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Does trade cause capital to flow? Evidence from historical rainfall

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ABSTRACT

We use a historical quasi-experiment to estimate the causal effect of trade on capital flows. We argue that fluctuations in regional rainfall within the Ottoman Empire capture the exogenous variation in exports from the Empire to Germany, France, and the U.K., during the period of 1859–1913. The identification is based on the following historical facts: First, only surplus production was allowed to be exported from the Empire (provisionistic policy). Second, different products grown in different regions were subject to variation in regional rainfall. Third, different bundles of products were exported to Germany, France, and the U.K. by the Empire. Using the export-bundle-weighted regional rainfall as an instrument for Ottoman exports to each country, our instrumental variable regression suggests the following: When a given region of the Empire received more rainfall than others, the resulting surplus production was exported more to countries that historically imported more of those products, and this leads to higher foreign investment by those countries in the Empire. Our findings support theories predicting complementarity between trade and finance, in which causality runs from trade to capital flows.

1. Introduction

Theory predicts an ambiguous relationship between trade and financial flows. Mundell (1957) shows that trade and capital flows are substitutes as an increase in trade integration reduces the incentive for capital to flow. Formalized by the Heckscher-Ohlin-Mundell paradigm, in a two-goods, two-factors framework, free trade leads to factor price equalization, and so there is no need for international capital mobility. Other papers modify this framework by adding technological differences (Kemp, 1966; Jones, 1967) and/or production uncertainty (Helpman and Razin, 1978), and these papers show that trade and factor flows can be complements with causality running from international capital to trade flows.

The recent theoretical models incorporating financial frictions advocate another view. It is not only that there is the complementarity between trade and capital flows but also the causality runs from trade to capital flows (Antràs and Caballero, 2009). In this paper, a historical quasi-experimental setting was used to identify the causal effect of trade on capital flows in a dynamic framework. It is argued that fluctuations in regional rainfall within the Ottoman Empire capture the exogenous variation in exports from the Empire to Germany, France, and the U.K., during the period of 1859–1913. The identification is based on the following historical facts: First, only surplus production was allowed to be exported from the Empire (provisionistic policy). Second, different products grown in different regions were subject to variation in regional rainfall. Third, different bundles of products were exported to Germany, France, and the U.K. by the Empire. Using the export-bundle-weighted regional rainfall as an instrument for Ottoman exports to each country, our instrumental variable regression suggests the following: When a given region of the Empire received more rainfall than others, the resulting surplus production was exported more to countries with higher ex-ante export shares of those products, and this leads to higher foreign investment by those countries in the Empire. The empirical results show that higher trade integration leads to higher capital inflows to the capital-scarce country.

We illustrate a plausible mechanism for this cause-effect relationship based on the theoretical model of Antràs and Caballero (2009) in the historical context of the Ottoman Empire during the late 18th and early 19th centuries. The Empire was a financially-underdeveloped country exporting agricultural goods, while Germany, France and the U.K. were

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financially-developed countries exporting manufactured goods. This trade pattern was consistent with the fact that the manufacturing sector was more capital-intensive than the agricultural sector, and Germany, France and the U.K. were financially-developed enough to finance investment in capital. The Empire was less financially-developed than Germany, France and the U.K., and the Empire allocated their resources mainly in the agricultural sector, which contributed to an increase in output and a decrease in prices of agricultural goods. With trade integration, the Empire could take advantage of the low prices of its agricultural goods (comparative advantage) and increase export revenues. As a result, the return to capital in the Ottoman agricultural sector increased, and Germany, France and the U.K. had more incentive to invest in industries that were complementary to the agricultural sector of the Empire. In fact, railroads constituted 33 percent of the foreign direct investment from Europe in the Empire as of 1888, and the construction of railroads reduced transportation costs of crops. Thus, the trade integration attracted capital flows from Germany, France and the U.K. into the Empire, as the return to capital in the Ottoman agricultural sector rose due to increases in export revenues in this sector.

During the late 18th and early 19th centuries, similar to other countries in that era, the Ottoman economy was closely determined by the political and administrative environment. The leading concern of the Ottoman policy was the adequate provisioning of food for the army, palace, and urban areas. This emphasis on “provisioning” created an important distinction between imports and exports. Imports were encouraged since they added to the available goods in the urban markets. Exports, on the other hand, were permitted *only* once the requirements of the domestic economy were met (See Genc (1994) and Inalcik and Quataert (1994)).[1] During 1880–1913, 90% of the labor force was employed in the agricultural sector, while industrial production constituted only 10% of Ottoman GDP (Altug et al., 2008). As a result, during our sample period, the Empire was an importer of manufactured goods and exporter of *surplus* agricultural goods. Given the dependency on widely-used furrow irrigation systems, weather—rainfall variation—was an exogenous factor that determined exports since surplus production varied with the regional variation in rainfall in the Ottoman Empire.[2]

Our identification methodology can be summarized as follows. The Ottoman Empire only exported agricultural goods, namely cotton, wheat, grapes, corn, barley, olives, raisins, nuts, and figs. These goods grow in different regions of the Empire, and hence, depending on regional variation in the rainfall, there is surplus production in a given region and thus in a given group of goods. We will group goods as grains and orchards. We use this broad category rather than the narrow one since we know that the specialization of regions in crops by this broad category stays more or less the same in the last 200 years, based on the maps provided by the State Institute of Statistics (SIS) historical and contemporaneous yearbooks. We know the regions where these goods were grown, and we combine this information with historical rainfall data that vary by region and by time to obtain good groups specific surplus production. Different regions of the Empire specialize in different types of good groups. While some consist of cultivated land and grow various grains, others consist of non-cultivated orchard land and grow primarily fruits and vegetables. Hence, within the Empire, differences in rainfall ensure that Ottoman grain and orchard products were affected differently in different years. Ottoman trading partners were historically purchasing very different export bundles from the Empire: while some were mainly buying grains, others were interested in olives and grapes. Therefore, if we interact the time-varying grain and orchard production shocks, caused by the time variation in rainfall, with the country-specific export bundles, we obtain rainfall-based time-varying country-specific instruments for Ottoman exports into France, Germany, and the U.K.

We obtain unique yearly panel data for the period 1859–1913 that covers trade and private financial flows between France, Germany, the U.K., and the Ottoman Empire. As a measure of private capital inflows, we use foreign direct investment (FDI) of these three source countries into the Empire. For trade flows, we use exports from the Empire into France, Germany, and the U.K. Hence, trade flows are outflows from the Empire, and financial flows are inflows to the Empire. The predominantly uni-directional capital flows were typical for the first wave of globalization when the industrialized North was investing in the agricultural South. It is important to notice that our data set covers all major Ottoman Empire investors – as of 1914, FDI from France, Germany, and the U.K. constituted 96% of total foreign direct investment into the Empire (Geyikdagi, 2011). A simple OLS regression of FDI in the Empire on exports from the Empire to France, Germany, and the U.K., using country fixed effects for the investor countries, dummies for important events like default, and time fixed effects on the medium-term cycle, produces a positive coefficient. This result is the panel version of the cross-sectional findings in the literature. The advantage of the panel data is that we can use country fixed effects and hence control for the unobserved investor country heterogeneity in foreign investment. Nevertheless, these OLS estimates suffer from reverse causality, therefore we run a 2SLS regression instrumenting bilateral trade with our instrument described above and verifying that our results are causal; that is, trade flows causally determine foreign investment. Our first stage predicts that a deviation of 10 percent in rainfall from the mean (which approximately corresponds to one standard deviation in rainfall from the mean) resulted in a 5 percent increase in Ottoman exports.[3] Our second stage regressions deliver an effect of a 3 percent increase in FDI as a result of a 5 percent increase in exports.

Our instrument is similar to the instrument developed by Nunn and Qian (2014) who identify the causal effects of US food aid on the conflict in recipient countries. They instrument US food aid with the interaction of US wheat production and cross-sectional variation in a country's tendency to receive any US food aid. Our instrument is year-on-year regional rainfall variation weighted by the country-specific export bundles, which allows our instrument to vary across years and countries. This type of identification strategy follows the logic of the difference-in-differences estimator. Conceptually, our reduced-form estimates measure the difference in a change in foreign investment from a country importing grain and a change in foreign investment from a country importing orchard in years following an increase in rainfall for grain-growing regions.

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.[4] Our identification strategy is based on temporary fluctuations in agricultural production caused by year-to-year changes in *regional* rainfall around the “permanent” component of rainfall which might affect long-run production and trade patterns.[5] This strategy is relevant for our case since we want rainfall to affect capital flows *only* through exports in the

[1] Pamuk and Williamson (2011) argue that these provisionistic views paved the way for the Ottoman de-industrialization process that had been completed around 1880. They also argue that the Ottoman Empire specialized in agriculture and became a net importer of manufactured goods. This is what is predicted by the model of Antràs and Caballero (2009).

[2] The development of irrigation systems occurred in Turkey only at the end of the 20th century (Food and Agriculture Organization of the United Nations, 2009).

[3] See also Dell et al. (2009, 2012) who focus on the effect of weather changes (temperature and precipitation) on GDP and exports and find large estimates in the case of exports.

[4] This literature goes back to Paxson (1992), who used weather variability to measure the response of savings to temporary income fluctuations. See Schlenker and Roberts (2006), and Deschênes and Greenstone (2007) who focus on U.S. agricultural production. See Donaldson (2018) estimates for the India.

[5] Miguel et al. (2004) use yearly changes in rainfall to identify the effect of temporary growth on the likelihood of civil conflict in Africa.

short run. For this strategy to be valid, there should not be any significant autocorrelation in precipitations, which is indeed the case as shown in Figure A1. Short-run fluctuations in rainfall create temporary variation in the size of surplus production, which in turn creates variation in exports. Our strategy of using short-run fluctuations allows us to avoid the effects of permanent rainfall differences on permanent incomes, which might also affect capital flows.[6] 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/trending investment by Northern countries into the Ottoman Empire due to certain trade/war treaties.

We measure historical rainfall based on the "tree-ring" methodology. This methodology recovers the level of rainfall during a growing season based on the width of the tree rings in a given year. During droughts, 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. The real-time historical data comes from the Ottoman Archives but only for a few regions. The correlation between the real-time data and our data is 0.495 for the overlapping regions and significant at 5%. We use data that we obtain using the tree-ring methodology for our analysis since this data is available for all the regions of the Empire during the entire period we are interested in.

A valid threat to the identification is the possibility of a third variable driving both Ottoman exports to North and North's investment in the Empire. Our instrumental variable strategy will be able to deal with this issue as long as the omitted variable is not correlated with the instrument. To advance on this, in light of the model of Antràs and Caballero (2009), regressions control for Ottoman GDP per capita, which can capture a large part of the variation in the marginal product of capital, the return to capital, and thus capital inflows into the Empire. Additionally, we use country-specific time trends together with other controls. We also condition our results on 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 rainfall (Rose and Spiegel, 2004). We have also created a dummy to control the effect of the establishment of the Ottoman Public Debt Administration (OPDA) in 1881. The OPDA was established after the debt restructuring negotiations for the purpose of paying the creditors. If more trade induces more financial flows since trade serves as an implicit guarantee for the creditors, once an institution is established to pay the creditors (OPDA), there might be less need for trade (See Wright (2004), Mitchener and Weidenmier (2005); Rose and Spiegel (2004); Eaton and Gersovitz (1981)). Our results are robust to all these tests.

The empirical literature tries to identify whether or not trade and finance are complements or substitutes though the endogeneity issue is hard to solve. Most papers adopt the gravity approach focusing on the cross-sectional relationship and document a positive correlation between the two, such as Aviat and Coeurdacier (2007), Lane and Milesi-Ferretti (2008), and Portes and Rey (2005). Taylor and Wilson (2006) use a similar cross-sectional framework and instrument trade with distance to solve the endogeneity problem, obtaining a positive effect of instrumented-trade on capital flows. However, Guiso et al. (2009), Portes and Rey (2005), and Aviat and Coeurdacier (2007) show that distance determines both trade in assets and trade in goods since distance also captures information asymmetries that are important determinants of capital flows. Our contribution to this literature is to use a unique historical setting to identify the causal relationship running from trade to capital flows, using country-specific export-bundle weighted regional rainfall as an instrument for trade.

The rest of the paper proceeds as follows. Section 2 lays out the historical context and introduces 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 context and data

The Ottoman Empire stood at the crossroads of civilizations, stretching from the Balkans to Egypt for six centuries prior to World War I. Given the coverage of our data from 1859 to 1913, this paper focuses on the borders of the Empire from 1830 until World War I, as shown in Fig. 1. These borders include northern Greece, Syria, Iraq, and present-day Turkey but exclude Egypt and Libya.

In light of the new evidence from the archives, historians no longer think that the Ottoman Empire was in a state of a permanent decline since the 16th century. It is now realized that the Ottoman state was flexible and pragmatic and was able to adapt to the changing environment. Although the 17th century was a period of crisis, the 18th century witnessed an expansion of trade and an increase in production. The Empire was shrinking starting in the middle of the 18th century due to territorial losses, but at the same time, during most of the 19th century, the Empire became more linked to Europe via commercial and financial networks. The provisioning of the capital city, armed forces and urban areas, taxation, support, regulation of long-distance trade, and the maintenance of a steady supply of money were among the main policy concerns of the state. Hence, the government constantly intervened in economic affairs. The Ottoman Empire is not unique in this respect, as the pursuit of similar policy goals is thought to have led to 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 the center and periphery countries. Thanks to the Industrial Revolution, European countries became exporters of manufactured goods. These countries were selling their manufactured products to the third world (periphery) countries, while at the same time buying primary products and raw materials from them.

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 also 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 were not available in Ottoman lands, and 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 the development of mercantilism in Europe, the priorities of the central bureaucracy dominated economic thought in the Ottoman Empire.

The policy priority was such that only surplus agricultural production could 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 increased 15-fold between 1820 and 1914. However, given the provisionistic policy, the share of Ottoman exports in total production did not exceed 6 to 8 percent and – in agricultural production – 12 to 15 percent until 1910 (Pamuk, 1987). By 1910, 25 percent of agricultural

[6] Temporary fluctuations in income will affect savings only, resulting in net capital outflows, according to the standard models. During the course 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. The authors argue that this is either because periphery countries were full colonies or they were not integrated fully into the world markets to invest their savings.

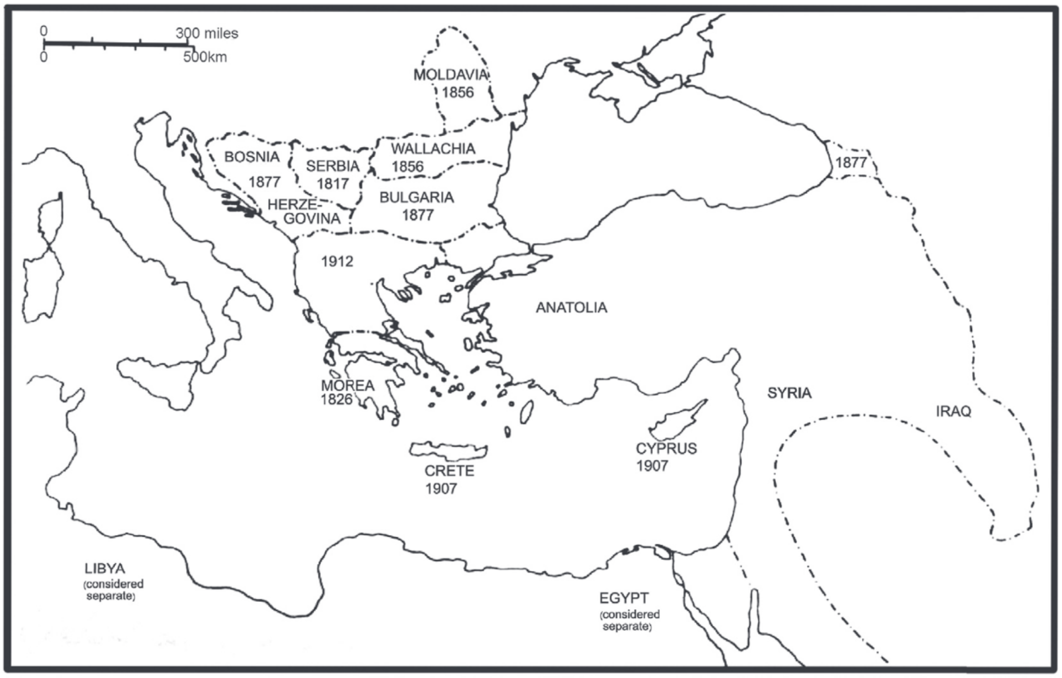


Fig. 1. Ottoman Borders: 1830–1913. *Notes:* This map is taken from Pamuk (1987).

production was exported, whereas 80 percent of manufactured goods were imported.

The 19th century was 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 U.K. into the Ottoman Empire during 1859–1913 period. These three countries were responsible for practically all FDI inflows over that period. For example, right before World War I, all other countries combined contributed only 4% of total FDI. 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 sets of data come from Pamuk (2003) and Pamuk (1987), and they are expressed in British pound sterling. Fig. 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 the accumulation of foreign debt.

The expansion of trade between the center and periphery countries was followed by investment of European powers into the third world. It was not only the case that European governments lent money to the periphery governments, but in addition private foreign money flowed into the periphery countries.[7] Some of this investment was in the form of foreign direct investment (FDI) to finance infrastructure such as railroads, with the aim to expand trade even more. Foreign investment was not solely concentrated on infrastructure. As of 1888, while 33 percent of 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 the agricultural sector remained limited until the end of World War I.

The top panel of Fig. 3 shows private investment (FDI) from the 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 construction of the Berlin-Baghdad railroad 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, are low compared to the U.K. and France, and only slightly increased during the last three decades of our sample period, coinciding with the increased FDI from Germany. Similar to exports and imports in the previous figure, there is a stark decline after 1876 in FDI, up to 60 percent, and then a recovery. This is also true for Ottoman exports by destination country as shown in the bottom panel. Both declines follow the default of the Ottoman Empire on its external debt in 1876.

In the course of the 19th century, the 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 cost of Russian and Balkan wars. The Ottomans borrowed heavily from Europe during the 1850s and 1860s. This did not prevent the financial crisis of 1873 and the subsequent default in 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 to ensure debt payments. The outstanding debt was reduced to half of its value in nominal terms during the debt restructuring negotiations (Blaisdell, 1929). The OPDA helped to repair the lost reputation of the Ottomans, and hence the Ottoman state gained renewed access to the international capital markets.

3. Descriptive statistics

Table 1 shows the descriptive statistics. The longest series for capital inflows is for the U.K., where data is 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. We can also see from Table 1 that Britain was the biggest trading partner of the Ottoman Empire and purchased, on average, 4.6 million sterling worth of the Empire's exports, while selling about 7.6 million sterling worth of imports, on average. The smallest trade was between the Empire and Germany – only 0.4 million sterling worth of goods were exported into Germany, and 1.1 mil-

[7] Ottoman government bond issues and major purchasers over 1854–1914 are listed in Pamuk (1987) on page 74, Table 4.4.

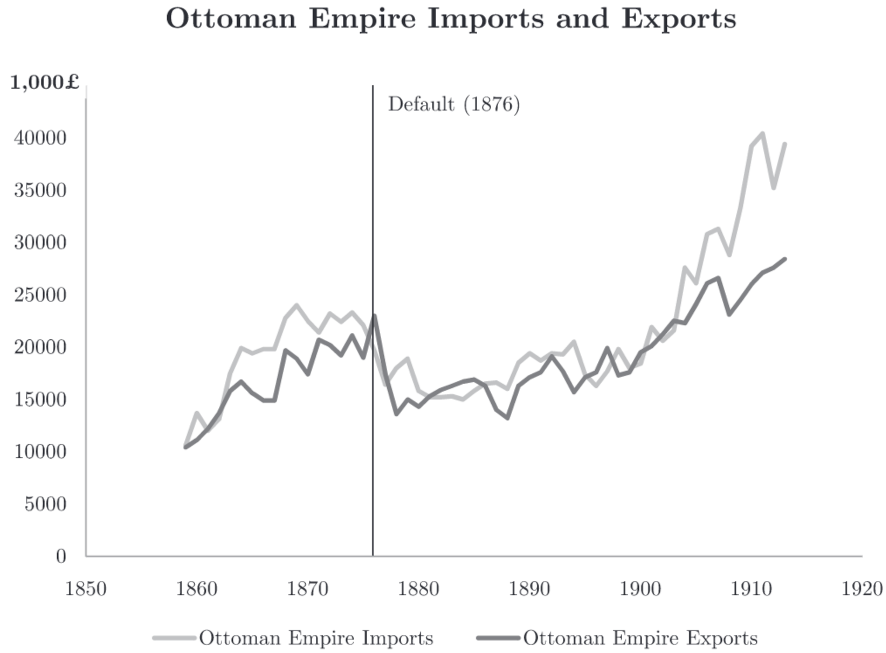


Fig. 2. Aggregate Imports and Exports of the Ottoman Empire during 1859–1913. *Notes:* This data is taken from Pamuk (1987). All variables are measured in thousand sterling.

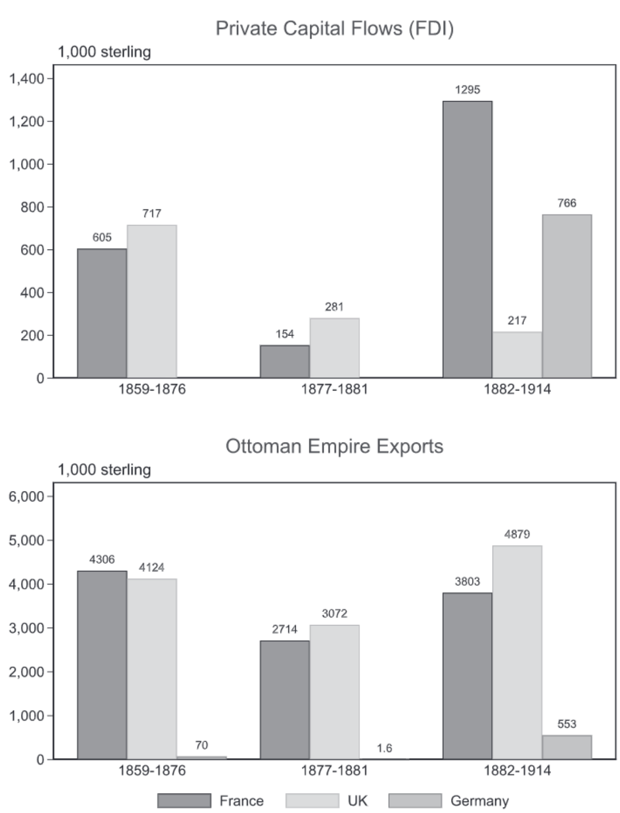


Fig. 3. Private Capital Inflow (FDI) and Exports of the Ottoman Empire during 1859–1913. *Notes:* This data is taken from Pamuk (1987). All variables are measured in thousand sterling and averaged over each period.

lion sterling was imported by Germany. Unlike the U.K. and Germany, France was the only country (out of three) which had purchased more than it sold, with Ottoman exports into France being 3.8 million and Ottoman imports from France being 2.5 million sterling, respectively. Overall, the Empire was running a current account deficit against all these three countries in total, during our sample period.

The Gross Domestic Product (GDP) of France, Germany, and the U.K. comes from Mitchell (1988). Mitchell (1992) and Maddison (1995) also provide some GDP numbers for Turkey. However, we use the GDP data for the Ottoman Empire that comes from Clemens and Williamson (2004), which is based on Pamuk's GDP estimates.[8] All the GDP data is expressed in local currencies, which we have converted into British sterling using the "Gold Standard" exchange rates (see Table A1). During our sample period, 1 sterling corresponded to a fixed 7.3224 g of fine gold, and thus we implicitly measure all the "monetary" variables in gold. As shown in Table 1, the Ottoman Empire was roughly 10 times poorer, per capita, than the European countries.

Population numbers for the Ottoman Empire come from Behar (1996), while the data on the population of France, Germany, and the U.K. comes from Maddison (1995). Table 1 shows that at the beginning of the sample in 1859, France was the largest country among those three, with a population of over 37 million. The smallest was Great Britain with about 29 million in population. During 1859–1913, France, Germany, and Great Britain experienced drastic differences in population growth rates. By 1913, Germany's population had increased by 85 percent, and it approached WWI with more than 65 million people. The population of France and the U.K. in the middle of 1913 was 41 and 46 million, respectively.

We impute data on FDI and exports to maximize the sample size

[8] Those sources, however, provide comparable GDP estimates as well as relative ratios. For example, while Maddison's UK and Turkey per capita GDP estimates for 1913, expressed in 1990 International Geary-Khamis dollars, are 4921 and 1,213, Clemens and Williamson estimates, expressed in British Sterling, are 52 and 10.

Table 1
Descriptive statistics by source country: 1859–1913.

Variable	# of Obs	Mean	Std. Dev.	Min	Max
France					
GDP	55	1137.10	272.21	706.34	1965.43
FDI	41	1.04	1.54	0.04	9.23
Imports from France	40	2.49	4.84	1.58	3.56
Exports into France	40	3.77	0.59	2.32	4.92
Population	55	39.47	1.26	37.24	41.46
UK					
GDP	55	1401.04	405.29	761.00	2354.00
FDI	55	0.39	0.43	0.03	2.12
Imports from the UK	40	7.62	1.47	3.43	9.93
Exports into the UK	40	4.58	1.00	2.49	6.34
Population	55	36.63	5.18	28.66	45.64
Germany					
GDP	55	1259.98	633.49	431.60	2782.56
FDI	26	0.77	0.76	0.09	3.40
Imports from Germany	40	1.11	1.39	0.02	4.66
Exports into Germany	40	0.43	0.51	0.00	1.46
Population	55	47.50	8.69	35.63	65.05
Ottoman Empire					
GDP	49	153.27	36.70	73.97	208.64
Population	55	16.54	3.10	10.17	21.89
Regression Variables (Pooled Panel Sample)					
FDI/GDP (raw)	122	0.001	0.001	0.000	0.008
FDI/GDP (imputed)	165	0.001	0.002	0.000	0.009
Exports/GDP (raw)	105	0.002	0.002	0.000	0.005
Exports/GDP (imputed)	165	0.003	0.002	0.000	0.009
Source GDP per capita	165	30.43	8.479	12.11	51.57
Host GDP per capita	147	8.825	1.424	5.128	10.89
Rainfall	165	−0.024	0.141	−0.716	0.268

Notes: For France, the U.K., Germany, and the Ottoman Empire, all variables except population are measured in millions of British Sterling. The population is measured in million people. Imports and Exports are the Ottoman Empire Imports and Exports. FDI denotes Private Capital Inflows from source countries (France, Germany and the U.K.) into the Ottoman Empire during 1859–1913. Data comes from Pamuk (1987), Table A3.3. Exports and Imports are values of goods exported from and imported into the Ottoman Empire with three trading partners (France, Germany and the U.K.) over 1859–1913, from Pamuk (2003) Table 7.5 and Pamuk (1987) Table 2.3, with values converted from Turkish Golden Lira into British sterlings using Gold Standard exchange rates from Table A1. GDP of each of source country comes from Mitchell (1992) Table J1. 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 (1992). Ottoman GDP data comes 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. comes from the Maddison dataset. The rainfall variable ($R_{mt} = \theta^g_{m0} P^g_t + \theta^o_{m0} P^o_t$) is calculated as the weighted sum of rainfall shocks to grain P^g_t and orchard P^o_t in time t, where weights are initial export shares of grain θ^g_{m0} and orchard θ^o_{m0} for each source country m.

in regression analysis.[9] However, we use both raw and imputed data, and the main regression results are based on raw data. Table 1 shows statistics for regression variables including both raw and imputed data. Summary statistics between raw and imputed data are close to each other. For each source country, Figs. 4 and 5 show imputed data for FDI-to-GDP ratios and export-to-GDP ratios, respectively, together with raw data.

[9] We impute missing data on FDI-to-GDP ratios, using the regression of log FDI-to-GDP ratios on log Ottoman government-debt-flow-to-GDP ratios with country fixed effects and country-specific time trends. This regression explains substantial variation in historical FDI-to-GDP ratios with an R-squared of 0.4114. We also impute missing data on Export-to-GDP ratios, using the regression of log Export-to-GDP ratios on log GDP per capita of each source country and log Ottoman GDP per capita with country fixed effects and country-specific time trends. This regression gives an R-squared of 0.8405. Remaining missing values are interpolated using the average of the values in years $t-1$ and $t+1$. If the value in $t+1$ is not feasible, the value in $t+2$ is used. When the value in $t-1$ is missing, we fill the value in t with the value in $t+1$.

4. OLS analysis

4.1. Empirical specification

Our benchmark specification is as follows:

$$\log\left(\frac{FDI_{it}}{GDP_{it}}\right) = \alpha_i + \lambda_t + \alpha_i t + \beta \log\left(\frac{EXPORTS_{it}}{GDP_{it}}\right) + \gamma W_t + \epsilon_{it} \quad (1)$$

where α_i indicates country dummies, and λ_t indicates either time dummies or event dummies. Time dummies consist of a series of dummy variables that equal 1 for five consecutive years without overlapping. Using event dummies, we control for specific events such as a dummy for the creation of the Ottoman Public Debt Administration (OPDA) in 1881, and other dummies characterizing the effect of Empire's default on the foreign debt in 1876, and the Resettlement of the debt in 1903. $\alpha_i t$ controls for country-specific trends.[10] The left-hand side variable is

[10] Country-specific trends are included as the interaction term ($\alpha_i t$) between country dummies α_i and time trend t.

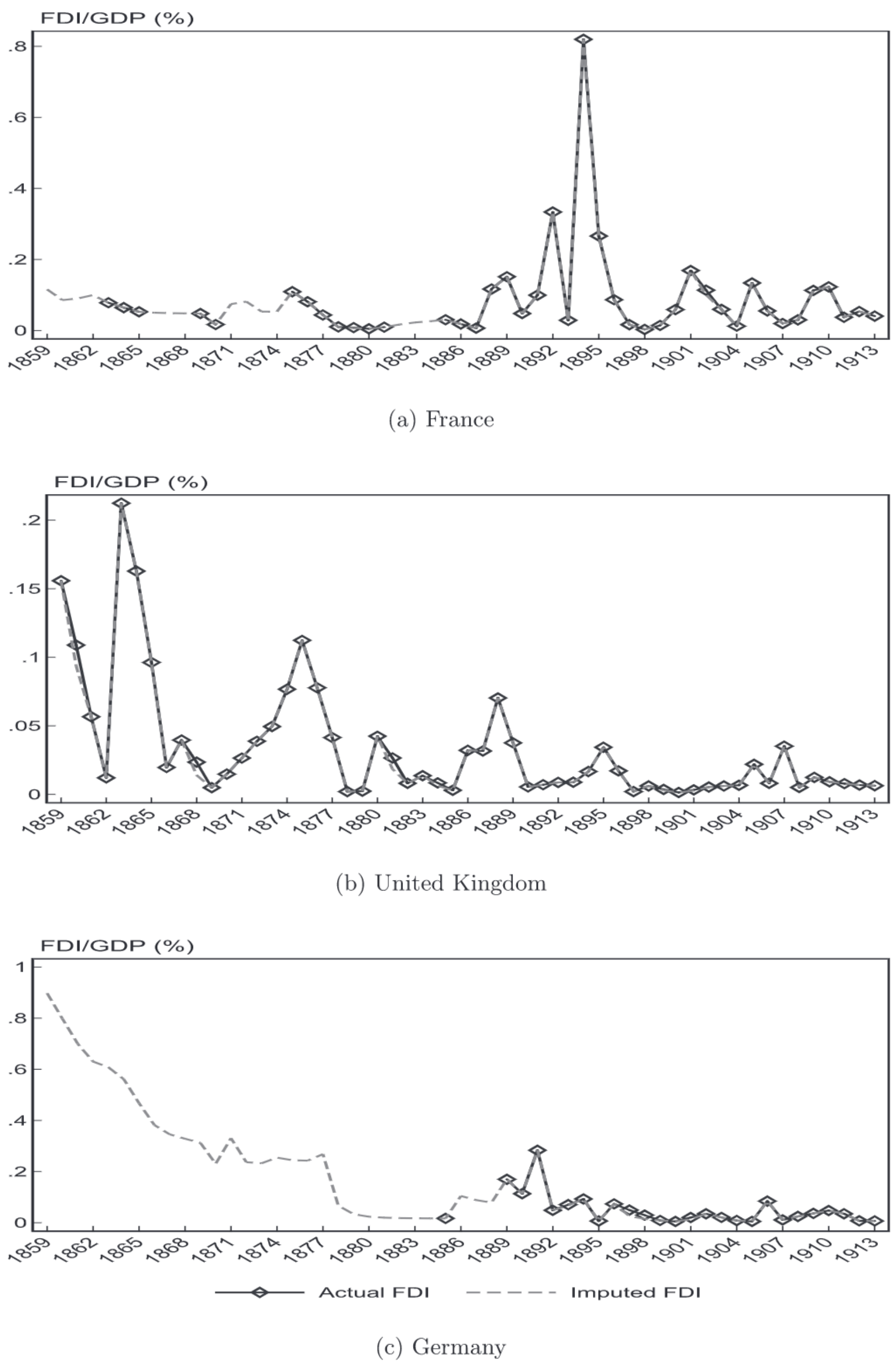


Fig. 4. Foreign Direct Investment (FDI) from Source Countries to the Ottoman Empire during the Period 1859–1913. *Notes:* Raw data is taken from Pamuk (1987). We impute missing data on FDI-to-GDP ratios, using the regression of log FDI-to-GDP ratios on log Ottoman government-debt-flow-to-GDP ratios with country fixed effects and country-specific time trends. This regression explains substantial variation in historical FDI-to-GDP ratios with an R-squared of 0.4114. Remaining missing values are interpolated using the average of the values in years $t-1$ and $t+1$. If the value in $t+1$ is not feasible, the value in $t+2$ is used. When the value in $t-1$ is missing, we fill the value in t with the value in $t+1$.

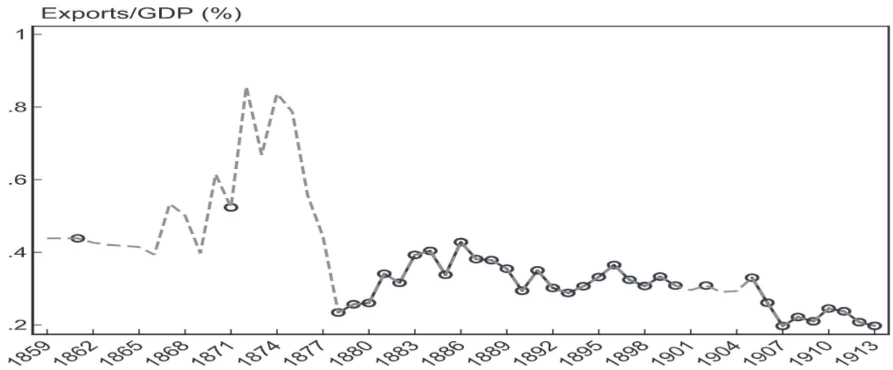
gross FDI inflows from the source countries i, which are France, Germany, and the U.K., into the Ottoman Empire; Exports are Ottoman exports into these countries. Both FDI and Exports are normalized by the GDP of each source country GDP_{it}. A control variable W_t is the Empire's contemporaneous GDP per capita.

4.2. OLS results

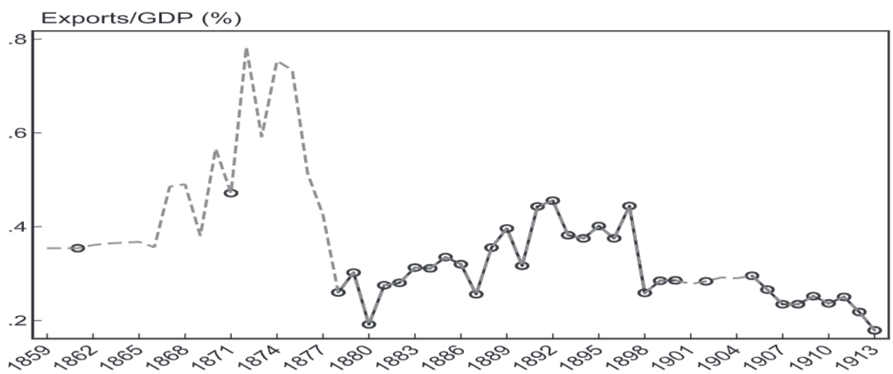
We report results from the OLS estimation of equation (1) without time dummies in Table 2.[11] Our result in column 1 is strong given our sample size of 87 observations for raw data.[12] In column 2, we use imputed data for FDI-to-GDP ratios and export-to-GDP ratios, and the log export-to-GDP ratio is contemporaneous with the log FDI-to-GDP ratio. In column 3, we use imputed data for FDI-to-GDP ratios and export-to-GDP ratios, and the log export-to-GDP ratio is lagged. In all of the specifications, coefficients of exports turn out to be positive and significant. The results are also economically significant, in which a 10 percent increase in exports is associated with a 2.1–3.1 percent increase in FDI flows.

[11] We use Driscoll and Kraay (1998) standard errors with the lag length 3, which is robust to heteroskedasticity and clustering on year and kernel-robust to common correlated disturbances.

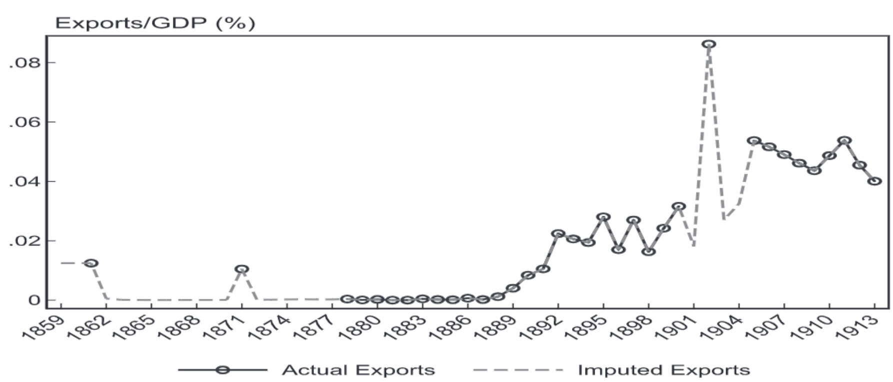
[12] Even though the raw dataset contains 122 FDI observations (for all three countries combined) and 105 Exports observations, for some years, one of the variables is missing while the other is not. As a result, we end up with only 87 complete FDI-Exports pairs, which constitutes the effective sample size.



(a) France



(b) United Kingdom



(c) Germany

Fig. 5. Exports from the Ottoman Empire to Source Countries during the Period 1859–1913. *Notes:* Raw data is taken from Pamuk (1987). We impute missing data on Export-to-GDP ratios, using the regression of log Export-to-GDP ratios on log GDP per capita of each source country and log Ottoman GDP per capita with country fixed effects and country-specific time trends. This regression gives an R-squared of 0.8405. Remaining missing values are interpolated using the average of the values in years $t-1$ and $t+1$. If the value in $t+1$ is not feasible, the value in $t+2$ is used. When the value in $t-1$ is missing, we fill the value in t with the value in $t+1$.

In Table 3, we first present results with time dummies and then replace them with dummies for important events such as default while also allowing for country-specific time trends.[13] To estimate 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. In 1881, the Ottoman government decided to take action toward repayment of the debt, and it 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. 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. All the dummies appear to have expected signs. We also control for GDP per capita of the Ottoman Empire to partial out the effect of exports on FDI via the exporter's income channel. This variable does not seem to have an impact, and

[13] When we include year fixed effects, the coefficients of exports become insignificant. This is because we have only three countries (trading partners) in panel data, which gives insufficient within-year variation across countries. Event dummies explained in this paragraph (Default, OPDA, and Resettlement) are not collinear with other controls such as country-specific time trends. These event dummies will be collinear with year fixed effects, but we do not have year fixed effects in our regressions.

Table 2
Ottoman exports and FDI inflows.

	Dependent Variable: $\log(\text{FDI/GDP})_{it}$		
	(1) Contemp. Raw	(2) Contemp. Imputed	(3) Lag. Imputed
log(Exports/GDP)	0.31**	0.27***	0.21**
	(0.13)	(0.08)	(0.09)
Adjusted R^2	0.2875	0.4655	0.4450
Number of Observations	87	147	144
Country Dummies	yes	yes	yes
Time Dummies	no	no	no
Country-specific Trends	yes	yes	yes
Controls	GDP p.c.	GDP p.c.	GDP p.c.

Notes: Exports and FDI are normalized by the GDP of each source country (France, Germany, and the UK). In column 1, we use raw data for FDI-to-GDP ratios and export-to-GDP ratios, and log Exports/GDP is contemporaneous with log FDI/GDP. In column 2, we use imputed data for FDI-to-GDP ratios and export-to-GDP ratios, and log Exports/GDP is contemporaneous with log FDI/GDP. In column 3, we use imputed data for FDI-to-GDP ratios and export-to-GDP ratios, and log Exports/GDP is lagged. Time dummies consist of a series of dummy variables that equal 1 for five consecutive years without overlapping. Country dummies, country-specific trends, and the log of the Ottoman GDP per capita are included as controls. The log of the Ottoman GDP per capita is contemporaneous with log FDI/GDP in columns 1 and 2 and lagged in column 3. ***, **, and * indicate significance at 1, 5, and 10% levels, respectively. Driscoll and Kraay (1998) standard errors (robust to heteroskedasticity and clustering on years and kernel-robust to common correlated disturbances with the lag length 3) are in parentheses.

Table 3
Ottoman exports and FDI inflows with time or event dummies.

	Dependent Variable: $\log(\text{FDI/GDP})_{it}$		
	(1) Contemp. Imputed	(2) Contemp. Imputed	(3) Contemp. Raw
$\log(\text{Exports/GDP})_{it}$	0.15**	0.22***	0.35**
	(0.07)	(0.08)	(0.17)
Default		−1.05**	−1.42**
		(0.42)	(0.71)
OPDA		0.57	1.30**
		(0.47)	(0.64)
Resettlement		0.30	0.92
		(0.53)	(0.68)
Adjusted R^2	0.5184	0.4954	0.3247
Number of Observations	147	147	87
Country Dummies	yes	yes	yes
Time Dummies	yes	no	no
Country-specific Trends	yes	yes	yes
Controls	GDP p.c.	GDP p.c.	GDP p.c.

Notes: Exports and FDI are normalized by the GDP of each source country (France, Germany, and the UK). In columns 1 and 2, we use imputed data for FDI-to-GDP ratios and export-to-GDP ratios, and log Exports/GDP is contemporaneous with log FDI/GDP. In column 3, we use raw data for FDI-to-GDP ratios and export-to-GDP ratios, and log Exports/GDP is contemporaneous with log FDI/GDP. Time dummies consist of a series of dummy variables that equal 1 for five consecutive years without overlapping, which are included in column 1. In columns 2 and 3, we include event dummies: Default, OPDA, and Resettlement. Default is a time dummy variable which equals 1 after the default of the Ottoman Empire in 1876. OPDA is a time dummy variable which equals 1 after the establishment of the Ottoman Public Debt Administration (OPDA) in 1881. Resettlement is a time dummy variable which equals 1 after 1903 when the Ottoman external debt decreased significantly after negotiations with creditors. Country dummies, country-specific trends, and the log of the Ottoman GDP per capita are included as controls. ***, **, and * indicate significance at 1, 5, and 10% levels. Driscoll and Kraay (1998) standard errors (robust to heteroskedasticity and clustering on years and kernel-robust to common correlated disturbances with the lag length 3) are in parentheses.

hence we do not report those results.[14]

To understand structural breaks in the relationship over time, we re-estimate our baseline regression (Table 2 column 1) at every 5-year period, using the following specification:

$$\log\left(\frac{FDI_{it}}{GDP_{it}}\right) = \alpha_i + \beta_j \log\left(\frac{EXPORTS_{it}}{GDP_{it}}\right) + \gamma W_t + \epsilon_{it},\ t \in j \tag{2}$$

where j refers to each 5-year period during the sample period 1885–1913 (the last period has only 4 years), and α_i indicates country dummies. The left-hand side variable is gross FDI inflows (raw data) from the source countries i, which are France, Germany, and the U.K., into the Ottoman Empire; Exports are Ottoman exports into these countries (raw data). Both FDI and exports are normalized by the GDP of each source country GDP_{it}. A control variable W_t is the Empire's con-

[14] For robustness, we also normalize FDI and exports by the population of source countries instead of their GDP. Note that there is no point in normalizing by the Ottoman GDP and population since that will be a common factor among the three source countries and be absorbed by the constant term. When we normalize by the population of the source country, the results are very similar in magnitude to those described and are available upon request.

Table 4
Ottoman exports and FDI inflows: Regressions at every 5-year period.

Sample Period:	Dependent Variable: $\log(\text{FDI/GDP})_{it}$					
	(1) 1885–1889	(2) 1890–1894	(3) 1895–1899	(4) 1900–1904	(5) 1905–1909	(6) 1910–1913
$\log(\text{Exports/GDP})_{it}$	0.25***	−0.76	−1.67	0.89***	0.84	2.35***
	(0.08)	(0.50)	(1.18)	(0.00)	(1.08)	(0.43)
Adjusted R^2	0.0622	0.5922	0.2327	0.9568	0.1841	0.7806
Number of Observations	12	15	15	6	15	12
Country Dummies	yes	yes	yes	yes	yes	yes
Controls	GDP p.c.	GDP p.c.	GDP p.c.	GDP p.c.	GDP p.c.	GDP p.c.

Notes: We use raw data for FDI-to-GDP ratios and export-to-GDP ratios, and log Exports/GDP is contemporaneous with log FDI/GDP. Country dummies and the log of the Ottoman GDP per capita are included as controls. ***, **, and * indicate significance at 1, 5, and 10% levels, respectively. Driscoll and Kraay (1998) standard errors (robust to heteroskedasticity and clustering on years and kernel-robust to common correlated disturbances with the lag length 2) are in parentheses.

Table 5
Placebo test.

	Dependent Variable: $\log(\text{FDI/GDP})_{it}$	
	(1) Baseline	(2) Placebo
$\log(\text{Exports/GDP})_{it}$	0.35**	0.01
	(0.17)	(0.09)
Adjusted R^2	0.3247	0.3078
Number of Observations	87	87
Country Dummies	yes	yes
Event Dummies	yes	yes
Country-specific Trends	yes	yes
Controls	GDP p.c.	GDP p.c.

Notes: Exports and FDI are normalized by the GDP of each source country (France, Germany, and the UK). We use raw data for FDI-to-GDP ratios and export-to-GDP ratios, and log Exports/GDP is contemporaneous with log FDI/GDP. In column 1, we reproduce the baseline regression in Table 3 column 3, and countries which send capital into the Ottoman Empire are also the countries to which the Ottoman Empire exports. In column 2, we switch trading partners. FDI from France is matched to exports into the UK, the UK is matched to Germany, and Germany is matched to France. Using event dummies, we control for specific events such as a dummy for the creation of the Ottoman Public Debt Administration (OPDA) in 1881, and other dummies characterizing the effect of Empire's default on the foreign debt in 1876, and the Resettlement of the debt in 1903. Country and event dummies, country-specific trends, and the log of the Ottoman GDP per capita are included as controls. ***, **, and * indicate significance at 1, 5, and 10% levels, respectively. Driscoll and Kraay (1998) standard errors (robust to heteroskedasticity and clustering on years and kernel-robust to common correlated disturbances with the lag length 3) are in parentheses.

temporaneous GDP per capita in logs. In Table 4, we find that Ottoman exports and FDI inflows into the Ottoman Empire are positively associated during the periods 1885–1889, 1900–1904, and 1910–1913, and these correlations are significant at a 1 percent level. Although correlations during some periods are not significant due to the small sample size, these regression results suggest that there is no evident structural break in the relationship between exports and FDI.

Furthermore, we perform a placebo test to show that bilateral trade matters in explaining bilateral FDI. In Table 5 column 2, we switch all three trading partners and rerun the baseline regression of column 1. We find that exports do not explain FDI after switching trading partners, which suggests that bilateral trade matters for bilateral FDI. Also, we investigate whether coefficients in our regressions capture the correlation between FDI and unobserved common time-varying factors. To do this, we construct a measure for the time-varying factor that can capture competition amongst source countries, which leads to the boom-bust cycle in capital flows. We measure this cycle in capital flows (FDI cycle) facing a country i in a year t as the average of log FDI-to-GDP ratios of other countries in a year t excluding the country i. Table 6 reproduces the baseline regression in column 1 and adds an FDI cycle to the regression in column 2. We find that the FDI cycle is positively correlated with FDI of each source country only at a 15 percent significance level. Importantly, the coefficient on exports is still significant at a 5 percent level, and the magnitude of this coefficient rarely decreases (from 0.35 to 0.34) after adding the FDI cycle.

4.3. Dynamic responses

To investigate dynamic responses of FDI to exports, we run regressions by local projections (Jordà (2005)) as follows:

$$\log\left(\frac{FDI_{it+h}}{GDP_{it+h}}\right) = \alpha_i + \alpha_i t + \beta_h \log\left(\frac{EXPORTS_{it}}{GDP_{it}}\right) + \sum_{j=1}^{3} \gamma_j W_{it-j} + \epsilon_{it+h} \tag{3}$$

where α_i indicates country dummies, and $\alpha_i t$ controls for country-specific trends. The left-hand side variable is interpolated gross FDI inflows from the source countries i, which are France, Germany, and the U.K., into the Ottoman Empire in time $t + h$; Exports are interpolated Ottoman exports into these countries in time t. Both FDI and Exports are normalized by the GDP of each source country. The set of control variables W_{it} includes FDI-to-GDP ratios, export-to-GDP ratios, and the Empire's GDP per capita (which does not vary across countries),

Table 6
A Test of FDI cycle.

	Dependent Variable: log(FDI/GDP)$_{it}$	
	(1) baseline	(2) FDI cycle
log(Exports/GDP)$_{it}$	0.35**	0.34**
	(0.17)	(0.13)
FDI cycle$_{it}$		0.25
		(0.16)
Adjusted R^2	0.3247	0.4431
Number of Observations	87	69
Country Dummies	yes	yes
Event Dummies	yes	yes
Country-specific Trends	yes	yes
Controls	GDP p.c.	GDP p.c.

Notes: Exports and FDI are normalized by the GDP of each source country (France, Germany, and the UK). We use raw data for FDI-to-GDP ratios and export-to-GDP ratios, and log Exports/GDP is contemporaneous with log FDI/GDP. In column 1, we reproduce the baseline regression in Table 3 column 3. In column 2, we add an FDI cycle variable for country *i* in year *t*, which is calculated as the average of log FDI-to-GDP ratios of other countries in year *t*, excluding country *i*. Using event dummies, we control for specific events such as a dummy for the creation of the Ottoman Public Debt Administration (OPDA) in 1881, and other dummies characterizing the effect of Empire's default on the foreign debt in 1876, and the Resettlement of the debt in 1903. Country and event dummies, country-specific trends, and the log of the Ottoman GDP per capita are included as controls. ***, **, and * indicate significance at 1, 5, and 10% levels. Driscoll and Kraay (1998) standard errors (robust to heteroskedasticity and clustering on years and kernel-robust to common correlated disturbances with the lag length 3) are in parentheses.

and all of them are included up to past three years.

We find that a rise in exports has persistently significant effects on FDI up to a 3-year ahead horizon at a 5 percent significance level. We collect estimates β_h in Fig. 6. On impact, a 1 percent increase shock from the export-to-GDP ratio is associated with a 0.18 percent increase in the FDI-to-GDP ratio. After three years, the FDI-to-GDP ratio increases by 0.20 percent in response to the same shock.

5. IV analysis

5.1. Rainfall, agricultural production, and trade

In this section, we lay out our argument on the linkage between trade, production, and weather conditions, specifically the regional variation in the amount of rainfall within the Ottoman Empire. We explain in detail how the composition of exports into the U.K., France, and Germany, as well as specialization of the Empire's regions in different types of crops, allows 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 that were available for sale in and out of the country, causing exports to increase. This line of thought mainly comes from the "provisionistic" nature of the Empire's policy. 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 was low, it had to go first towards satisfying the army needs; if there remained any excess over this amount, it could be traded abroad.

As discussed in Pamuk and Williamson (2011), by the beginning of the second half of the 19th century, the de-industrialization of the Ottoman Empire was practically complete. Labor and other resources were pulled out of the industry, and agricultural production constituted the biggest part of the Ottoman Empire's GDP. Altug et al. (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."

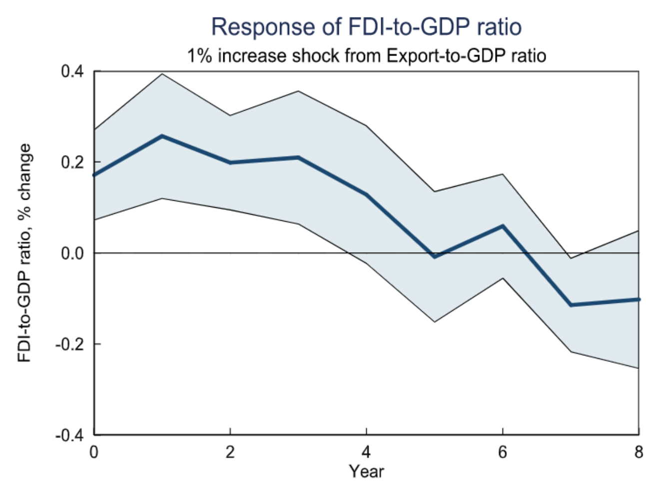


Fig. 6. Dynamic Responses of Foreign Direct Investment (FDI) from Source Countries to the Ottoman Empire. *Notes:* We run regressions by local projections (Jordà, 2005) as follows:

$$\log\left(\frac{FDI_{it+h}}{GDP_{it+h}}\right) = \alpha_i + \alpha_i t + \beta_h \log\left(\frac{EXPORTS_{it}}{GDP_{it}}\right) + \gamma W_{it} + \epsilon_{it+h}$$

where α_i indicates country dummies, and $\alpha_i t$ controls for country-specific trends. The left-hand side variable is gross FDI inflows from the source countries (denoted as *i*), which are France, Germany and the U.K., into the Ottoman Empire in time $t + h$; Exports are Ottoman exports into these countries in time *t*. The set of control variables W_{it} includes three lagged variables of each of FDI-to-GDP ratios, export-to-GDP ratios, and the Empire's GDP per capita. Estimates β_h are plotted as a solid line connecting the estimate in each horizon *h*. The shaded area shows 95% confidence intervals with Driscoll and Kraay (1998) standard error (lag length 3).

Agricultural goods made up a significant share of Ottoman exports. Therefore, the amount of rainfall was an important determinant of both domestic production and trade. Indeed, Donaldson (2018) 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 crops. 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 the quantity and quality of crops. 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 was 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 is regular and predictable rainfall. Similar patterns hold for other important agricultural export goods of the Ottoman Empire such as corn, grain, and olives. Agricultural production was critically dependent on rainfall during the sample period, given that the development of irrigation systems occurred in Turkey only at the end of the 20th century (Food and Agriculture Organization of the United Nations, 2009), which is outside the time frame we consider in this paper.

Measuring the effect of rainfall 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 specialized 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 (Prime Ministry Republic of Turkey and Turkish Statistical Institute, 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. We will focus on the regions that constitute today's modern Turkey and assume the specialization of regions in crops stays more or less the same in the last 200 years. This assumption is based on the maps provided by the State Institute of Statistics (SIS) historical and contemporaneous yearbooks for grain and orchard production. Hence, we aggregate the products to groups such as "grains" and "orchards" and focus on bigger geographical regions than cities.

Let us explain this in detail. Turkey consists of 80 administrative provinces, 12 statistical regions (SRE) and 7 geographical regions. The first 4 of the 7 geographical 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 cultivated 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 an area reserved for tea plantations. For consistency, we call the first type of land "grain" land, and the second type "orchard" land. As shown in Table 7, the share of "grain" land varies from 35 percent in the East Black Sea region to as high as 99 percent in North East Anatolia. These shares of "grain" and "orchard" lands remained roughly the same in the last 200 years.

Let us work out an example. Assume there is extensive rain in the Aegean region and abnormally dry weather in the Mediterranean region. 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 7, we can see that the area of positively affected "grain" land in the Aegean region equals 2,187 thousand hectares, and it is fairly close to the negatively affected "grain" area in the Mediterranean region, which equals 2,132 million hectares. Second, we expect the whole country's output of "orchard" products to increase. The reason is that the "orchard" land in the 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 recovers relatively precisely the level of rainfall during a growing season in each particular year based on the width of age rings, where each ring corresponds to a certain year. During droughts, 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.[15]

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 in Fig. 7. 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 of those series 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 Turkey under consideration corresponded to TR2 statistical region. Touchan et al. (2003) build the dataset which reconstructs Southwestern Turkey (TR3) Spring (May–June) precipitations. Their data starts in 1776, and the sites were located in the TR3 statistical region. Finally, Touchan et al. (2007) is an extensive reconstruction of precipitations in the Eastern-Mediterranean Region for the last 600 years. This study covers not only Turkey but also other countries in the region. The majority of sites located in Turkey are concentrated in TR3 and the West half of TR6.

The rainfall variable constructed from tree-ring methodology might capture overall conditions that affect plant growth. The reason is that measured tree-ring growth in a given year will be higher when temperature or timing of rainfall was ideal. We believe that the rainfall instrument is still valid and relevant, as long as plant growth conditions are exogenous to capital flows and affect exports given the provisionistic policy of the Ottoman Empire.

To identify whether there was unusually rainy weather or unusually dry weather in a region $j (j = 1..J)$, and hence whether there was a shock to productivity, we proceed as follows. First, we measure the percentage deviation of yearly precipitation r_{jt} in a region j during a year t from their average values over the period under consideration (1859–1913):

$$dr_{jt} = \log(r_{jt}) - \log\left(\frac{1}{T}\sum_{t=1859}^{1913} r_{jt}\right) \tag{4}$$

where t indexes years, and T, the sample length, is 55, and dr_{jt} measures the deviation from the average. Positive values of this statistic would indicate that in a year t region j experienced a large amount of rainfall, which most likely would have resulted in high yield. Having this index and knowing the distribution of land between the "grain" and "orchard" land in each region allow us to construct a variable, which reflects the country-wide "grain" and "orchard" production shocks as a result of a unique rain map over the Ottoman Empire in a year t. Let L_j be the agricultural area of a region j. It is split into two parts: "grain" land L_j^g

[15] As a robustness check, we compare reconstructed precipitation data to "true" historical data from the Ottoman Archives. Unfortunately, archival data only covers limited regions. The correlation between the two datasets for the overlapping regions is 0.495.

Table 7
Agricultural land of Turkey by statistical region (SRE).

	Agricultural Land by SRE, thousand Hectare			
Region	Total Land L_j	Cultivated Field Area "Grain Land"	Non Cultivated Area "Orchard Land"	Share of Cultivated Land in Total Land S_j (percent)
Istanbul (TR1)	83	76	7	92
Marmara				
West Marmara (TR2)	1736	1510	226	87
East Marmara (TR4)	1564	1226	338	78
Aegean (TR3)	3010	2187	828	73
Mediterranean (TR6)	2623	2132	490	81
Black Sea				
West Black Sea (TR8)	2251	1996	256	87
East Black Sea (TR9)	736	259	476	35
Anatolia				
West Anatolia (TR5)	4221	4050	171	96
Central Anatolia (TR7)	4003	3872	131	97
North East Anatolia (TRA)	1461	1443	18	99
Central East Anatolia (TRB)	1451	1328	123	92
South East Anatolia (TRC)	3453	3992	461	87
Total	26,593	23,066	3526	87

Notes: The data comes from Prime Ministry Republic of Turkey and Turkish Statistical Institute (2005) Table 11.11 on page 177. "Grain" produce includes corn, wheat, barley, and rye. Also, we included cotton into this category, because cotton is typically rotated with the grain. "Orchard" produce includes grape, fig, unspecified fruits and vegetables, vine, olive oil, acorn, hazelnuts, and peanuts. "Other" produce includes animal products such as sheep, goat and lamb wool, leather, silk, and several minor categories.

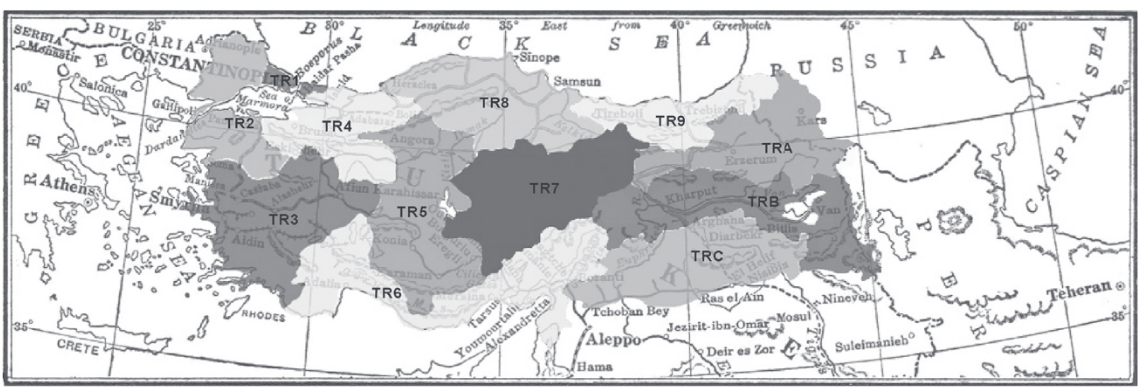


Fig. 7. Statistical Regions of Turkey with Long-term Rainfall Data. *Notes:* The figure shows the location of the statistical regions (SRE). TR1-Istanbul, TR2-West Marmara, TR3-Aegean, TR4-East Marmara, TR5-West Anatolia, TR6-Mediterranean, TR7-Central Anatolia, TR8-West Black Sea, TR9-East Black Sea, TRA-North East Anatolia, TRB-Central East Anatolia, TRC-South East Anatolia. Names of the statistical regions and their tags accord to Prime Ministry Republic of Turkey and Turkish Statistical Institute (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).

and "orchard" land L_j^o, and $L_j = L_j^g + L_j^o$. We can define S_j as the share of "grain" land in the total agricultural area of a region j

$$S_j = \frac{L_j^g}{L_j} \tag{5}$$

Then the country-wide output shock to "grain" production P_t^g and the output shock to the "orchard" production P_t^o in a year t would be the average of the regional shocks, weighted by the share of their area in the total area:

$$P_t^g = \frac{\sum_{j=1}^J L_j^g \times dr_{jt}}{\sum_{j=1}^J L_j^g} = \frac{\sum_{j=1}^J S_j L_j \times dr_{jt}}{\sum_{j=1}^J S_j L_j} \tag{6}$$

$$P_t^o = \frac{\sum_{j=1}^J L_j^o \times dr_{jt}}{\sum_{j=1}^J L_j^o} = \frac{\sum_{j=1}^J (1-S_j) L_j \times dr_{jt}}{\sum_{j=1}^J (1-S_j) L_j} \tag{7}$$

This set of indices is used to model the deviations in the production of both types of agricultural outputs as a function of the amount *and* location of rainfall in Turkey, under the assumption that both types of crops are similarly affected by rainfall.[16] 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 percent for the West Marmara region, 20 percent for Aegean, and 6 percent for West Anatolia. All other regions experienced usual level of rainfall. What can we say about the deviations of grain and orchard 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

[16] We do a robustness check for different sensitivities of crop production with regard to rainfall in Table 10.

S_j come from Table 7, and they are equal to {1736; 0.87}, {3010; 0.73} and {4221; 0.96} for the West Marmara, Aegean, and West Anatolia regions, respectively. To find country-wide shocks to the production of "grain" and "orchard," we need to use Eq. (6) and Eq. (7). After substituting the values, we get $P_t^g = \frac{0.10\times1{,}510+0.20\times2{,}187+0.06\times4{,}050}{23{,}066} = 3.60\times10^{-2}$ and $P_t^o = \frac{0.10\times226+0.20\times828+0.06\times171}{3{,}526} = 5.63\times10^{-2}$. These numbers mean that in a year t production of grain has experienced a positive shock of about 4 percent, while the production of the orchard has experienced a positive shock of about 6 percent. Different rain patterns from year to year cause the time variation of production.

Our next step is to introduce cross-sectional variation (meaning between the Empire and the various Northern trading partners) 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 (2011) argue that the Ottoman Empire, while importing manufactures, specialized in the export of primary products. As is evident from Table 8, at the beginning of the sample, agricultural products constituted about 70 percent of exports to both Germany and the U.K. For France, this share makes up only 26 percent. We speculate that the reason 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 percent of France imports, falling to 18.3 percent only in 1880–1882, right after the default (Pamuk, 2003).

The differences in export 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 $\vec{\theta}_m = (\theta_m^g, \theta_m^o, \theta_m^0)$ represent the decomposition of exports of country m into "grain," "orchard," and "other" according to Table 8. It is important that we use initial values (first year in our sample) for these export bundles and do not allow them to vary over time. Hence, these initial export shares can be thought of as structural demand for the Empire's products by the Northern countries.

We construct the variable "Rainfall," R_{mt}, which reflects export-share-weighted plant productivity shocks for a trading country m in a year t, and thus this variable is able to instrument for country-time varying exports:

$$R_{mt} = \theta_{m0}^g P_t^g + \theta_{m0}^o P_t^o \tag{8}$$

where as usual, "g" and "o" denote "grain" and "orchard" production, respectively, and the values of shocks to outputs P_t^g and P_t^o are defined according to Eq. (6) and Eq. (7).

5.2. IV results and threats to identification

The top panel of Table 9 shows the two-stage least square (2SLS) results and the bottom panel reports the coefficient on rainfall from the corresponding first-stage regression.[17] We can see that exports are indeed a significant determinant of FDI. This is true when we do not have event dummies (column 1) and when we include event dummies (column 2). In column 2, the coefficient on exports is larger than the OLS counterpart and significant at a 1 percent level. This result shows that the OLS estimates are biased downward, possibly because omitted factors (such as regulations on financial flows) – that increase FDI into the Ottoman Empire – are negatively correlated with Ottoman exports. This also suggests that substitutability between FDI and exports might exist in which the causal relationship runs from FDI to exports. Heckscher-Ohlin-Mundell paradigm can explain this finding in that goods need not be traded to achieve factor price equalization when capital flows into a country.

The first-stage regressions show that rainfall is a significant determinant of exports, in which the first-stage F statistic exceeds the rule-of-thumb threshold level of 10. The value of the coefficient is around

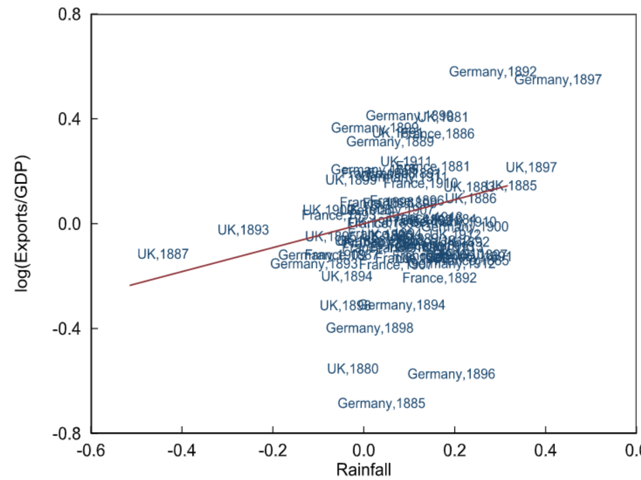


Fig. 8. The Partial Effect Scatterplot of Rainfall and the Ottoman Empire Exports. *Notes:* The scatterplot and the solid line correspond to the first-stage regression in Table 9 column 2 with the partial effect of rainfall on exports being equal to 0.46 with the standard error of 0.17. The log export-to-GDP ratio and rainfall variables are purged out of control variables in the first-stage regression.

0.46, suggesting that an increase in the rainfall index by about 10 percent (which corresponds to one standard deviation in rainfall from the mean) leads to a 5 percent increase in Ottoman exports. This rise in exports, in turn, causes a 3 percent increase in capital inflows, on average. Fig. 8 shows the partial plot for column 2 of the first-stage regression, and it is clear that the strong first-stage correlation is not driven by outliers. Moreover, we take a formal test of the exclusion restriction, using the Hansen's overidentifying restriction test. Hansen's J statistics do not reject the null hypothesis that instruments are excludable, which provides suggestive evidence that the rainfall instrument is valid.

In columns 3 and 4, we rerun regressions using the sample in which all observations start in 1885 to alleviate concerns about missing observations before 1885.[18] In column 3 without the "Resettlement" event dummy, we lose some significance due to the small sample size, but the coefficient is still positive and significant at a 10 percent level. In column 4 with the "Resettlement" event dummy, we have a positive causal relationship, which is significant at a 1 percent level.

Guided by the model of Antràs and Caballero (2009), we validate the exclusion restriction that rainfall affects FDI only via the export channel. This means that rainfall is not associated with FDI or unobserved factors that determine FDI, once we control for exports and include our other control variables. In their model, differences in the returns to capital in the agricultural sector between the Ottoman Empire (δ^H) and each source country i (δ_i^F) drive capital flows. When the return to capital in the Ottoman Empire is greater than the one in source countries, capital flows from source countries to the Ottoman Empire. Therefore, we can think of capital inflows into the Ottoman Empire as an increasing function of $\delta^H - \delta_i^F$, for simplicity. Also, δ^H is determined by the Ottoman variables: the marginal product of capital and export revenues per unit $p(1-\tau)$ — in which p is the unit price of exporting goods, and τ is trade costs — together with structural parameters such as the preference for goods and the degree of financial development. Thus, from the perspective of the Ottoman Empire, we can characterize capital flows as a function of the marginal product of capital and export revenues of the Ottoman Empire given constant structural parameters. Regressions include country dummies α_i to control for differences in

[17] For all of 2SLS regressions, we use raw data on exports and FDI.

[18] In the full regression sample using raw data on exports and FDI, observations from France start in 1878; the U.K. in 1871; and Germany in 1885.

Table 8
Ottoman decomposition of exports.

	Decomposition of Exports, percent		
	France	U.K.	Germany
Grain produce	16.9	44.8	41.4
Orchard produce	9.2	21.0	31.4
Other	73.9	34.2	27.2
Total	100.0	100.0	100.0

Notes: "Grain" produce includes corn, wheat, barley, and rye. Also, we included cotton into this category, because cotton is typically rotated with the grain. "Orchard" produce includes grape, fig, unspecified fruits and vegetables, vine, olive oil, acorn, hazelnuts, and peanuts. "Other" produce includes animal products such as sheep, goat and lamb wool, leather, silk, and several minor categories. Export 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 export shares that correspond to the beginnings of the respective samples.

Table 9
Ottoman exports and FDI inflows (2SLS).

	A. Second Stage Regression			
	Full Sample		Starting in 1885	
	Dependent Variable: $\log(\text{FDI/GDP})_{it}$			
	(1)	(2)	(3)	(4)
$\log(\text{Exports/GDP})_{it}$	0.33**	0.57***	0.31*	0.60***
	(0.13)	(0.18)	(0.16)	(0.17)
	B. First Stage Regression			
	Dependent Variable: $\log(\text{Exports/GDP})_{it}$			
	(1)	(2)	(3)	(4)
Rainfall_{it}	0.46***	0.46***	0.37**	0.37**
	(0.17)	(0.17)	(0.16)	(0.16)
Adjusted R^2	0.2696	0.2796	0.2911	0.3303
Number of Observations	73	73	66	66
Country Dummies	yes	yes	yes	yes
Event Dummies	no	yes	no	yes
Country-specific Trends	yes	yes	yes	yes
First-stage F	13.34	11.20	14.13	12.51
F (p-value)†	0.0000	0.0000	0.0000	0.0000
Hansen J (p-value)††	0.1927	0.2482	0.1695	0.2903
Controls	GDP p.c.	GDP p.c.	GDP p.c.	GDP p.c.

Notes: We use raw data for FDI-to-GDP ratios and export-to-GDP ratios, and log Exports/GDP is contemporaneous with log FDI/GDP. Event dummies are "Default," "OPDA," and "Resettlement." Default is a time dummy variable which equals 1 after the default of the Ottoman Empire in 1876. OPDA is a time dummy variable which equals 1 after the establishment of the Ottoman Public Debt Administration (OPDA) in 1881. Resettlement is a time dummy variable which equals 1 after 1903 when the Ottoman external debt decreased significantly after negotiations with creditors. Country dummies, country-specific trends, and the log of the Ottoman GDP per capita are included as controls. ***, **, and * indicate significance at 1, 5, and 10% levels, respectively. Driscoll and Kraay (1998) standard errors (robust to heteroskedasticity and clustering on years and kernel-robust to common correlated disturbances with the lag length 3) are in parentheses. Adjusted R^2 is calculated for second stage regressions. † This p-value – which is associated with the Sanderson and Windmeijer (2016) first-stage F test – is used to test the null that instruments are weak. †† This p-value – which is associated with Hansen's overidentifying test – is used to test the null that instruments are excludable. The rainfall variable ($R_{mt} = \theta^g_{m0} P^g_t + \theta^o_{m0} P^o_t$) is calculated as the weighted sum of rainfall shocks to grain P^g_t and orchard P^o_t in time t, where weights are initial export shares of grain θ^g_{m0} and orchard θ^o_{m0} for each source country m. Contemporaneous rainfall and two lagged variables of each of rainfall and log Exports/GDP are used as instruments. The first stage regression is as follows: $\log(\text{Exports/GDP})_{it} = \beta \text{Rainfall}_{it} + \gamma_j \sum_{j=1}^{2} \text{Rainfall}_{it-j} + \delta_j \sum_{j=1}^{2} \log(\text{Exports/GDP})_{it-j} + \omega \log(\text{GDPpercapita})_t + \alpha_i + \lambda_t + \alpha_i t + \epsilon_{it}$ where α_i indicates country dummies; λ_t indicates event dummies; $\alpha_i t$ refers to country-specific trends. We use a full regression sample in columns 1 and 2 (observations from France start in 1878; the U.K. in 1871; and Germany in 1885.), while we use the sample starting in 1885 in columns 3 and 4.

structural parameters in δ^F_i across countries i.

In 2SLS regressions, rainfall generates exogenous variation in trade frictions τ and is correlated with export revenues, given the provisionistic nature of the Ottoman policy. If rainfall was not enough in a given year, and in turn, the production of agricultural goods might have dropped below the threshold, the Ottoman government banned exports (the trade cost was at a maximum level, $\tau = 1$). If the level of production was above the threshold, the trade cost τ would decrease as production increased (rainfall increased), given that a smaller portion of total production is allocated to the Ottoman government and that τ is a unit cost associated with trade frictions.

The main threat to the exclusion test is that rainfall can affect capital flows via the marginal product of capital rather than export revenues. We argue that we can control for the marginal product of capital by including GDP per capita of the Ottoman Empire. Suppose production Y is given by $ZK^{\alpha}L^{(1-\alpha)}$ in which Z is aggregate productivity,

Table 10
Ottoman exports and FDI inflows (2SLS) with alternative instruments.

A. Second Stage Regression

	Dependent Variable: $\log(\text{FDI/GDP})_{it}$									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Baseline		Sensitivity: Grain 1.5 & Orchard 0.5		Sensitivity: Grain 0.5 & Orchard 1.5		Exports: Grain +20% & Orchard −20%		Exports: Grain −20% & Orchard +20%	
$\log(\text{Exports/GDP})_{it}$	0.33**	0.57***	0.33**	0.57***	0.33**	0.57***	0.33**	0.57***	0.33**	0.57***
	(0.13)	(0.18)	(0.13)	(0.18)	(0.14)	(0.18)	(0.13)	(0.18)	(0.14)	(0.18)

B. First Stage Regression

	Dependent Variable: $\log(\text{Exports/GDP})_{it}$									
Rainfall_{it}	0.46***	0.46***	0.38***	0.38***	0.56***	0.56***	0.43***	0.43***	0.49***	0.49***
	(0.17)	(0.17)	(0.14)	(0.14)	(0.21)	(0.21)	(0.16)	(0.16)	(0.18)	(0.18)
Adjusted R^2	0.2696	0.2796	0.2696	0.2797	0.2698	0.2798	0.2696	0.2796	0.2697	0.2796
Number of Observations	73	73	73	73	73	73	73	73	73	73
Country Dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Event Dummies	no	yes	no	yes	no	yes	no	yes	no	yes
Country-specific Trends	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
First-stage F	13.34	11.20	12.92	10.87	13.82	11.59	13.16	11.06	13.52	11.35
F (p-value)[†]	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Hansen J (p-value)[††]	0.1927	0.2482	0.2007	0.2346	0.1857	0.2717	0.1960	0.2420	0.1896	0.2560

Notes: We use raw data for FDI-to-GDP ratios and export-to-GDP ratios, and log Exports/GDP is contemporaneous with log FDI/GDP. Event dummies are "Default," "OPDA," and "Resettlement." Default is a time dummy variable which equals 1 after the default of the Ottoman Empire in 1876. OPDA is a time dummy variable which equals 1 after the establishment of the Ottoman Public Debt Administration (OPDA) in 1881. Resettlement is a time dummy variable which equals 1 after 1903 when the Ottoman external debt decreased significantly after negotiations with creditors. Country and event dummies, country-specific trends, and the log of the Ottoman GDP per capita are included as controls. ***, **, and * indicate significance at 1, 5, and 10% levels. Driscoll and Kraay (1998) standard errors (robust to heteroskedasticity and clustering on years and kernel-robust to common correlated disturbances with the lag length 3) are in parentheses. Adjusted R^2 is calculated for second stage regressions. [†] This p-value – which is associated with the Sanderson and Windmeijer (2016) first-stage F test – is used to test the null that instruments are weak. [††] This p-value – which is associated with Hansen's overidentifying test – is used to test the null that instruments are excludable. The rainfall variable ($R_{mt} = \theta^g_{m0} P^g_t + \theta^o_{m0} P^o_t$) is calculated as the weighted sum of rainfall shocks to grain P^g_t and orchard P^o_t in time t, where weights are initial export shares of grain θ^g_{m0} and orchard θ^o_{m0} for each source country m. Contemporaneous rainfall and two lagged variables of each of rainfall and log(Exports/GDP) are used as instruments. The first stage regression is as follows: $\log(\text{Exports/GDP})_{it} = \beta \text{Rainfall}_{it} + \gamma_j \sum_{j=1}^{2} \text{Rainfall}_{it-j} + \delta_j \sum_{j=1}^{2} \log(\text{Exports/GDP})_{it-j} + \omega \log(\text{GDPpercapita})_{it} + \alpha_i + \lambda_t + \alpha_i t + \epsilon_{it}$ where α_i indicates country dummies; λ_t indicates event dummies; $\alpha_i t$ refers to country-specific trends. We reproduce IV regression results from Table 9 in columns 1 and 2, which are without and with event dummies, respectively. Then, we reconstruct a rainfall variable ($R_{mt} = \theta^g_{m0} \omega^g P^g_t + \theta^o_{m0} \omega^o P^o_t$) such that sensitivities for grain ω^g and orchard ω^o are 1.5 and 0.5, and we replace the baseline rainfall variable with the reconstructed rainfall variable in columns 3 and 4. Columns 5 and 6 present results with another rainfall variable such that sensitivities for grain and orchard are 0.5 and 1.5, respectively. Also, we reconstruct a rainfall variable ($R_{mt} = \theta^g_{m0} P^g_t + \theta^o_{m0} P^o_t$) such that export shares of grain θ^g_{m0} are increased by 20% and export shares of orchard θ^o_{m0} are decreased by 20% for all countries m, and we replace the baseline rainfall variable with the reconstructed rainfall variable in columns 7 and 8. Columns 9 and 10 show results with another rainfall variable such that θ^g_{m0} are decreased by 20% and θ^o_{m0} are increased by 20% for all countries m.

K is capital, and L is labor. Then, the marginal product of capital is $\partial Y/\partial K = \alpha Z(K/L)^{(\alpha-1)}$. We can rewrite the marginal product of capital as $(\alpha Y/K) = (\alpha Y/N) \times (N/L) \times (L/K) = \alpha(Y/N) \times 1/(K/N)$ in which N is population. We can control for the part of the marginal product of capital using GDP per capita Y/N. In addition, there is no compelling reason that aggregate capital per capita K/N is systematically correlated with year-on-year variation in country-specific region-weighted rainfall after controlling for trends. Thus, as we include GDP per capita in our regressions, we can control for the bulk of the variation in the marginal product of capital and alleviate the threat to the exclusion restriction. Nevertheless, given the limitation on data, we cannot fully control for unobserved factors that are correlated with our instrument and can affect FDI.

In addition, we use country-specific time trends to account for secular time-varying factors of source countries. Furthermore, using event dummies, we control for events that could drive our causal estimates. Ottoman default in 1876 could lead both trade and financial flows to go down (Rose and Spiegel, 2004). We also include a dummy to control the effect of the establishment of the Ottoman Public Debt Administration (OPDA) in 1881. The OPDA could increase financial flows, while reducing trade (Wright (2004); Mitchener and Weidenmier (2005); Rose and Spiegel (2004); Eaton and Gersovitz (1981)).

Moreover, we do a robustness check for the rainfall instrument and find that our IV results are robust to alternative weights for grain and orchard in rainfall variables. In Table 10, we reproduce IV regression results in columns 1 and 2, which are without and with event dummies, respectively. Then, we reconstruct a rainfall variable ($R_{mt} = \theta^g_{m0}\omega^g P^g_t + \theta^o_{m0}\omega^o P^o_t$) such that sensitivities for grain ω^g and orchard ω^o are 1.5 and 0.5, and we replace the baseline rainfall variable with the reconstructed rainfall variable in columns 3 and 4. Columns 5 and 6 present results with another rainfall variable such that sensitivities for grain and orchard are 0.5 and 1.5, respectively. Also, we construct a rainfall variable ($R_{mt} = \theta^g_{m0}P^g_t + \theta^o_{m0}P^o_t$) such that export shares of grain θ^g_{m0} are increased by 20% and export shares of orchard θ^o_{m0} are decreased by 20% for all source countries m. Again, we replace the baseline rainfall variable with the reconstructed rainfall variable in columns 7 and 8. Columns 9 and 10 show results with another rainfall variable such that θ^g_{m0} are decreased by 20% and θ^o_{m0} are increased by 20% for all source countries m. We find that coefficients in the first and the second stage regressions rarely change across columns and that reconstructed instruments are still relevant (all first-stage F statistics exceed 10).

6. Conclusion

This paper investigates the causal effect of trade on financial flows using a historical quasi-natural experiment from the Ottoman Empire. We use fluctuations in regional rainfall within the Ottoman Empire to capture the exogenous variation in exports from the Empire to Germany, France, and the U.K., during 1859–1913. The provisionistic policy of the Ottoman Empire provides the basis for our identification. This policy dictates that only surplus production was allowed to be exported. Since different products grow in different sub-regions of the Empire, there will be differences in the surplus production based on the differences in regional variation in rainfall. The trading partners of the Empire, namely, France, Germany, and the U.K., have different demands and hence import different products. As a result, we can link regional variation in rainfall to exogenous cross-sectional variation in exports over time to these three countries.

When a given region of the Empire gets more rainfall than others, the resulting surplus production is exported to countries with higher ex-ante export shares for those products, and this leads to higher investment by those countries in the Ottoman Empire. We find that a one standard deviation increase in rainfall from the mean leads to a 5 percent increase in Ottoman exports, which in turn causes a 3 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 the complementarity between trade and capital flows as a result of causality running from exports to foreign direct investment.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jdeveco.2020.102537.

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