of

[18] F stat and p-value for columns (1) and (2) respectively are 0.10 (0.79) and 0.23 (0.68).

the weather, but instead was determined by political reasons towards the end of our sample. Germany-Ottoman strategic partnership started and in 1885, to undermine the hegemony of France and the U.K. who fought against the Ottomans in the WWI. Germany was Ottomans ally. Circa 1885 is the start of German built and partly owned railroad construction from Berlin to Baghdad, with the aim to end British influence in the Middle East.

The 2SLS results show that exports were indeed a significant determinant of FDI: when the interaction term of Exports and OPDA was not included, the coefficient before exports is about 0.330, somewhat exceeding in magnitude its OLS counterpart but in staying in the same ballpark. When the interaction term is included, the 2SLS estimate reaches 5.000 before 1881, and that effect significantly decreases after 1881 (the $Exports \times OPDA$ coefficient is negative but insignificant), supporting our previous findings. The 3.5% increase in exports from the first stage regression corresponds to a 5-15% increase in FDI given the second stage estimates.

5.3 Threats to Identification

The key issue is whether rainfall shocks meet the exclusion restriction. As we discussed our peculiar institutional environment, where only a surplus agricultural production as a result of rainfall shocks is exported, provides the basis for the exclusion restriction. Nevertheless, in Table 5 using aggregate data and time series variation, we provide evidence that in response to positive rainfall shocks exports increase (columns (1) and (2).) Conditional on time trends there is a significant effect of rainfall shocks on exports. We also report an informal test of exclusion restriction where we regress GDP on rainfall shocks and exports to show that rainfall shocks do not have an independent effect on income, since such an effect will violate the exclusion restriction. It is clear as shown in column (3) that rainfalls enter this regression insignificantly upon controlling for exports which has a negative and significant effect on GDP.

6 Conclusion

In the light of the recent global crisis, economists turn to various historical episodes for lessons.[19] This paper investigates the causal effect of trade on financial flows using a historical quasi-natural

[19] See Reinhart and Rogoff (2009).

experiment from the Ottoman Empire to pin down the identification. The provisionistic policy of the Empire during this period – only a surplus production was exported after the Ottoman army was fed – constitutes the basis of our identification strategy. Heavier rainfall than usual created a surplus agricultural production, which was exported under the provisionistic policy. We find that one standard deviation in rainfalls from the mean lead to a 3.5 percent increase in Ottoman exports, which in turn causes a 10 percent increase in capital inflows, on average. This result holds also after accounting for the negative effect of the Ottoman 1876 default on foreign investment and trade. Our findings are supportive of trade theories predicting complementarity between trade and capital flows as a result of causality running from exports to foreign direct investment.

References

[1] Altug, S., Filiztekin, A., and Pamuk, S. 2008. Sources of long-term economic growth for Turkey, 18802005. *European Review of Economic History, Vol. 12, pages 393-430*

[2] Antràs, P. and Caballero, R., 2009. Trade and Capital Flows: A Financial Frictions Perspective. *Journal of Political Economy, University of Chicago Press, vol. 117(4), pages 701-744, 08*

[3] Akkemik, Ü. and A. Aras. 2007. South-Central Turkey April-August Precipitation Reconstruction. *IGBP PAGES/World Data Center for Paleoclimatology Data Contribution Series 2007-026. NOAA/NCDC Paleoclimatology Program, Boulder CO, USA.*

[4] Akkemik, Ü., N. Dagdeviren, and A. Aras. 2007. Western Black Sea Region, Turkey Spring Precipitation Reconstruction. *IGBP PAGES/World Data Center for Paleoclimatology Data Contribution Series 2007-025. NOAA/NCDC Paleoclimatology Program, Boulder CO, USA.*

[Aviat, A., and N. Coeurdacier. 2007.] 'The Geography of Trade in Goods and Asset Holdings." *Journal of International Economics*, 71(1): 22–51.

[5] Barbieri, K., Keshk, O. and Pollins, B. 2008. Correlates of War Project Trade Data Set Codebook, Version 2.01. Online: http://correlatesofwar.org

[6] Behar, Cem, 1996. 1500-1927: The Population of the Ottoman Empire and Turkey. *State Institute of Statistics, Historical Statistics Series, Volume 2*

[7] Bordo, M. 2006. Sudden stops, financial crises and original sin in emerging countries: deja vu? *NBER Working Paper No. 12393*

[8] Clemens, M. and Williamson, J. 2004. Wealth bias in the first global capital market boom, 1870-1913. *Economic Journal, Royal Economic Society, vol. 114(495), pages 304-337, 04*

[9] Donaldson, D. 2009. Railroads of the Raj: Estimating the Impact of Transportation Infrastructure, *Working Paper*

[10] FAO: Food and Agriculture Organization of the United Nations, 2003. Medium-term prospects for agricultural commodities, projection to the year 2010.

[11] Feinstein, C. 1972. National income, expendeture and output of the United Kingdom 1855-1965, *Cambridge University Press, Cambridge, ISBN-10: 0521072301*

[12] Feyrer, J. 2009. Trade and Income – Exploiting Time Series in Geography, *NBER Working Paper No. W14910*

[13] Fetzner, Rudolf, 1902. Niedershlag und Bewölkung in Kleinasien. *GOTHA: Jusus Perthes. Erganzungsheft No. 140 Zu "Petermanns Mitteilungen"*

[14] Jones, M. and Obstfeld, M. 1997. Saving, Investment, and Gold: A Reassessment of Historical Current Account Data. *NBER Working Paper No. W6103*

[15] Griggs, C.B., A.T. DeGaetano, P.I. Kuniholm, and M.W. Newton. 2007. A regional high-frequency reconstruction of May-June precipitation in the north Aegean from oak tree-rings, A.D. 1089-1989. *International Journal of Climatology, Vol. 27, Issue 8, pp. 1075 - 1089, 30 June 2007.*

[16] Grimes, D., Miller, R., and Yamada, H. 1970. Water stress during flowering of cotton. *California Agricalture, Vol. 24, Pages 4-6*

[Guiso L., Sapienza P., and L. Zingales. 2009.] 'Cultural Biases in Economic Exchange?" *Quarterly Journal of Economics*, 124(3).

[17] Hellman, E. 2004. Irrigation Scheduling of Grapevines with Evapotranspiration Data. Downloaded from: http://winegrapes.tamu.edu/grow/irrigationscheduling.pdf

[18] Keller, W., and Shiue, C. 2006. Tariffs, Trains, and Trade: The Role of Institutions versus Technology in the Expansion of Markets. *CEPR Discussion Papers 6759, C.E.P.R. Discussion Papers*

[19] Lane, L., and Milesi-Ferretti, G. 2008. International Investment Patterns. *The Review of Economics and Statistics, MIT Press, vol. 90(3), pages 538-549, 03.*

[20] Lévy-Leboyer, M. and Bourguignon, F., 1985. L'Économic Francaise au XIX Siècle: Analyse macro économique. *Paris: Economica*

[21] Madisson, A. 1991. A long run perspective on saving. *Research mamorandum nr. 443, Institute of Economic Research, Faculty of Economics, University of Groningen, October*

[22] Meissner and Taylor, 2006. Losing our marbles in the new century? The great rebalancing in historical perspective. *Conference Series; [Proceedings], Federal Reserve Bank of Boston.*

[23] Mitchell, B., 1988. British historical statistics, *Camridge University Press, Cambridge, ISBN-10: 0521330084*

[24] Mitchell, B. R., 1992. International Historical Statistics, Europe 1750–1988, *Stockton Press, ISBN-10: 156159038X*

[25] Mitchener K., and Weidenmier, M. 2005. Supersanctions and Sovereign Debt Repyament, *NBER Working Paper No. 11472*

[26] O'Donoghue, J. 2004. Consumer Price Inflation Since 1750, *Economic Trends, No. 604, pages 38-46.*

[27] Pamuk, S. 1987. The Ottoman Empire and European Capitalism, 1820-1913. *Cambridge University Press, ISBN-10: 0521331943*

[28] Pamuk, S. 2003. Ottoman foreign trade in the 19th century. *State Institute of Statistics, Historical Statistics Series, Volume 1*

[29] Pamuk, S. and Williamson, J., 2009. Ottoman De-Industrialization 1800-1913: Assessing the Shock, Its Impact and the Response, *NBER Working Papers 14763, National Bureau of Economic Research, Inc.*

[30] Portes, R., and Rey, H. 2005. The determinants of cross-border equity flows. *Journal of International Economics 65, pp. 269-296.*

[31] Quataert, D. 1994, The Age of Reforms, 1812-1914. In *H. Inalcyk and D. Quataert (eds.) An Economic and Social History of the Ottoman Empire, 1300-1914 (Cambridge: Cambridge University Press): 759-946.*

[32] Reinhart, C. and Rogoff K., 2004. Serial Default and the "Paradox" of Rich to Poor Capital Flows. *American Economic Review, American Economic Association, vol. 94(2), pages 53-58, May.*

[33] Steger, A., Silvertooth J., and Brown, P. 1998. Upland cotton growth and yield response to timing the initial postplant irrigation. *Agronomy Journal, Vol. 90, Pages 455-461*

[34] Taylor, A., and Wilson, J. 2006. International Trade and Finance under the Two Hegemons: Complementaries in the United Kingdom 1870-1913 and the United States 1920–30. *NBER Working Paper No. 12543*

[35] Prime Ministry Republic of Turkey and Turkish Statistical Institute, 2005. TSY: Turkey's Statistical Yearbook.

[36] Touchan, R., G.M. Garfin, D.M. Meko, G. Funkhouser, N. Erkan, M.K. Hughes, and B.S. Wallin, 2003. Preliminary reconstructions of spring precipitation in southwestern Turkey from tree-ring width. *International Journal of Climatology, 23:2, pp. 157-171, Feb. 2003.*

[37] Touchan, R., E. Xoplaki, G. Funkhouser, J. Luterbacher, M.K. Hughes, N. Erkan, Ü. Akkemik, and J. Stephan. 2007. Eastern Mediterranean Spring/Summer Precipitation Reconstruction. *IGBP PAGES/World Data Center for Paleoclimatology Data Contribution Series 2007-020. NOAA/NCDC Paleoclimatology Program, Boulder CO, USA.*

[38] Villa, P. 1993. Une Analyse Macroéconomique de la France au XX Siècle, Monographies D'Économétrie, CNRS Editions, Paris

Table 1: Descriptive Statistics by Source Country

Variable	Units of Measurement, millions	# of Obs	Mean	Std. Dev.	Min	Max
	France					
GDP	British Sterling	55	1137.10	272.21	706.34	1965.43
FDI	British Sterling	41	1.04	1.54	0.04	9.23
Debt	British Sterling	38	4.70	6.91	0.00	28.00
Ottoman Imports from France	British Sterling	40	2.49	4.84	1.58	3.56
Ottoman Exports into France	British Sterling	40	3.77	0.59	2.32	4.92
Population	People	55	39.47	1.26	37.24	41.46
	UK					
GDP	British Sterling	55	1401.04	405.29	761.00	2354.00
FDI	British Sterling	55	0.39	0.43	0.03	2.12
Debt	British Sterling	38	1.77	2.27	0.00	10.00
Ottoman Imports from the UK	British Sterling	40	7.62	1.47	3.43	9.93
Ottoman Exports into the UK	British Sterling	40	4.58	1.00	2.49	6.34
Population	People	55	36.63	5.18	28.66	45.64
	Germany					
GDP	British Sterling	55	1259.98	633.49	431.60	2782.56
FDI	British Sterling	26	0.77	0.76	0.09	3.40
Debt	British Sterling	38	1.40	1.96	0.00	10.56
Ottoman Imports from Germany	British Sterling	40	1.11	1.39	0.02	4.66
Ottoman Exports into Germany	British Sterling	40	0.43	0.51	0.00	1.46
Population	People	55	47.50	8.69	35.63	65.05
	Ottoman Empire					
GDP	British Sterling	49	153.27	36.70	73.97	208.64
Population	People	55	16.54	3.10	10.17	21.89
	Constructed Variables					
FDI/GDP	N/A	122	0.001	0.001	0.000	0.008
Exports/GDP	N/A	103	0.002	0.002	0.000	0.005
Imports/GDP	N/A	120	0.003	0.002	0.000	0.007
Source GDP per capita	N/A	165	30.43	8.479	12.11	51.57
Host GDP per capita	N/A	147	8.825	1.424	5.128	10.89
Rainfalls	N/A	165	-0.024	0.141	-0.716	0.268

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 **??**. 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 A-1. 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: Ottoman Exports and FDI Inflows: 1859–1913

	Dependent Variable: log FDI/GDP						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
log Exports/GDP	0.394	0.297	0.266	0.324	0.551	0.490	0.546
	(0.134)	(0.069)	(0.034)	(0.073)	(0.099)	(0.123)	(0.089)
log Exports/GDP $\times$ OPDA					-0.229	-0.172	-0.161
					(0.096)	(0.038)	(0.040)
Default	-1.344	-2.177	-2.190	-0.988			
	(0.011)	(0.685)	(0.690)	(0.536)			
OPDA		0.939	0.982	1.396			
		(0.782)	(0.790)	(0.542)			
Default/OPDA					-0.874	-1.666	-1.617
					(0.503)	(1.378)	(1.367)
Resettlement			-0.101	0.876	0.863	1.017	1.014
			(0.200)	(0.488)	(0.485)	(0.346)	(0.325)
log Source GDP per capita						-2.325	-2.613
						(2.850)	(2.502)
log Host GDP per capita						2.137	2.202
						(2.138)	(2.193)
log Imports/GDP							-0.295
							(0.385)
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Trends	No	No	No	Yes	Yes	Yes	Yes
R-Square	0.274	0.314	0.315	0.393	0.391	0.409	0.412
Sample size	88	88	88	88	88	87	87

Notes: Exports and FDI are normalized by source countries (France, Germany, the U.K) GDPs. Default is a time dummy variable equals 1 after 1876 after the default of the Ottoman Empire. OPDA is a time dummy 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. Default/OPDA is a dummy variable that is 1 after 1876. For the specifications without country time trends, the Exports variable for each country was detrended prior to estimation. The standard errors are robust and clustered by country.

Table 3: Rainfalls and FDI Inflows: Reduced Form Regressions

	Dependent Variable: log FDI/GDP	
	(1)	(2)
Rainfalls	3.666	4.336
	(0.180)	(0.132)
Rainfalls × OPDA	-3.976	-4.773
	(1.175)	(0.780)
log Source GDP per capita	-1.116	-1.205
	(0.975)	(2.290)
log Host GDP per capita	-1.712	-0.107
	(0.437)	(1.183)
Default/OPDA	0.212	-1.206
	(0.711)	(0.764)
Country dummies	Yes	Yes
Time Trends	No	Yes
R-Square	0.248	0.371
Sample size	114	114

Notes: FDI is normalized by source countries (France, Germany, the U.K) GDPs. Default/OPDA is a time dummy variable equals 1 after 1876 after the default of the Ottoman Empire. The standard errors are robust and clustered by country.

Table 4: Ottoman Exports and FDI Inflows: 2SLS Regressions

	Dependent Variable: log FDI/GDP				
	(1)	(2)	(3)	(4)	(5)
				No Germany	No Germany
log Exports/GDP	0.343	0.325	0.345	5.368	5.097
	(0.022)	(0.055)	(0.037)	(3.177)	(3.275)
log Exports/GDP × OPDA		-3.971	-4.489	-5.724	-5.619
		(1.889)	(1.867)	(5.211)	(5.357)
Default	-2.160	-2.168	-0.974		
	(0.688)	(0.693)	(0.526)		
OPDA	0.924	0.955	1.394	-0.497	-32.245
	(0.784)	(0.795)	(0.543)	(1.092)	(30.895)
Resettlement		-0.079	0.891	0.475	0.716
		(0.211)	(0.475)	(0.647)	(0.870)
log Source GDP per capita				-1.322	-3.082
				(2.526)	(4.913)
log Host GDP per capita				2.929	3.605
				(1.770)	(1.736)
R-Square	0.314	0.315	0.393	0.285	0.321
	First Stage Regressions of Exports on Rainfalls and Controls				
Rainfalls	0.275	0.297	0.298	1.177	1.174
	(0.131)	(0.119)	(0.118)	(0.466)	(0.445)
Rainfalls × OPDA				-0.921	-0.932
				(0.487)	(0.465)
F-test	4.42	6.20	6.38	4.85	5.08
p-value	0.039	0.015	0.014	0.011	0.009
Country Dummies	Yes	Yes	Yes	Yes	Yes
Time Trends	No	No	Yes	No	Yes
Sample size	88	88	88	64	64

Notes: Exports and FDI are normalized by source countries (France, Germany, the U.K) GDPs. 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, the Exports variable for each country was detrended prior to estimation. In specifications (1) through (5), U.K. and French Exports are instrumented with Rainfalls, while German Exports are left uninstrumented. In specifications (6) and (7), Germany is excluded from estimation completely. For the first stage regressions, other controls were present besides the Rainfalls variables; they are omitted to preserve space. The F-test and its p-value correspond to the null that the instruments are jointly insignificant. The standard errors are robust and clustered by country.

Table 5: Aggregate Ottoman Exports and GDP on Rainfalls

	Dependent variable		
	log Exports	log Exports (only Rainfalls>0)	log GDP
	(1)	(2)	(3)
Rainfalls	0.059	0.232	0.011
	(0.033)	(0.153)	(0.023)
log Exports			-0.772
			(0.105)
Time Trends	Yes	Yes	Yes
R-Square	0.525	0.503	0.818
Sample size	55	27	49

Notes: "Rainfalls" is percentage deviations of rainfalls from the long-run mean in the TR5 statistical region, West Anatolia, chosen as a representative region due to its largest relative to other statistical regions agricultural land area according to Table A-2. The standard errors are robust and clustered by country.

Table A-1: 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 A-2: 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

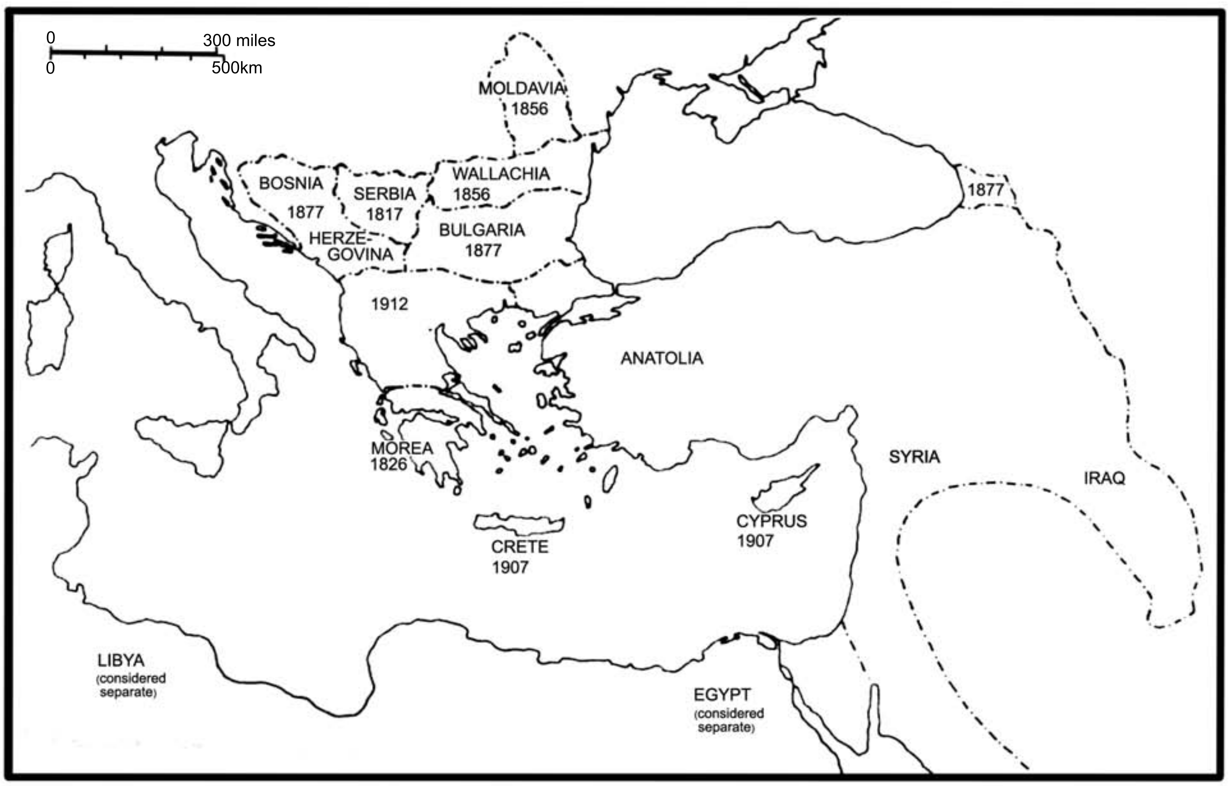
Notes: The data come from Turkey's Statistical Yearbook, 2005. Table 11.11 at page 177. See Data Appendix for details.

Table A-3: Ottoman Decomposition of Exports

	Decomposition of Exports, %		
	France	U.K.	Germany
Grain produce	16.9	44.8	41.4
Fruit and vegetable produce	9.2	21.0	31.4
Other	73.9	34.2	27.2
Total	100.0	100.0	100.0

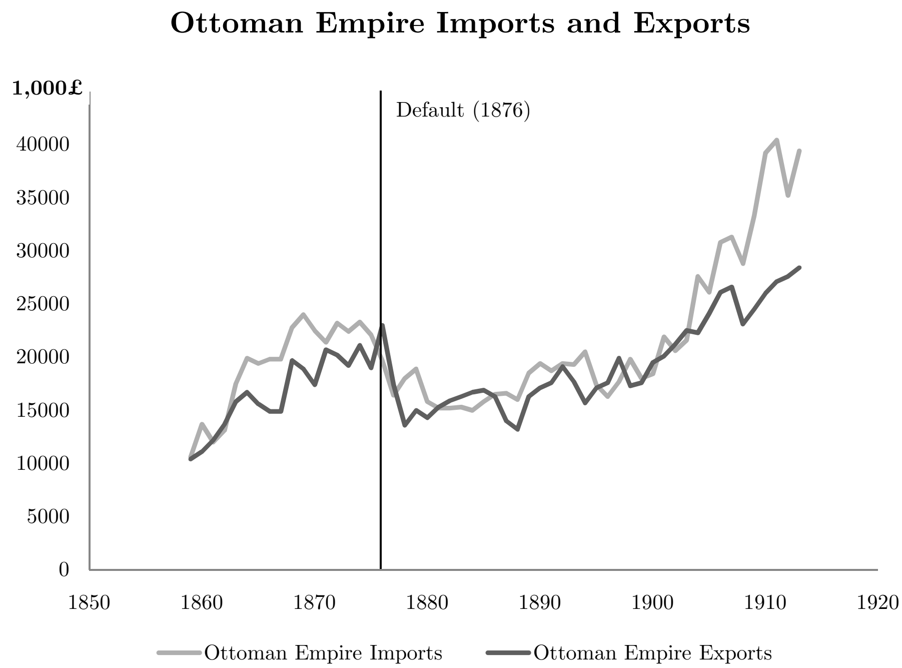
Notes: "Grain" produce include corn, wheat, barley, rye. Also, we included cotton into this category, because cotton is typically rotated with the grain. "Fruit and vegetable" produce include grape, fig, unspecified fruits and vegetables, vine, olive oil, acorn, hazelnuts and peanuts. "Other" include 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; for Germany, we take averages over 1880-82. This way, for all three countries, we are using the initial exports shares that correspond to the beginnings of the respective samples.

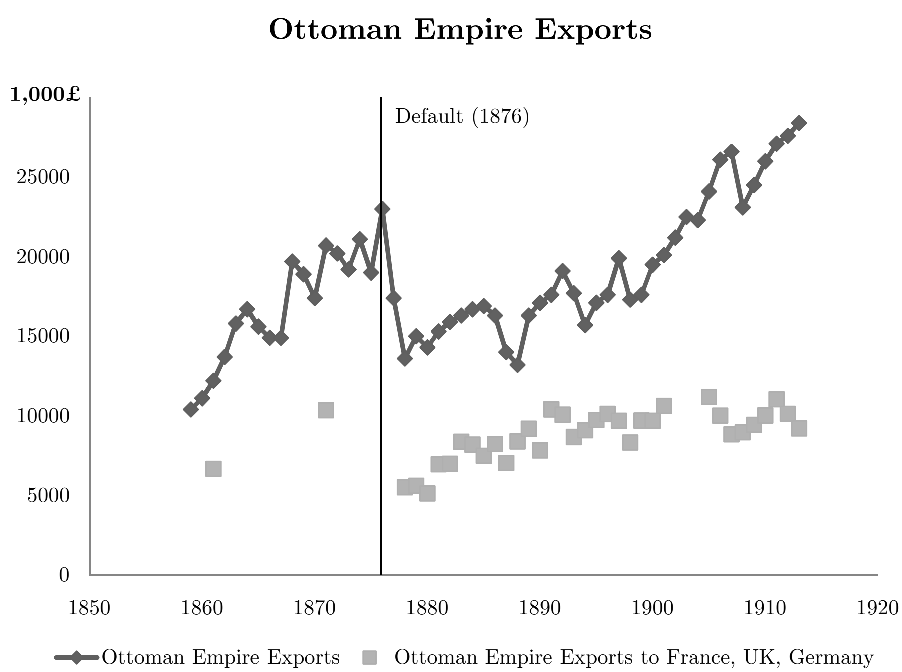
Figure 1: Ottoman Borders: 1830–1913



Notes: This map is taken from Pamuk (1987).

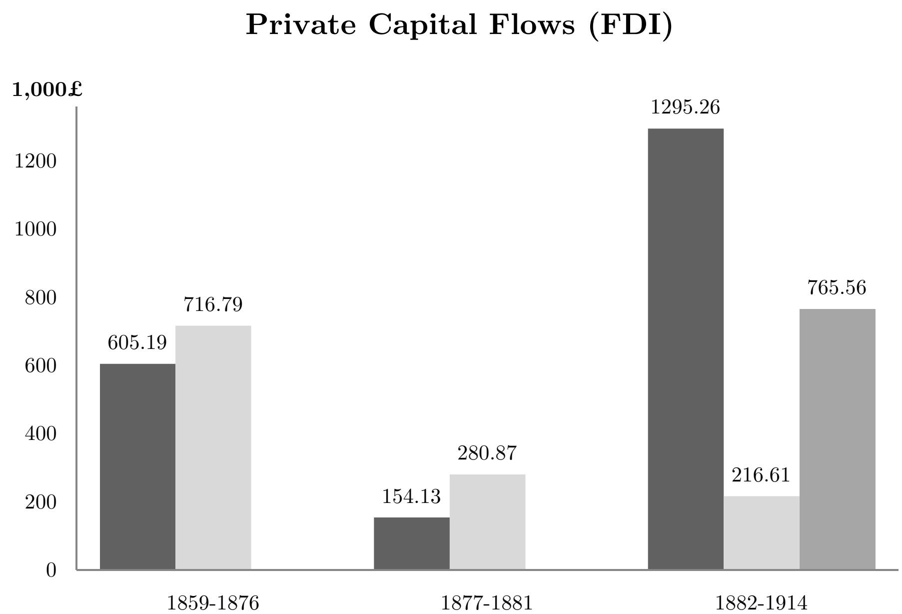
Figure 2: Exports and Imports of the Ottoman Empire during 1859–1913

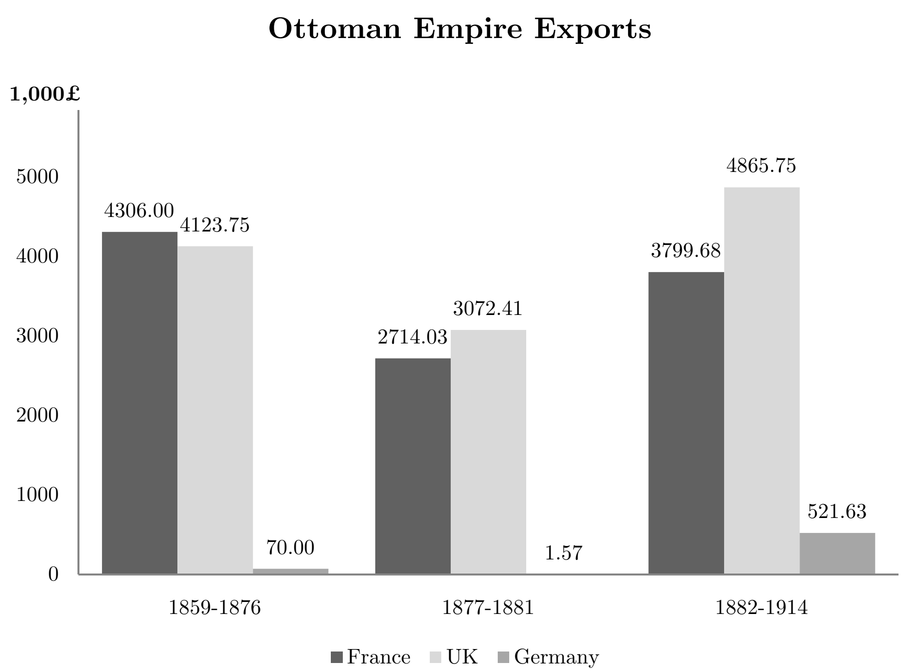




Notes: Data is from Pamuk (1987). All variables are measured in thousand sterling.

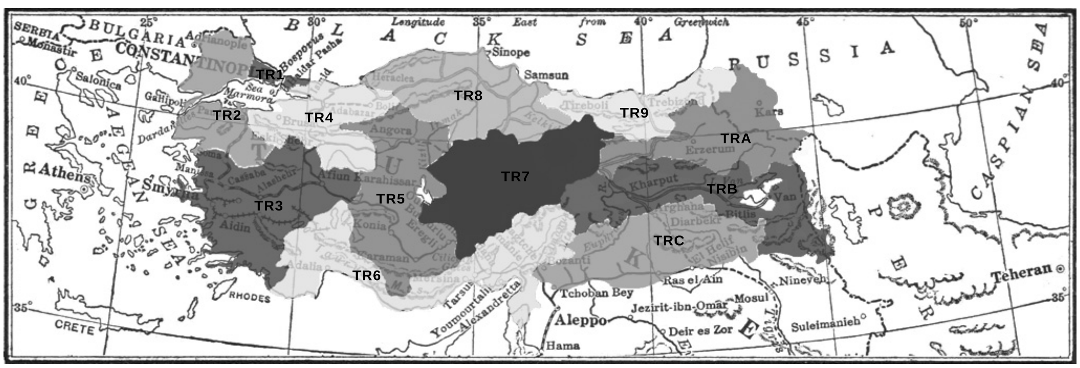
Figure 3: Private capital inflow (FDI) and Exports of the Ottoman Empire during 1859–1913





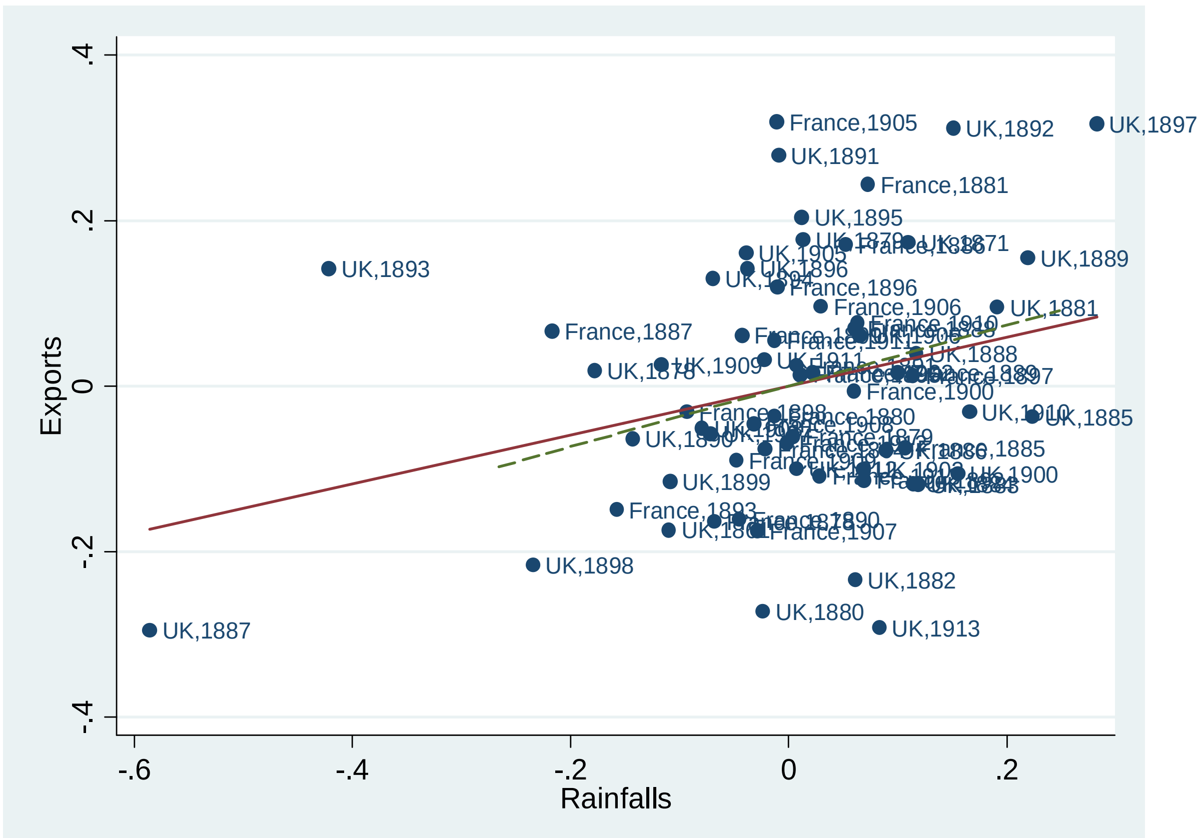
Notes: Data is from Pamuk (1987). All variables are measured in thousand sterling.

Figure 4: 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)).

Figure 5: The partial effect scatterplot of rainfalls and Ottoman Empire exports



Notes: The scatterplot and the solid line correspond to the first stage regression for specification (3) from Table 4 with the partial effect of rainfalls on exports being equal to 0.298 with the standard error of 0.118. The dashed line corresponds to the same specification that excludes UK,1887 and UK,1893. In that case, the coefficient is 0.372 with the standard error 0.150.