Religion and International Trade: Evidence from Ramadan Fasting

Faisal Z. Ahmed* Muhammad Farhan Majid†

August 30, 2026

Abstract

Religion shapes economic life around the world, yet we know little about how variation in the intensity of religious practice affects international trade. We exploit a unique natural experiment: the rotation of Ramadan through the solar calendar, generating plausibly exogenous variation in fasting hours. This religious shock alters relative production conditions, filtering through export supply, import reliance, and the allocation of trade across partners. Combining bilateral trade data with gravity specifications that absorb persistent bilateral determinants and country-specific annual conditions, we find that longer Ramadan exposure reduces exports from Muslim-majority economies while increasing their imports. A 10 percent increase in Ramadan daylight hours lowers exports by about 0.8 percent and raises imports by about 0.3 percent, with both responses strongest in countries with the highest Muslim population shares. The export decline is concentrated in non-OPEC Muslim economies, while manufacturing wage responses are stronger in more labor-intensive industries. Crucially, bilateral trade contracts as partners' Ramadan exposure becomes more dissimilar, altering the allocation of trading partners. Religious practice therefore affects not only how much countries trade, but also how international production and expenditure are allocated across trading partners.

JEL codes: F14, J22, O19, O40, Z12

Acknowledgments and Disclosures: The authors received no financial support for this research. The authors have no relevant financial relationships or other potential conflicts of interest to disclose.

*Associate Professor, Wellesley College. E-mail: faisal.ahmed@wellesley.edu

†Assistant Professor of Economics, The University of Alabama in Huntsville; Research Affiliate, Population Studies Center, University of Pennsylvania. E-mail: farhan.majid@uah.edu

1 Introduction

Religion shapes the economic lives of billions of people (Weber, 1930; Iannaccone, 1998; Barro and McCleary, 2019), yet we know remarkably little about how religious practice causally affects international trade. This gap matters because religious practices need not affect economies in isolation. When they alter productive capacity or demand in one country, international trade can transmit those effects across borders through exports, imports, and the reallocation of trading partners. Moreover, when the intensity of religious practice differs across countries, it can change relative production conditions and potentially reshape comparative advantage (Costinot et al., 2012, 2016). We study these forces using Ramadan, a major recurring religious practice whose intensity varies predictably across countries and over time as daylight hours interact with the Islamic lunar calendar. This setting allows us to move beyond religion as a persistent marker of identity, trust, culture, or long-run economic development (Greif, 1993; Rauch, 1999; Guiso et al., 2009; Rubin, 2017; Kuran, 2018; Ahmed, 2023) and ask how variation in the intensity of religious practice changes the international allocation of production and expenditure.

Ramadan provides an unusually useful setting for this question. During Ramadan, Muslims abstain from food and drink between dawn and sunset. Because the Islamic calendar is lunar, Ramadan moves roughly eleven days earlier through the solar calendar each year, generating substantial variation in fasting hours across locations and within the same location over time. Campante and Yanagizawa-Drott (2015) exploit this variation and show that longer Ramadan fasting hours reduce economic growth in Muslim countries. Their result establishes an important aggregate effect but leaves open how an open economy adjusts. Figure 1 provides a first clue. Panel A reproduces the negative relationship between Ramadan daylight hours and real GDP-per-worker growth. Panels B and C decompose this relationship into the portions of growth corresponding to exports and signed imports: greater Ramadan exposure is associated with a declining export contribution and an increasing import contribution. These patterns suggest that international trade is an important margin of adjustment to Ramadan exposure: more exposed economies appear to supply less to foreign markets while relying more heavily on foreign production.

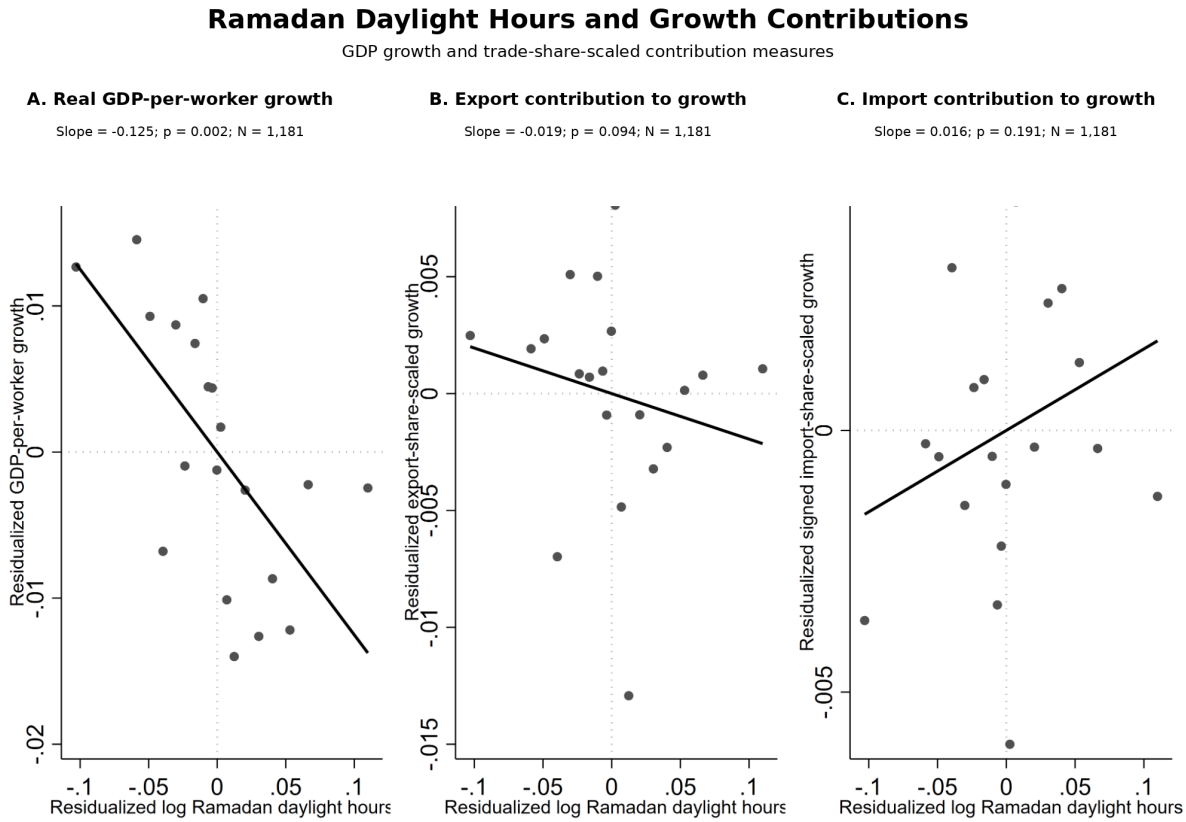


Figure 1: Ramadan Daylight Hours and Growth Contributions

Notes: The figure reports residualized binned scatterplots for 29 Muslim-majority countries and 1,181 country-year observations. All regressions include country and year fixed effects and control for population growth; standard errors are clustered by country. Panel A reports real GDP-per-worker growth, g_Y. Using $Y = C + I + G + X - M$, Panel B reports the export contribution $g_Y(X/Y)$, implemented as GDP-per-worker growth multiplied by the contemporaneous Penn World Table export share, csh_x. Panel C reports the signed import contribution $g_Y(-M/Y)$, implemented using the Penn World Table signed import share, $csh_m < 0$. The reported slopes are -0.125 ($p = 0.002$), -0.019 ($p = 0.094$), and 0.016 ($p = 0.191$), respectively.

This observation connects the Ramadan setting to a central idea in international trade. The consequences of a shock depend not only on its average effect on economic activity, but also on how unevenly it changes production conditions across locations and on the ability of trade to reallocate activity in response. In Ricardian models, changes in relative productivity alter comparative advantage and therefore patterns of specialization and trade (Costinot et al., 2012). Costinot et al. (2016), for example, show how spatially heterogeneous climate shocks can reshape comparative advantage, production, and international trade. Ramadan generates a very different shock, but the economic logic is related. If longer fasting hours reduce effective labor input, countries experiencing greater Ramadan exposure may temporarily lose export capacity relative to less-exposed producers. Trade then provides an adjustment margin: affected economies can substitute toward foreign supply while foreign producers can redirect sales toward them. Unlike a pure productivity shock, however,

Ramadan can also shift consumption, so the resulting trade response can reflect both changes in relative supply conditions and changes in demand.

We bring this logic to bilateral trade data. We combine annual trade flows with country-year measures of Ramadan daylight exposure and estimate gravity equations by Poisson pseudo-maximum likelihood (PPML). The empirical design exploits the predictable interaction of geography with the movement of Ramadan through the solar calendar. Country-pair fixed effects absorb persistent bilateral determinants of trade, including geographic distance, common language, historical relationships, and other time-invariant trade costs. Destination-by-year fixed effects identify exporter-side responses by comparing origins serving the same destination in the same year while absorbing destination demand and inward multilateral resistance. Origin-by-year fixed effects analogously identify importer-side responses by comparing destinations served by the same exporter in the same year. This structure, rooted in the structural-gravity approach to multilateral resistance (Anderson and van Wincoop, 2003), lets us separate origin-side and destination-side responses to Ramadan exposure rather than conflating them with changes in overall trade conditions.

Our first result is a sharp asymmetry across these two margins. Longer Ramadan exposure reduces exports from Muslim-majority economies but increases their imports. In our preferred exporter-side specification, a 10 percent increase in Ramadan daylight hours is associated with roughly 0.8 percent lower exports from Muslim-majority origins. On the importer side, a comparable increase in exposure is associated with approximately 0.3 percent higher imports into Muslim-majority destinations. Both responses are strongest in countries with the highest Muslim population shares. This exposure pattern is important for interpretation. Daylight hours can affect economic activity through many channels, but the concentration of the response where a larger share of the population is exposed to Ramadan fasting points toward religious practice rather than daylight variation alone. Taken together, the estimates are consistent with longer fasting hours weakening domestic export capacity while increasing reliance on foreign supply.

We next show that Ramadan affects not only how much countries export and import, but also how trade is allocated across partners. We introduce *bilateral Ramadan distance*, defined as the absolute difference in log Ramadan daylight hours between an exporter and importer. The construction parallels recent work showing that changes in bilateral climate distance can alter trade opportunities (Lamonaca et al., 2024), and a broader literature in which differences across trading partners—including time-zone differences—act as bilateral frictions (Egger and Larch, 2013). Unlike geographic or cultural distance, Ramadan distance changes within the same country pair over time. This allows us to estimate its effect while simultaneously including origin-by-year, destination-by-year, and country-pair fixed effects. All annual origin conditions, all annual destination conditions, and all permanent bilateral trade costs are therefore absorbed; identification comes from whether the same pair trades differently as the partners' Ramadan exposure becomes

more or less similar.

Greater Ramadan distance reduces bilateral trade. In the fully saturated specification, the coefficient for Muslim–non-Muslim dyads is approximately -0.089, implying roughly 0.9 percent lower trade for a 10 percent widening in the ratio of partners' Ramadan daylight hours. Disaggregating the relationship shows that the effect is concentrated particularly among non-Muslim exporters serving Muslim-majority destinations. We also estimate a smaller negative relationship among non-Muslim pairs. The latter cautions against interpreting the entire distance effect as uniquely religious: seasonal synchronization, Muslim minorities, or exposure to third-country Muslim markets may generate broader spillovers. But the substantially larger response in mixed Muslim–non-Muslim pairs points to an additional Ramadan-related component. When Ramadan changes working schedules, production, purchasing, and logistics in a Muslim destination, suppliers whose economic conditions are less closely aligned with that destination may lose relative market share. Religious practice can therefore affect not only the level of trade but the matching of buyers and sellers across countries.

We then ask whether the exporter response varies in ways predicted by a production-side mechanism. It does. The negative export effect is concentrated among non-OPEC Muslim economies and is absent among Muslim OPEC exporters.[1] Because oil production is relatively capital intensive and less dependent on short-run variation in daytime labor input than many manufacturing and agricultural activities, this heterogeneity is consistent with a labor-dependent export-supply channel.

We also examine dates, a particularly informative product because it is exposed on both sides of the market: production, processing, packing, and distribution require substantial labor input, while dates are a canonical Ramadan consumption good. Exports of dates from Muslim-majority countries fall sharply as fasting hours lengthen. The importer-side differential for Muslim destinations is positive but imprecisely estimated, potentially because Ramadan demand is partly met through pre-Ramadan inventories or because annual trade data attenuate a concentrated seasonal demand response. Together, these results suggest that the export response is strongest where production is more exposed to fasting-related changes in effective labor input.

We further investigate the labor channel with employment data from two-digit manufacturing industries. This analysis reveals that longer Ramadan exposure raises average-wage growth substantially more in non-OPEC Muslim economies than in OPEC economies. In addition, direct-industry analysis shows that wage growth responds more strongly in industries with greater labor intensity.

The paper makes two main contributions. First, it provides new evidence on a margin for which causal evidence remains scarce: the effect of religious practice on contemporary international

[1] We view OPEC status as a proxy rather than a definitive test of production technology.

trade. Existing work shows that religion and culture can shape exchange through persistent channels such as trust, networks, informal enforcement, religious proximity, managerial knowledge, and preferences (Greif, 1993; Rauch, 1999; Guiso et al., 2009; Atkin, 2013; Lo Turco and Maggioni, 2018; Guillouët et al., 2026). Ramadan gives us repeated within-country variation in the intensity of a common religious practice, allowing us to distinguish this margin from persistent differences in religion, culture, institutions, or bilateral affinity. We show that religion can shape international exchange not only through relatively fixed identities and networks, but through recurring changes in production and expenditure that are transmitted across borders.

Second, the paper speaks to a contemporary trade literature on how heterogeneous shocks propagate and how economies reorganize in response. Recent work emphasizes that shocks affecting one location, sector, or set of firms can spread to nominally unexposed units through trade, finance, and production networks, and that adjustment often occurs through changes in sourcing and trading relationships rather than only through quantities within existing links (Dix-Carneiro et al., 2023; di Giovanni et al., 2024; Federico et al., 2025). Ramadan offers a distinctive laboratory for this question: the shock is recurring and predictable, its intensity is spatially heterogeneous, and it can operate simultaneously through production and demand. Our results show that its consequences do not remain where they originate. Greater exposure changes a country's exports and imports, while differences in exposure across countries change who trades with whom. International trade therefore both reallocates and transmits the economic consequences of religious practice across borders.

2 Conceptual Framework

Ramadan can affect bilateral trade through three connected margins: export supply, import demand, and the matching of buyers and suppliers across countries. The first two operate through a country's own exposure; the third governs how trade is allocated across partners.

2.1 Export supply and import demand

Let X_{ijkt} denote exports of product k from country i to country j in year t, h_{it} log Ramadan daylight hours, m_i the Muslim share of the population, ℓ_k the labor intensity of production, and d_k the Ramadan sensitivity of demand. A parsimonious representation is

$$S_{ikt} = \bar{S}_{ikt} \exp\{-\beta_S m_i h_{it} \ell_k\}, \qquad \beta_S > 0, \tag{1}$$

$$Q_{jkt} = \bar{Q}_{jkt} \exp\{\beta_D m_j h_{jt} d_k\}, \qquad \beta_D > 0. \tag{2}$$

Longer fasting hours may reduce effective labor input, compress working time, and disrupt production, processing, and logistics. Equation (1) therefore predicts larger export losses where more workers fast and production is more labor intensive. Equation (2) allows imports to rise either because Ramadan shifts consumption demand or because foreign supply substitutes for constrained domestic production. We provide reduced-form probes of these mechanisms by distinguishing major oil exporters (OPEC countries) from non-oil exporters and analyzing trade in dates. For the former, oil exports proxy for a relatively capital-intensive, continuous-process production structure, while for the latter, dates are both labor intensive to produce and closely tied to Ramadan consumption.

2.2 Bilateral matching and Ramadan distance

Trade can also depend on various dimensions of "match" between countries. Bilateral cultural similarity affects trust and exchange (Guiso et al., 2009); effective bilateral distance changes trade when technologies alter routes asymmetrically (Pascali, 2017); and time-zone differences can impede real-time coordination (Egger and Larch, 2013; Stein and Daude, 2007). More generally, daylight and clock time coordinate work and market activity (Hamermesh et al., 2008). The closest empirical analogue to our construction is Lamonaca et al. (2024), who build a time-varying climate-distance measure and estimate it with exporter-year, importer-year, and country-pair fixed effects.

We define bilateral Ramadan distance as:

$$RD_{ijt} = \left| h_{it} - h_{jt} \right|. \tag{3}$$

Unlike geographic, cultural, or time-zone distance, RD_{ijt} changes within a country pair as Ramadan moves through the solar calendar. In the main analysis, we use a reduced-form representation in which Ramadan distance lowers the quality of a bilateral match:

$$q_{ijt} = q_{ij}^{0} \exp\{-\kappa_0 RD_{ijt} - \kappa_1 RD_{ijt} Mixed_{ij}\}, \tag{4}$$

where $Mixed_{ij}$ equals one when exactly one member of the dyad is Muslim-majority. A positive κ_0 captures a general synchronization cost associated with differences in working schedules, production cycles, or logistics. A positive κ_1 captures an additional loss in match quality when only one partner experiences broad Ramadan-related changes in work, consumption, and commercial schedules. Appendix A provides a simple supplier-choice matching model under which this reduced-form term appears directly in bilateral trade shares.

Combining the own-exposure channels with this bilateral matching term gives the conditional

mean for the volume of exports X of product k from country i to country j in year t:

$$E[X_{ijkt} \mid \cdot] = \exp\{\mu_{ijk} + \alpha_{it} + \delta_{jt} + \lambda_{kt} - \beta_S m_i h_{it} \ell_k + \beta_D m_j h_{jt} d_k - \theta_0 RD_{ijt} - \theta_1 RD_{ijt} Mixed_{ij}\}. \quad (5)$$

The framework yields four predictions: longer Ramadan hours should reduce exports more strongly where Muslim population exposure and labor intensity are greater; the exporter response should be attenuated among OPEC economies and amplified for labor-intensive Ramadan-sensitive goods; imports into Muslim economies may rise as foreign supply substitutes for constrained domestic production or meets Ramadan-sensitive demand; and bilateral trade should fall with Ramadan distance when synchronization costs dominate comparative-advantage or insurance forces, especially in mixed Muslim–non-Muslim dyads.

3 Empirical Strategy

3.1 Specifications

Export supply and import demand. For the aggregate bilateral analysis, the baseline conditional mean can be written schematically as

$$E[X_{ijt} \mid \cdot] = \exp\{\beta_o h_{it} M_i + \beta_d h_{jt} M_j + \gamma_o h_{it} + \gamma_d h_{jt} + \mu_{ij} + \lambda_t + Z'_{ijt}\Gamma\}, \quad (6)$$

where M_i and M_j indicate Muslim-majority status, μ_{ij} are dyad fixed effects, and Z_{ijt} denotes the time-varying controls in the baseline trade specification. To appropriately model export volumes, we estimate equation (6) by PPML (Santos Silva and Tenreyro, 2006) and cluster standard errors by origin-destination pair.

We model multilateral resistance flexibly, by adding one side's country × year fixed effects to our equation (6). Destination-year fixed effects absorb all destination-specific annual conditions, leaving the exporter-side Ramadan interaction identified by differences across origins serving the same destination-year. Origin-year fixed effects analogously identify the importer-side response.[2]

Bilateral matching and Ramadan distance. For the bilateral matching margin, we estimate interactions of RD_{ijt} with the Muslim status of the two partners. The preferred specification includes

[2]To further account for each country's multilateral resistance, we report specifications that employ a Baier–Bergstrand-style measure of remoteness (**?**) in the appendix rather than the main tables.

dyad, origin-year, and destination-year fixed effects simultaneously:

$$E[X_{ijt} \mid \cdot] = \exp\{\mu_{ij} + \alpha_{it} + \delta_{jt} + \sum_{g} \theta_g RD_{ijt} \mathbf{1}\{g_{ij} = g\}\}. \tag{7}$$

Here g_{ij} indexes the Muslim-status composition of the pair. Because the signed gap $h_{it} - h_{jt}$ is additively separable into origin-year and destination-year components, it is absorbed by the two country-year fixed effects. The absolute gap is nonlinear in the pairing and remains identified. The preferred coefficient is therefore a bilateral matching and partner-allocation effect: it asks whether the same origin and destination trade relatively more or less as their Ramadan exposure becomes more dissimilar, after absorbing each country's aggregate annual trade conditions and multilateral resistance.

3.2 Data

Construction. The paper's core analysis combines country-year measures of Ramadan daylight hours from Campante and Yanagizawa-Drott (2015) with annual bilateral trade flows from CEPII and the International Monetary Fund. The main estimation sample contains 494,395 origin–destination–year observations covering 21,973 country dyads over more than 60 years, from 1950 to 2011. We classify countries by Muslim-majority status and divide them into Muslim-population-share categories to examine whether the response strengthens with the proportion of the population exposed to Ramadan fasting.

To examine whether the effects of Ramadan vary with an economy's reliance on labor relative to natural-resource and capital-intensive production, we further distinguish Muslim-majority countries by OPEC membership. OPEC economies provide a useful country-level contrast because their production and export structures are unusually concentrated in the petroleum sector, whereas non-OPEC Muslim economies are, on average, more reliant on non-oil production and employment. We therefore compare the estimated effects of Ramadan across OPEC and non-OPEC Muslim-majority countries. We view this split as a broad country-level proxy for differences in production structure rather than as a direct measure of labor intensity.

Finally, bilateral trade in dates comes from the UN Comtrade Database and contains 76,369 observations. Appendix Table A1 reports summary statistics for the principal variables used in the trade analysis.

Variation. Appendix Figures A1–A3 illustrate the variation underlying the empirical design. Following Campante and Yanagizawa-Drott (2015), Appendix Figure A1 maps countries by their sample-period mean Muslim population share, using the three categories employed in our

heterogeneity analysis: below 25 percent, 25–75 percent, and strictly above 75 percent. Appendix Figure A2 plots Ramadan fasting hours for Bangladesh, Indonesia, and Turkey, illustrating how Ramadan's movement through the solar calendar interacts with latitude to generate different within-country time paths. Appendix Figure A3 extends this comparison to our new measure of bilateral Ramadan distance. Panel A shows, for each of the same three countries, the unweighted mean distance from a fixed set of 166 other countries observed throughout 1950–2011; Panel B shows three selected bilateral comparisons. The measure varies substantially within fixed country pairs over time, providing the variation used to identify changes in trade as partners become more or less similar in Ramadan exposure.

4 Results

4.1 Export supply and import reliance

Building on the aggregate pattern in Figure 1, we first separate the exporter- and importer-side responses to Ramadan exposure.

Exporter-side supply response. Panel A in Table 1 shows that longer Ramadan exposure is associated with lower exports from Muslim-majority origins.[3] In column 1, the implied elasticity for a Muslim exporter is $0.007 - 0.073 = -0.066$, implying that a 10 percent increase in Ramadan daylight hours is associated with approximately 0.66 percent lower exports. In column 3, destination-year fixed effects absorb all destination-specific annual shocks and the corresponding elasticity is $0.005 - 0.086 = -0.081$. Panel B in Table 1 shows that this negative exporter response is concentrated among countries that are more than 75 percent Muslim. The pattern is consistent with longer fasting exposure constraining export supply, with larger effects where a greater share of the economy is exposed to Ramadan.

Importer-side demand and substitution response. The importer-side response moves in the opposite direction. In panel A of Table 1, the implied elasticity for a Muslim importer is 0.033 in the baseline and 0.032 when origin-year fixed effects absorb all exporter-specific annual conditions. Panel B in Table 1 shows a pronounced population-share gradient: the importer response rises sharply with the Muslim share of the destination. This pattern is consistent with Ramadan increasing import demand through two potentially complementary channels—Ramadan-sensitive consumption and substitution toward foreign supply when domestic production is constrained. The estimates

[3]The exporter and importer-side inferences in Table 1 are robust to potential outliers – e.g., dropping the bottom and top decile of trade volumes.

identify the resulting import response rather than separately identifying these two mechanisms.

Table 1: Ramadan Exposure and Bilateral Trade

	(1) Baseline	(2) Origin×Year FE	(3) Destination×Year FE
Panel A. Ramadan Exposure			
Log Ramadan hours, origin × Muslim	−0.073***		−0.086***
	(0.014)		(0.013)
Log Ramadan hours, destination × Muslim	0.025***	0.029***	
	(0.009)	(0.009)	
Log Ramadan hours, origin	0.007*		0.005
	(0.004)		(0.004)
Log Ramadan hours, destination	0.008*	0.003	
	(0.004)	(0.004)	
Panel B. Muslim Share Heterogeneity			
Log Ramadan hours, origin × Muslim share < 25%	0.002		0.002*
	(0.002)		(0.001)
Log Ramadan hours, origin × Muslim share 25–75%	0.011*		0.008
	(0.006)		(0.006)
Log Ramadan hours, origin × Muslim share > 75%	−0.023***		−0.029***
	(0.009)		(0.008)
Log Ramadan hours, destination × Muslim share < 25%	0.002	0.001	
	(0.002)	(0.001)	
Log Ramadan hours, destination × Muslim share 25–75%	0.032***	0.032***	
	(0.006)	(0.006)	
Log Ramadan hours, destination × Muslim share > 75%	0.040***	0.043***	
	(0.007)	(0.007)	
Log Ramadan hours, origin	0.003		0.001
	(0.004)		(0.004)
Log Ramadan hours, destination	0.005	0.001	
	(0.005)	(0.004)	
Baseline controls	Yes	Yes	Yes
Dyad fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Origin × year fixed effects	–	Yes	–
Destination × year fixed effects	–	–	Yes
Observations	494,395	494,395	494,395
Pseudo R^2	0.24	0.24	0.25

Notes: Estimation via PPML. The dependent variable is bilateral trade from origin to destination. Standard errors clustered by origin-destination pair are in parentheses. Baseline controls include: log GDP per capita of the origin and destination country and a composite measure of participation in trade agreements (from CEPII). The remoteness-control specification is reported in Appendix Table A2. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

4.2 Bilateral matching and Ramadan distance

Table 2 presents the bilateral matching estimates using Ramadan distance. Panel A distinguishes the four directional dyad types. Column 4 is the preferred specification because it includes dyad, origin-year, and destination-year fixed effects simultaneously. The largest and most precise estimate occurs when non-Muslim exporters serve Muslim destinations: the coefficient is -0.080 implying that a 10 percent increase in the partners' Ramadan-hours ratio gap is associated with approximately 0.8 percent lower bilateral trade. The estimate for Muslim exporters serving non-Muslim destinations is close to zero, and the Muslim–Muslim estimate is negative but imprecise.

Panel B combines the two mixed directions. In the fully saturated specification, the coefficient is -0.089 for mixed Muslim–non-Muslim dyads and -0.021 for non-Muslim dyads. The smaller non-Muslim coefficient may capture a general seasonal or scheduling-synchronization component, Muslim minorities, or indirect exposure through firms serving Muslim markets. The much larger mixed-dyad estimate is consistent with an additional Ramadan-related friction. Panel A shows that this relationship is concentrated in sales by non-Muslim exporters to Muslim destinations.

Since Ramadan distance is an absolute difference, it does not reveal which partner has longer fasting hours. With origin-year and destination-year fixed effects, the estimate is also a bilateral partner-allocation effect rather than an effect on either country's total trade. The result establishes that trade falls as partners become more dissimilar, especially when a non-Muslim supplier serves a Muslim market; it does not by itself establish that exposure is greater on the importer side.

Table 2: Bilateral Ramadan Distance and Partner Reallocation

	(1) Baseline	(2) Origin×Year FE	(3) Destination×Year FE	(4) Both Country×Year FE
Panel A. Directional dyad types				
Ramadan distance × Muslim origin, Muslim destination	−0.098	−0.126	−0.059	−0.133
	(0.091)	(0.099)	(0.098)	(0.103)
Ramadan distance × Muslim origin, non-Muslim destination	−0.001	−0.032	−0.047**	−0.010
	(0.023)	(0.031)	(0.023)	(0.031)
Ramadan distance × non-Muslim origin, Muslim destination	−0.066***	−0.072***	−0.059***	−0.080***
	(0.014)	(0.015)	(0.021)	(0.022)
Ramadan distance × non-Muslim origin, non-Muslim destination	0.014**	0.012*	−0.005	−0.021***
	(0.006)	(0.007)	(0.007)	(0.008)
Panel B. Combined Muslim–non-Muslim mismatch				
Ramadan distance × Muslim origin, Muslim destination	−0.099	−0.016	−0.048	−0.131
	(0.091)	(0.093)	(0.095)	(0.103)
Ramadan distance × mixed Muslim–non-Muslim dyad	−0.044***	−0.060***	−0.053***	−0.089***
	(0.014)	(0.014)	(0.016)	(0.018)
Ramadan distance × non-Muslim origin, non-Muslim destination	0.014**	0.014**	−0.006	−0.021***
	(0.006)	(0.007)	(0.007)	(0.008)
Baseline controls	Yes	Yes	Yes	Yes
Dyad fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Origin × year fixed effects	–	Yes	–	Yes
Destination × year fixed effects	–	–	Yes	Yes
Observations	494,395	494,395	494,395	494,395
Pseudo R^2	0.24	0.25	0.25	0.25

Notes: Ramadan distance is the absolute difference in log Ramadan daylight hours between origin and destination. The dependent variable is bilateral trade from origin to destination. Estimates are PPML. Standard errors clustered by origin-destination pair are in parentheses. In Panel B, the mixed-dyad indicator equals one when exactly one country is Muslim-majority. Column 4 includes dyad, origin-year, and destination-year fixed effects simultaneously. The remoteness specification is reported in Appendix Table A2. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

4.3 Evaluating mechanisms

Labor-intensive production and Ramadan-sensitive demand. We now probe mechanisms by asking whether the trade response varies with production technology and with a product that is unusually exposed to both Ramadan production and consumption channels. Table 3 Panel A uses whether a country is a member of OPEC as a proxy for the labor intensity of export production. With destination-year fixed effects, the implied elasticity is $0.004 - 0.065 = -0.061$ for non-OPEC Muslim exporters, whereas OPEC exporters show no adverse response. Since oil production and export are relatively capital intensive and continuous-process, this attenuation is consistent with a labor-dependent production channel. OPEC membership is nonetheless a coarse proxy that also captures income, institutions, and trade composition.

Panel B examines trade in dates, a product that is both labor intensive to produce and closely tied to Ramadan consumption.[4] The implied exporter elasticity in the destination-year specification is $0.020 - 0.371 = -0.351$, substantially larger than for aggregate trade. The importer interaction is positive but imprecise, possibly because annual data may obscure a short-lived demand increase if importers accumulate inventories before Ramadan or source through regional hubs. The estimates for trade in dates therefore provide stronger evidence for the supply channel than for a demand response in annual trade data.

Manufacturing labor-market evidence. Campante and Yanagizawa-Drott (2015) provide evidence from manufacturing industries to suggest that Ramadan fasting induces workers to allocate more time to religious services and reduce their labor supply. Following this labor-market interpretation, we complement the country-level comparison with a more direct industry-level analysis using manufacturing data from the UNIDO INDSTAT database. The UNIDO sample covers 1963–2010 and provides country-year observations for two-digit manufacturing industries, including employment, wages and salaries, and value added. We measure an industry's labor intensity as employment per unit of value added, equivalently the inverse of value added per worker.

To construct an external benchmark of industries' underlying labor intensity, we use countries in which Muslims constitute less than 25 percent of the population. We residualize the labor-intensity measure with respect to country-by-year fixed effects and, for each two-digit industry, take the median residual in this reference sample through 2010. We then standardize the resulting industry scores to have mean zero and standard deviation one and apply this fixed industry ranking to the manufacturing panel of Muslim countries. The reference sample is used only to construct the

[4] Breaking one's fast with dates during Ramadan is a highly encouraged prophetic tradition (Sunnah), rooted in several authentic sayings of the Prophet Muhammad. For example, one sunnah (reported in Sunan Al-Tirmidhi and Sunan Abi Dawud) commands: " When one of you breaks his fast, let him break it with dates for they are blessed. If they are not found, let him break it with water for it is pure."

Table 3: Evaluating Mechanisms: Production Technology and Ramadan-Sensitive Trade

	(1) Baseline	(2) Origin×Year FE	(3) Destination×Year FE
Panel A. Production technology: OPEC and non-OPEC Muslim economies			
Origin × Muslim × OPEC	0.098**		0.092**
	(0.045)		(0.044)
Destination × Muslim × OPEC	0.162***	0.068***	
	(0.022)	(0.023)	
Origin × Muslim × non-OPEC	−0.049***		−0.065***
	(0.017)		(0.016)
Destination × Muslim × non-OPEC	0.024**	0.053***	
	(0.011)	(0.010)	
Log Ramadan hours, origin	0.006		0.004
	(0.004)		(0.004)
Log Ramadan hours, destination	0.007*	0.003	
	(0.004)	(0.004)	
Observations	494,395	494,395	494,395
Pseudo R^2	0.24	0.25	0.25
Panel B. Labor-intensive production and Ramadan-sensitive demand: dates			
Origin × Muslim	−0.309***		−0.371***
	(0.114)		(0.113)
Destination × Muslim	0.142	0.183	
	(0.131)	(0.115)	
Log Ramadan hours, origin	−0.034		0.020
	(0.083)		(0.086)
Log Ramadan hours, destination	−0.208***	−0.227***	
	(0.053)	(0.053)	
Observations	76,369	76,369	76,369
Pseudo R^2	0.45	0.48	0.48
Baseline controls	Yes	Yes	Yes
Dyad fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Origin × year fixed effects	–	Yes	–
Destination × year fixed effects	–	–	Yes

Notes: Both panels report PPML estimates. Panel A divides Muslim countries by OPEC membership. Panel B uses bilateral trade in dates from UN Comtrade. Standard errors clustered by origin-destination pair are in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

industry ranking; labor-market outcomes in the Muslim countries whose Ramadan exposure we study do not enter its construction.

We estimate two specifications. In the continuous specification, we interact Ramadan exposure with the standardized labor-intensity score. In the categorical specification, we compare industries in the top quartile of labor intensity with those in the lower three quartiles. We construct annual employment growth and average-wage growth only when observations occur in genuinely consecutive years. These data allow us to test more directly whether the labor-market response to Ramadan exposure is stronger in manufacturing industries that rely more intensively on labor.

Table 4 presents our industry-level analysis. The wage response provides the clearest signature of a labor-supply mechanism. Longer Ramadan exposure raises average-wage growth substantially more in non-OPEC Muslim economies than in OPEC economies. The direct industry-level analysis yields a similar pattern: wage growth responds more strongly in industries with greater labor intensity and particularly in the most labor-intensive quartile. Employment growth, by contrast, need not move monotonically with labor intensity because observed employment reflects equilibrium adjustments in both labor supply and labor demand. In OPEC economies, the pronounced employment decline without a corresponding significant increase in wages is potentially more consistent with a labor-demand mechanism.

Together, the OPEC comparison and industry-intensity estimates provide supporting evidence for the predicted wage signature of a labor-supply mechanism: Ramadan exposure creates greater wage pressure where manufacturing production is more dependent on labor.

Table 4: Ramadan Exposure, OPEC Status, and Manufacturing Labor Intensity

	Employment growth		Average-wage growth	
	(1) > 50%	(2) CYD > 75%	(3) > 50%	(4) CYD > 75%
Panel A. Muslim OPEC versus Muslim non-OPEC countries				
Log Ramadan hours: Muslim OPEC	−0.312***	−0.331***	0.284	0.285
	(0.090)	(0.103)	(0.241)	(0.249)
Log Ramadan hours: Muslim non-OPEC	−0.158	−0.155	0.733**	0.631*
	(0.103)	(0.119)	(0.354)	(0.337)
OPEC − non-OPEC difference	−0.154	−0.176*	−0.449***	−0.346**
	(0.094)	(0.102)	(0.160)	(0.126)
Observations	12,653	11,013	11,848	10,208
Panel B. Direct labor-intensity heterogeneity				
Exposure × labor intensity (one SD)	−0.012	−0.065	0.071**	0.081*
	(0.052)	(0.079)	(0.032)	(0.040)
Exposure × top-quartile intensity	0.077	−0.007	0.154**	0.180**
	(0.204)	(0.286)	(0.063)	(0.084)
Observations	12,768	11,108	11,935	10,277

Notes: The sample period is 1963–2010. Dependent variables are annual log changes in two-digit manufacturing-industry employment and average wages; growth is calculated only between consecutive years. Columns (1) and (3) include countries whose average Muslim population share exceeds 50 percent. Columns (2) and (4) use the classification of Campante and Yanagizawa-Drott (2015) (CYD) for countries whose average Muslim share is strictly greater than 75 percent. Panel A jointly estimates separate Ramadan-hours slopes for Muslim OPEC and Muslim non-OPEC countries. It includes country × industry and year fixed effects, country-specific linear trends, and population growth; standard errors are clustered by country. OPEC denotes membership at some point during 1963–2010. Panel B replaces OPEC status with predetermined two-digit industry labor intensity, measured as employment per unit of value added among donor countries with Muslim shares below 25 percent through 2010. Donor-country × year variation is residualized before forming the fixed industry ranking. The continuous coefficient is the differential Ramadan effect associated with a one-standard-deviation increase in labor intensity. The top-quartile coefficient compares the most labor-intensive 25 percent of industries with the bottom three quartiles. Panel B includes country × industry, country × year, and industry × year fixed effects; the main Ramadan-hours term and population growth are absorbed by country × year fixed effects. Standard errors clustered by country are in parentheses. Azerbaijan in 1992 is excluded from wage regressions. Missing values remain missing, zeros are not substituted, and neither outcomes nor intensity measures are winsorized. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

5 Discussion

The results fit a unified account in which Ramadan changes trade through production, demand, and bilateral matching. Longer fasting exposure reduces exports from Muslim economies, particularly where a large share of the population is exposed (Table 1, panel B). The attenuation among OPEC exporters and the much larger decline in dates exports are consistent with an effective-labor channel: production and export logistics appear more responsive where output depends more heavily on labor input and less responsive where exports are dominated by capital-intensive, continuous-process production. These exercises are suggestive rather than definitive mechanism tests, but they help distinguish the aggregate export response from a pattern driven by oil exporters or generic daylight variation.

A deeper interpretation connects these results to the development literature on nutrition, health, and productivity. Economists have long emphasized that nutrition and health are inputs into productive capacity, labor supply, and economic development (Fogel, 1994; Strauss and Thomas, 1998; Bleakley, 2007). Ramadan fasting imposes a recurring period of daytime food and fluid restriction, and related work has used Ramadan exposure as a nutritional shock with consequences for human capital and labor-market outcomes (Majid, 2015). More directly, experimental and field evidence from India links low caloric intake to lower physical and cognitive performance and finds that Ramadan overlap with labor-intensive agricultural periods reduces agricultural output (Schofield, 2020); related work emphasizes the broader cognitive and productivity consequences of nutritional deprivation (Schilbach et al., 2016). This literature suggests a physiological and nutritional foundation for part of the production-side response we observe. At the same time, our estimates should not be read as identifying caloric restriction as the sole mechanism. Ramadan also changes hydration, sleep, work schedules, labor-supply choices, and preferences; indeed, Campante and Yanagizawa-Drott (2015) emphasize labor-supply and occupational-choice responses rather than a purely mechanical productivity effect. Our evidence is therefore best interpreted as showing a change in effective productive capacity whose deeper determinants may include both nutritional constraints and behavioral adjustment.

The positive importer response points to a complementary adjustment margin. Longer Ramadan hours may constrain domestic production while also shifting consumption demand, causing Muslim destinations to rely more heavily on foreign supply. The gradient by Muslim population share supports this interpretation. In this sense, trade can partially buffer a domestic production shock by allowing expenditure to shift toward goods produced elsewhere, even as the affected economy's own exports contract. Looking at trade in dates illustrates why supply and demand can operate simultaneously: the product is labor intensive to produce and process, while Ramadan raises its salience in consumption. The strong exporter response but imprecise annual importer response is

consistent with production constraints being visible in annual flows while seasonal demand is partly anticipated through inventories and earlier shipments.

Ramadan distance adds a bilateral matching margin. Even after absorbing every origin-year and destination-year condition, countries trade less with partners whose exposure becomes more dissimilar. The negative coefficient among non-Muslim pairs cautions against labeling the full mixed-dyad coefficient uniquely religious; some component may reflect broader seasonal synchronization or spillovers through Muslim minorities and third-country trade networks. Yet the much larger mixed-dyad coefficient points to an additional friction associated with Ramadan-related changes in work, purchasing, inventories, customs activity, and delivery schedules. The matching formulation in Appendix A makes this logic explicit: a fall in bilateral match quality reallocates expenditure toward alternative suppliers even when the importing country's total expenditure and the exporter's aggregate supply conditions are absorbed by country-year fixed effects.

The directional asymmetry is especially informative. The distance effect is strongest for non-Muslim exporters serving Muslim destinations. One interpretation is that suppliers in Muslim economies are better adapted to recurring Ramadan demand and commercial schedules, whereas non-Muslim suppliers are less synchronized when partners experience very different exposure. Muslim destinations may consequently shift purchases toward suppliers whose production and delivery patterns are more closely aligned with Ramadan needs. This interpretation is consistent with a broader literature in which bilateral cultural, temporal, and climatic distance changes exchange by affecting trust, coordination costs, or relative trade opportunities (Guiso et al., 2009; Egger and Larch, 2013; Lamonaca et al., 2024). Because Ramadan recurs annually, these temporary contractions in trading opportunities may provide one recurring channel that helps explain the lower international economic integration documented in many Muslim-majority societies (Kuran, 2018; Ahmed and Malik, 2025).

Taken together, the evidence suggests that international trade reallocates the economic effects of Ramadan across borders. Longer fasting exposure reduces export supply and can increase reliance on imports, while differences in exposure change the matching of trading partners. The results connect the economics of religion not only to comparative advantage and trade adjustment, but also to a deeper development question: how health, nutrition, and other determinants of effective labor capacity are transmitted through international markets rather than remaining confined to the directly exposed economy.

References

Ahmed, Faisal Z., *Conquests and Rent: A Political Economy of Dicatorship and Violence in Muslim Societies*, New York, NY: Cambridge University Press, 2023.

_ **and Adeel Malik**, "Aiding Partial Liberalization," *Working paper*, 2025.

Anderson, James E. and Eric van Wincoop, "Gravity with Gravitas: A Solution to the Border Puzzle," *American Economic Review*, 2003, *93* (1), 170–192.

Arkolakis, Costas, Federico Huneeus, and Yuhei Miyauchi, "Production Network Formation, Trade, and Welfare," Working Paper 30954, National Bureau of Economic Research 2023. Revised January 2026.

Atkin, David, "Trade, Tastes, and Nutrition in India," *American Economic Review*, 2013, *103* (5), 1629–1663.

Barro, Robert J. and Rachel M. McCleary, *The Wealth of Religions: The Political Economy of Believing and Belonging*, Princeton, NJ: Princeton University Press, 2019.

Bernard, Andrew B., Andreas Moxnes, and Karen Helene Ulltveit-Moe, "Two-Sided Heterogeneity and Trade," *Review of Economics and Statistics*, 2018, *100* (3), 424–439.

Bleakley, Hoyt, "Disease and Development: Evidence from Hookworm Eradication in the American South," *Quarterly Journal of Economics*, 2007, *122* (1), 73–117.

Campante, Filipe R. and David Yanagizawa-Drott, "Does Religion Affect Economic Growth and Happiness? Evidence from Ramadan," *Quarterly Journal of Economics*, 2015, *130* (2), 615–658.

Costinot, Arnaud, Dave Donaldson, and Cory Smith, "Evolving Comparative Advantage and the Impact of Climate Change in Agricultural Markets: Evidence from 1.7 Million Fields around the World," *Journal of Political Economy*, 2016, *124* (1), 205–248.

_ **,** _ **, and Ivana Komunjer**, "What Goods Do Countries Trade? A Quantitative Exploration of Ricardo's Ideas," *Review of Economic Studies*, 2012, *79* (2), 581–608.

di Giovanni, Julian, Andrei A. Levchenko, and Isabelle Méjean, "Foreign Shocks as Granular Fluctuations," *Journal of Political Economy*, 2024, *132* (2), 391–433.

Dix-Carneiro, Rafael, Jo ao Paulo Pessoa, Ricardo M. Reyes-Heroles, and Sharon Traiberman, "Globalization, Trade Imbalances, and Labor Market Adjustment," *Quarterly Journal of Economics*, 2023, *138* (2), 1109–1171.

Egger, Peter H. and Mario Larch, "Time Zone Differences as Trade Barriers," *Economics Letters*, 2013, *119* (2), 172–175.

Federico, Stefano, Fadi Hassan, and Veronica Rappoport, "Trade Shocks and Credit Reallocation," *American Economic Review*, 2025, *115* (4), 1142–1169.

Fogel, Robert W., "Economic Growth, Population Theory, and Physiology: The Bearing of Long-Term Processes on the Making of Economic Policy," *American Economic Review*, 1994, *84* (3), 369–395.

Greif, Avner, "Contract Enforceability and Economic Institutions in Early Trade: The Maghribi Traders' Coalition," *American Economic Review*, 1993, *83* (3), 525–548.

Guillouët, Louise, Amit K. Khandelwal, Rocco Macchiavello, Madhav Malhotra, and Matthieu Teachout, "Language Barriers in Multinationals and Knowledge Transfers," *Review of Economics and Statistics*, 2026, pp. 1–19.

Guiso, Luigi, Paola Sapienza, and Luigi Zingales, "Cultural Biases in Economic Exchange?," *Quarterly Journal of Economics*, 2009, *124* (3), 1095–1131.

Hamermesh, Daniel S., Caitlin Knowles Myers, and Mark L. Pocock, "Cues for Timing and Coordination: Latitude, Letterman, and Longitude," *Journal of Labor Economics*, 2008, *26* (2), 223–246.

Iannaccone, Laurence R., "Introduction to the Economics of Religion," *Journal of Economic Literature*, 1998, *36* (3), 1465–1495.

Kuran, Timur, "Islam and Economic Performance: Historical and Contemporary Links," *Journal of Economic Literature*, 2018, *56* (4), 1292–1359.

Lamonaca, Emilia, Martina Bozzola, and Fabio Gaetano Santeramo, "Climate Distance and Bilateral Trade," *Economics Letters*, 2024, *237*, 111624.

Majid, Muhammad Farhan, "The Persistent Effects of in Utero Nutrition Shocks over the Life Cycle: Evidence from Ramadan Fasting," *Journal of Development Economics*, 2015, *117*, 48–57.

Manelici, Isabela and Jose P. Vasquez, "The Effects of Joining Multinational Supply Chains: New Evidence from Firm-to-Firm Linkages," *Quarterly Journal of Economics*, 2022, *137* (3), 1495–1552.

Noguera, Guillermo, "Buyers' Sourcing Strategies and Suppliers' Markups in Bangladeshi Garments," *Quarterly Journal of Economics*, 2023, *138* (4), 2391–2450.

Pascali, Luigi, "The Wind of Change: Maritime Technology, Trade, and Economic Development," *American Economic Review*, 2017, *107* (9), 2821–2854.

Patault, Bérengère and Clémence Lenoir, "Customer Capital Spillovers: Evidence from Sales Managers in International Markets," *American Economic Journal: Applied Economics*, 2024, *16* (4), 404–443.

Rauch, James E., "Networks versus Markets in International Trade," *Journal of International Economics*, 1999, *48* (1), 7–35.

Rubin, Jared, *Rulers, Religion, and Riches: Why the West Got Rich and the Middle East Did Not*, New York, NY: Cambridge University Press, 2017.

Schilbach, Frank, Heather Schofield, and Sendhil Mullainathan, "The Psychological Lives of the Poor," *American Economic Review*, 2016, *106* (5), 435–440.

Schofield, Heather, "Ramadan Fasting and Agricultural Output," 2020. Unpublished manuscript.

Silva, J. M. C. Santos and Silvana Tenreyro, "The Log of Gravity," *Review of Economics and Statistics*, 2006, *88* (4), 641–658.

Stein, Ernesto and Christian Daude, "Longitude Matters: Time Zones and the Location of Foreign Direct Investment," *Journal of International Economics*, 2007, *71* (1), 96–112.

Strauss, John and Duncan Thomas, "Health, Nutrition, and Economic Development," *Journal of Economic Literature*, 1998, *36* (2), 766–817.

Turco, Alessia Lo and Daniela Maggioni, "Effects of Islamic Religiosity on Bilateral Trust in Trade: The Case of Turkish Exports," *Journal of Comparative Economics*, 2018, *46* (4), 947–965.

Weber, Max, *The Protestant Ethic and the Spirit of Capitalism*, London: Allen & Unwin, 1930. Originally published 1905.

A A Buyer–Supplier Matching Interpretation of Ramadan Distance

This appendix provides a microeconomic interpretation of the bilateral Ramadan-distance specification. The starting point is a growing trade literature in which bilateral trade is the outcome of buyer–supplier relationships rather than anonymous country-level exchange. Bernard et al. (2018) develop a multi-country trade model with heterogeneous buyers and sellers and relation-specific costs; Noguera (2023) shows that buyer sourcing strategies and the value placed on reliable supply shape exporter–buyer outcomes; and, more recently, Arkolakis et al. (2023) model endogenous buyer–supplier link formation under matching frictions and show that aggregation of those links generates a gravity structure. Empirically, changes in customer access can induce business stealing and supplier reallocation across buyers (Patault and Lenoir, 2024), while the formation of a major buyer relationship can lead suppliers to reallocate sales across their customer base (Manelici and Vasquez, 2022). Our use of Ramadan distance can be interpreted within this class of relationship-based trade models.

The key Ramadan-specific idea is *schedule compatibility*. Let $a_{it}(u)$ denote the availability or effective operating intensity of suppliers in origin i at within-period time u, and let $d_{jt}(u)$ denote the timing of purchasing, communication, processing, and delivery needs in destination j. Ramadan can shift both objects: longer fasting changes work hours, breaks, sleep and meal timing, logistics, and the timing and composition of demand in Muslim economies. Define the synchronization value of an origin–destination relationship as

$$\chi_{ijt} = \int a_{it}(u) d_{jt}(u)\, du. \tag{8}$$

When the two sides' operating schedules are well aligned, χ_{ijt} is high; when their schedules diverge, coordination is more costly. A parsimonious local representation is

$$\log \chi_{ijt} = \mu_{ij} - \kappa_{g_{ij}} RD_{ijt}, \qquad RD_{ijt} = |h_{it} - h_{jt}|, \tag{9}$$

where g_{ij} indexes the Muslim-status composition and direction of the pair. The formulation allows κ_g to be larger for mixed Muslim–non-Muslim relationships and, importantly, to differ between non-Muslim-exporter–Muslim-importer and Muslim-exporter–non-Muslim-importer pairs. This directional flexibility maps directly to the empirical specification in Table 2.

Consider a continuum of buyers in destination j choosing among potential suppliers i. Let the

deterministic component of the value delivered by supplier i be

$$V_{ijt} = A_{it} + B_{jt} + \mu_{ij} - \kappa_{g_{ij}} RD_{ijt}, \tag{10}$$

where A_{it} captures exporter-year supply conditions, B_{jt} captures destination-year expenditure and demand conditions, and μ_{ij} captures permanent relationship quality and bilateral trade costs. A buyer also receives an idiosyncratic relationship-specific draw ε_{bijt}. Such match-specific heterogeneity is standard in models of two-sided trade relationships and endogenous sourcing (Bernard et al., 2018; Arkolakis et al., 2023).

If ε_{bijt} is Type-I extreme value with scale parameter $1/\eta$, the expenditure share of destination j allocated to origin i is

$$s_{ijt} = \frac{\exp\{\eta[A_{it} + \mu_{ij} - \kappa_{g_{ij}} RD_{ijt}]\}}{\sum_n \exp\{\eta[A_{nt} + \mu_{nj} - \kappa_{g_{nj}} RD_{njt}]\}}. \tag{11}$$

With total destination expenditure E_{jt}, bilateral trade is $X_{ijt} = E_{jt} s_{ijt}$. Hence the conditional mean can be written as

$$E[X_{ijt} \mid \cdot] = \exp\{\alpha_{it} + \delta_{jt} + \widetilde{\mu}_{ij} - \eta \kappa_{g_{ij}} RD_{ijt}\}, \tag{12}$$

where exporter-year fixed effects absorb A_{it}, importer-year fixed effects absorb E_{jt} and the destination-specific sourcing denominator, and dyad fixed effects absorb permanent bilateral match quality and trade costs. Equation (12) therefore delivers the saturated PPML specification in the main text. Its coefficient has a precise interpretation: it measures how a change in *relative Ramadan exposure* changes the share of a destination's expenditure allocated to a given origin, holding fixed each country's aggregate annual supply and demand conditions.

This formulation also clarifies why the distance result is conceptually distinct from the own-exposure results. Longer fasting in an exporter can reduce aggregate export capacity, and longer fasting in an importer can change aggregate expenditure or reliance on foreign supply. Those country-level effects are absorbed by α_{it} and δ_{jt} in equation (12). Ramadan distance instead changes the *quality of the bilateral match*: conditional on the total amount an importer buys and the total conditions facing an exporter, a buyer reallocates expenditure toward suppliers whose operating and delivery conditions are better synchronized with its own.

The matching interpretation yields several additional predictions. First, the distance effect should be largest when Ramadan materially changes schedules on one side of the transaction but not the other, consistent with a larger κ_g for mixed Muslim–non-Muslim dyads. Second, the effect may be asymmetric by trade direction. If Ramadan changes ordering, inventory, customs, and delivery requirements primarily at Muslim destinations, non-Muslim suppliers may be less adapted to those changes than suppliers operating in other Muslim markets, generating the stronger non-Muslim-exporter–Muslim-importer effect observed in the data. Third, the mechanism should be

stronger for goods and relationships requiring frequent coordination, reliable delivery, customization, or relationship-specific investment—the margins emphasized in the buyer–supplier literature (Rauch, 1999; Noguera, 2023)—and weaker for standardized, storable, or continuously produced commodities. Finally, a small effect among non-Muslim pairs is compatible with the model if RD_{ijt} also proxies for general seasonal synchronization or if Muslim minorities and third-market exposure transmit Ramadan-related schedule changes beyond Muslim-majority economies. The empirical comparison between mixed and non-Muslim dyads can therefore be viewed as separating a general synchronization component from the additional relationship cost associated with Ramadan exposure.

We use this framework as a microfoundation for the reduced-form bilateral-distance coefficient rather than as a structural model to be estimated. A richer version could endogenize the formation and dissolution of supplier links, as in Arkolakis et al. (2023), or allow buyers to choose between relational and spot sourcing, as in Noguera (2023). The current formulation is sufficient for the paper's empirical object: whether exogenous changes in the relative intensity of Ramadan alter the allocation of trade across otherwise fixed country pairs.

B Appendix Tables

Table A1: Summary Statistics

	Obs.	Mean	SD	Min	Max	Non-Muslim	Muslim
Log trade flow, origin measure	494,395	8.084	3.483	0.001	19.687	8.291	7.562
Log trade flow, destination measure	494,395	8.617	3.332	0.001	19.805	8.743	8.476
Log Ramadan hours, origin	494,395	2.465	0.161	1.491	3.041	2.463	2.472
Log Ramadan hours, destination	494,395	2.467	0.150	1.491	3.041	2.466	2.475
Log GDP per capita, origin	494,395	1.575	1.148	0.028	4.743	1.733	1.088
Log GDP per capita, destination	494,395	1.486	1.486	0.027	4.743	1.648	1.075
Co-membership in FTA or WTO	494,395	0.109	0.311	0	1	0.114	0.098
Trade flow, OPEC origin subsample	23,691	8.079	3.779	0.001	18.011	7.312	8.862
Trade flow, non-OPEC origin subsample	470,704	8.085	3.467	0.001	19.687	8.315	7.326
Trade flow of dates	76,369	3.655	4.898	0	18.059	4.657	4.581

Notes: Bilateral trade data are from CEPII and the IMF and are merged with country-year measures of Ramadan daylight hours. Dates trade is from UN Comtrade. Muslim-majority status follows the population-share classification used in the analysis.

Table A2: Specifications with Remoteness Controls

	Remoteness specification
Panel A. Own-country exposure	
Log Ramadan hours, origin × Muslim	-0.064^{***}
	(0.014)
Log Ramadan hours, destination × Muslim	0.041^{***}
	(0.009)
Log Ramadan hours, origin	0.006^{*}
	(0.004)
Log Ramadan hours, destination	0.007
	(0.004)
Observations	494,395
Pseudo R^2	0.25
Panel B. Bilateral Ramadan distance	
Muslim origin, Muslim destination	0.017
	(0.092)
Muslim origin, non-Muslim destination	0.016
	(0.024)
Non-Muslim origin, Muslim destination	-0.057^{***}
	(0.014)
Non-Muslim origin, non-Muslim destination	0.000
	(0.006)
Mixed Muslim–non-Muslim dyad	-0.028^{**}
	(0.013)
Observations	494,395
Pseudo R^2	0.25
Dyad fixed effects	Yes
Year fixed effects	Yes
Remoteness controls	Yes

Notes: Panel A reproduces the remoteness-control column of the own-exposure analysis. Panel B reports the corresponding remoteness-control estimates from the directional and combined Ramadan-distance specifications. Estimates are PPML; standard errors clustered by origin-destination pair are in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

C Appendix Figures

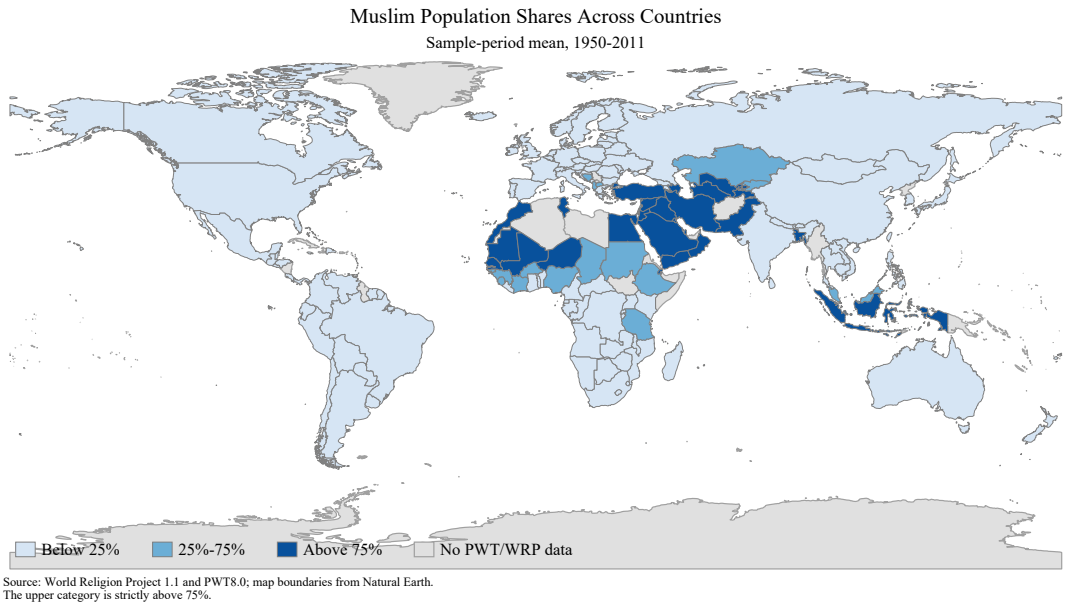


Figure A1: Muslim Population Shares Across Countries

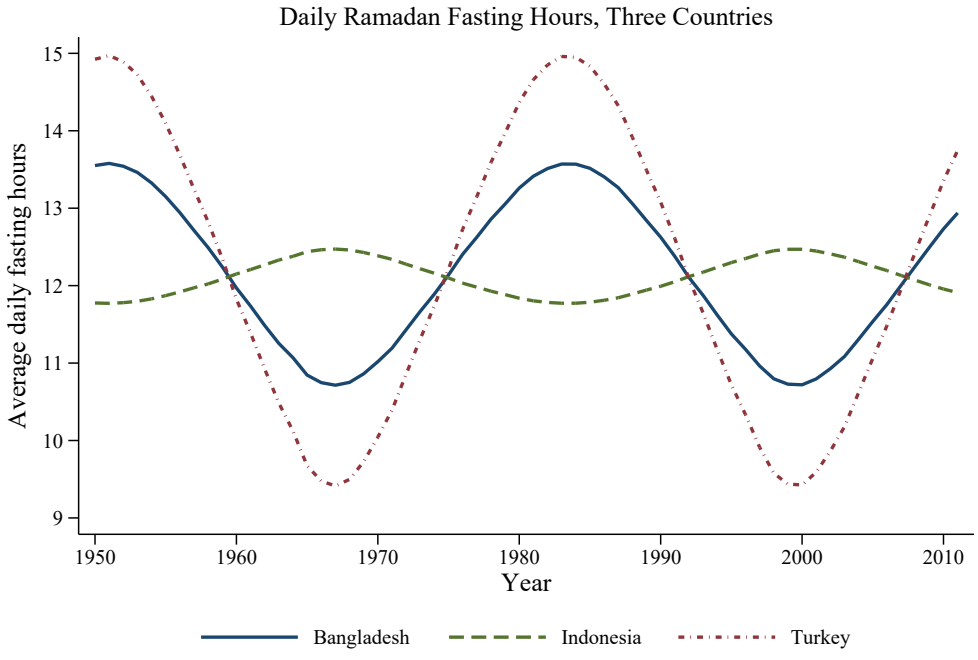
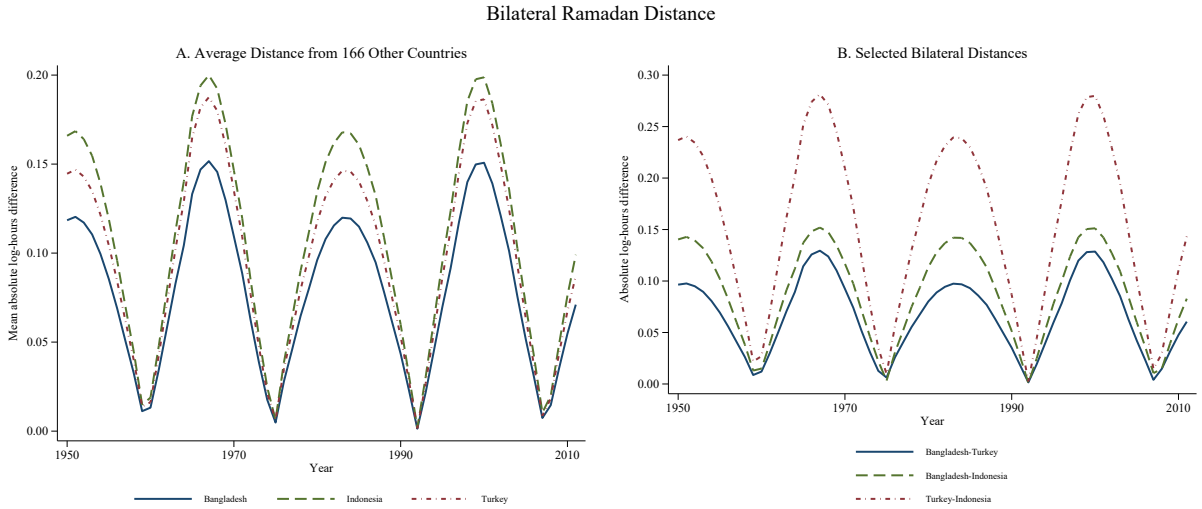


Figure A2: Daily Ramadan Fasting Hours in Three Countries



Source: Authors' calculations using fasting-hours data from Campante and Yanagizawa-Drott (2015).
Ramadan distance = |log fasting hours in country i - log fasting hours in country j|. Panel A is an unweighted mean over 166 other countries observed in every year.

Figure A3: Bilateral Ramadan Distance: Average and Selected Country Pairs