Barriers to Trade: How Border Walls Affect Trade Relations

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Abstract Since trade must cross borders, to what extent do border walls affect trade flows? We argue that border walls can reduce trade flows. Even if the objective is to only stem illicit flows, border walls heighten "border effects" that can also inhibit legal cross-border flows. Using a gravity model of trade that reflects recent developments in both economic theory and econometrics, we find that the creation of a wall is associated with a reduction in legal trade flows between neighboring countries. We provide a battery of evidence that suggests this reduction is not simply a function of worsening bilateral relations. Our findings have implications for understanding how governments have taken measures to assert sovereign control of their borders in an age of increasing economic globalization.

President Bill Clinton valued trade with Mexico. Although he authorized Operation Gatekeeper to construct a security fence at the US–Mexico border in 1994, his administration was not trying to restrict legal flows of goods between Mexico and the United States.[1] In fact, that same year he signed one of the signature accomplishments of his first term, the North American Free Trade Agreement (NAFTA), which enhanced economic exchange between the two countries and Canada. The goal of the fence, and the enhanced security procedures that accompanied it, was to stem the flow of illegal immigration. But some in the administration feared that the two policies would be at cross-purposes. A 1994 White House report on immigration and border control said, "efforts to facilitate travel across the US–Mexico border as part of the North American Free Trade Agreement may conflict with the need to establish closer controls on cross-border traffic to enforce immigration laws."[2]

The issues at the US–Mexico border point to a broader tension in the global economy. Accelerating volumes of international trade and investment are integrating the world. Some commentators claim that this process of economic "globalization" is rendering international borders, and the costs they impose on trade, obsolete.[3] However, a curious countertrend has emerged: the construction of physical barriers along borders, such as walls and fences. In earlier research on border walls, we show that while there were only nine border barriers in place in 1991, there were

1. This was a follow-up to "Operational Hold the Line" in 1993.
2. Clinton 1994, 42
3. Douglas 2000; French 2013; Strange 1996.

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thirty-five border barriers in 2013 and over fifty by 2016.[4] This post-Cold War boom in wall building is corroborated by other studies[5] and discussed in policy circles.[6]

If wall building is a response to increased cross-border illicit flows of goods and people, what are its effects on overall legal economic flows? While political debates about walls are frequently focused on the putative costs or benefits of wall building,[7] there is little to no systematic evidence across a wide set of cases regarding the effects of walls on either economic flows[8] or political outcomes.[9] Walls might be a response to the forces of globalization, but do they actually influence the flows of people and goods? Or are they analogous to some domestic counterterror provisions that are merely symbolic policies carried out to appease domestic interests?[10] While there are studies of how individual walls influence cross-border flows,[11] we offer the first study that engages this question using systematic data on trade flows and wall construction across a wide set of cases.

Offering systematic evidence is critical for detailing the economic consequences of border walls. It is plausible that border walls may have no effect on or association with legal trade flows. The entire exercise of wall construction could be symbolic:[12] a mere show meant only to assure citizens that increasing cross-border activity has not removed the state's control of the border. If the wall's purpose is to restrict labor flows but not flows of goods, then pro-trade domestic interests could be largely indifferent to wall construction or other restrictive immigration policies.[13] Moreover, if the beneficiaries of open trade are not labor-intensive firms, then these beneficiaries have little reason to advocate for open migration policies. This creates space for anti-immigration groups to push for policies, such as wall construction, that are meant to restrict and curb unwanted immigration. The overall result would be a rise in wall building that need not depress trade.

We provide ample evidence that bilateral trade flows are significantly lower after border barriers are built, and we offer two possible explanations for this finding. On the one hand, wall construction could have real consequences for trade flows. For reasons grounded in international trade theory, we argue that building a border wall will reduce trade between neighboring countries. Building a wall can heighten the well-known "border effect" that inhibits trade.[14] For example, observing the creation of a border fence along the United States–Mexico border between El

4. See Carter and Poast 2017. The update past 2013 is from Freiden, Lake, and Schultz 2019, 630.
5. Avdan and Gelpi 2017; Hassner and Wittenberg 2015; Vallet and David 2012.
6. Hinrikus 2017.
7. See Hassner and Wittenberg 2015, 157–58 for a discussion.
8. Getmansky, Grossman, and Wright 2019, 1.
9. Avdan and Gelpi 2017, 15.
10. Bueno de Mesquita 2007.
11. Allen, Dobbin, and Morten 2018; Amodio, Baccini, and Di Maio 2017; Getmansky, Grossman, and Wright 2019.
12. Brown 2010, 24–26
13. Peters 2015.
14. Anderson and van Wincoop 2003; McCallum 1995.

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Paso and Juárez, Reuter writes, "Participants [of interviews] stressed the high costs of the wall—not just financial costs of building the fence or of maintaining border security, but also the human costs (e.g., people who cannot see their families as easily or take classes at a different university), environmental costs (e.g., impact on water management, pollution, wildlife, etc.), and economic costs (e.g., wait times at the ports of entry)."[15] This indicates the local-level disruptions that, if sufficiently numerous, could translate into an overall disruption of trade between the two countries.

Even a government supportive of open trade might be willing to tolerate heightened "border effects" because the government also wants to reduce the negative externalities associated with an open border, namely an actual or perceived increase in the illegal flow of people and goods. A number of recent studies find that border walls are built by relatively wealthy neighbors attempting to block the entry of immigrants and black-market goods from poorer neighbors.[16] Wealth disparities across two neighbors, which proxy for individuals' economic incentive to immigrate or smuggle black market goods, is a good predictor of wall building across different data and research designs.[17] For some relatively wealthier neighbors, staunching illegal flows of people and goods, or at least providing the appearance of doing so, is worth the price of also damaging legal trade flows.

On the other hand, it is possible that a negative relationship between border walls and trade is spurious. With observational data, it is always possible that our models omit a key factor that is driving both the construction of walls and the reduction in trade. One possible omitted factor is that the states building barriers opposite particular neighbors are interested in reducing *all forms* of economic exchange between the two countries, illegal *and* legal. This argument suggests that the lower trade associated with a wall is not from the wall itself but because the wall's construction coincides with the implementation of a host of formal and informal policies aimed at restricting or lowering legal trade. For instance, a state might build a wall along the border of a neighbor while it also imposes tariffs or nontariff barriers on goods flowing from this neighbor. In this case, the wall might be a symbolic barrier between the countries, but the actual barriers to trade are the direct trade policies such as the tariffs. Hence, the reduced trade has little to do with a physical barrier.

It is not possible to definitively adjudicate between these possibilities. We can, however, provide suggestive evidence on how a wall affects trade relations. We do so by using a gravity model of trade that draws on recent developments in both economic theory and econometrics.[18] We consistently find a negative relationship between the creation of a border wall and cross-border trade flows. Additionally, we conduct a series of tests to assess the possibility that the negative correlation is spuriously driven by some alternative factor. These include tests for the sensitivity

15. Reuter 2018, 12.
16. Brown 2010; Carter and Poast 2017; Hassner and Wittenberg 2015; Rosière and Jones 2012.
17. See, for example, Carter and Poast 2017 and Hassner and Wittenberg 2015.
18. This includes accounting for "multilateral resistance" using country-year fixed effects for both the exporting country and importing country, in addition to directed dyadic fixed effects.

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of our estimates to selection on unobservables and accounting for the influence of border walls on trade between noncontiguous states. The results across a number of tests all show that walls are associated with decreased bilateral trade flows.

Walls and Trade: Theoretical Considerations

The putative benefit of wall construction is a reduction in illicit flows at the border, namely the reduction of illegal flows of goods and people. There are also often political benefits from wall construction because leaders often gain from a grand symbolic assertion of state sovereignty at the border. But the cost of wall construction, besides the large and direct monetary cost of funding construction, can also raise the transaction costs of legal trade and movement of people across the border. These heightened transaction costs, in turn, reduce trade flows. In short, by seeking to *reduce* illegal flows, governments will often *raise* the costs associated with legal flows. Some governments might find the reduction of legal trade an acceptable price for asserting border control; others will not.

Building Walls

States have constructed walls for a variety of reasons throughout history. These motivations range from territorial protection (as was the case of the Interwar Maginot line between France and Germany), to protection against suicide bombers (i.e., the wall between Israel and the Palestinian territories). But we among others argue that a primary motivation for the uptick in wall construction since the end of the Cold War is to impede illegal immigration and the flow of illicit goods.[19] Stable borders are institutions that the populations on both sides recognize and (for the most part) honor.[20] A border is unstable if its integrity is systematically violated by a subset of the population, which can produce negative externalities for both states. These externalities arise directly in the form of illicit goods (e.g., weapons) and people illegally entering the economy, and indirectly through the crime organizations and violence associated with the distribution of illegal trade flows.

The state of the macro-economy and the level of development in the two countries on either side of the border shape micro-level economic incentives. Neighbors with roughly similar levels of economic development are unlikely to experience high levels of economically induced border instability. Illicit activity is associated with risks and costs for individuals, which are less likely to be worthwhile if the level of economic opportunity within one's own country is comparable to what can be

19. Carter and Poast 2017.
20. Abramson and Carter 2016; Carter and Goemans 2011; Simmons 2005.

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gained across the border. But since economic disparity creates numerous opportunities for cross-border profit, neighboring countries that exhibit stark differences in levels of economic development are relatively likely to have an unstable border. Consequently, there will be a greater volume of illegal movement of people and goods across the border.

While some states might be relatively indifferent to these unofficial or illegal cross-border activities, many states will take policy measures to combat systematic violations of the border. Policy measures include increasing border security personnel, raising the number of patrols along a border, and constructing a physical border barrier. Constructing a border wall is a relatively extreme example of a "top-down" strategy of border management that reveals how neighbors can have inconsistent border-management strategies.[21] The construction of border barriers is intended to slow (or ideally stop) the flow of illegal goods and people across the border. States that build border walls want to construct them so that the main cross-border paths that smugglers use are blocked off or made more difficult.[22]

The story, however, is not as simple as "build wall, illegal flows fall."[23] Although the prevention of illegal flows of goods and people might motivate border wall construction, the wall's impact can be felt more generally. Specifically, *legal* flows of goods and people will not be impervious to the wall's construction. Understanding how and why this is the case requires detailing the influence of border walls on "border effects."

Walls and "Border Effects"

Border fortifications heighten the "border effect." In an influential article, McCallum refers to the "border effect" as the depressing effect of boundaries on trade: "Whatever the reasons may be and whatever the future may hold, the fact that even the relatively innocuous Canada–US border continues to have a decisive effect on continental trade patterns suggests that national borders in general continue to matter."[24] Border effects help us understand why trade between two firms would be higher volume within country than internationally even if the distance between two firms within a country is greater than the distance between two firms that must cross an international border.

21. Gavrilis 2008.

22. For example, Israel's border wall with the Gaza pushed Hamas to develop tunnels into Israeli territory, a tactic that they had also resorted to at the Egyptian border, which is also fenced. See "Israel Destroys 'Longest and Deepest' Gaza Tunnel," BBC News, 15 April 2018, retrieved from <https://www.bbc.com/news/world-middle-east-43775110>. In this example, the small geographic size of the Gaza strip likely makes Israel's border-fortification strategy more effective than in cases with much longer borders.

23. This is a restatement of a 23 January 2019 Tweet by US President Donald Trump: "BUILD A WALL & CRIME WILL FALL." Accessed 20 March 2019.

24. McCallum 1995, 622.

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Core to the border effect are bilateral trade costs. Firms face a number of additional costs when they choose to join the export market and trade internationally. The most obvious costs derive from geography, such as the costs of transport for a given distance, or from aspects of states' trade policies, which include tariff rates, currency exchange, and other policies that create barriers to trade.[25] A number of other factors that are less widely highlighted also generate costs, such as cultural differences that may decrease the ease of transactions or language differences that increase the cost of communications with a foreign firm.[26] Because international trade must cross an international boundary, the traded goods typically must pass through customs checkpoints. In the easiest cases, this means goods pass through a "one-stop" customs checkpoint.[27] Unfortunately, this more commonly implies at least two if not more checkpoints.[28] All of these inconveniences, restrictions, and regulations serve to impede and depress trade flows.

Border walls can heighten border effects in several ways, including diverted resources, heightened restrictions at ports of entry, and negative symbolism. Each of these can be understood by considering the US–Mexico border. First, constructing and maintaining a wall is not resource free. Resources dedicated toward wall construction and maintenance might be drawn away from resources needed for processing crossing at ports of entry, thereby slowing or even diverting trade. This is the concern raised by the Border Trade Alliance, a lobbying group that advocates for policies that promote trade between the US, Mexico, and Canada: "the construction of a wall along the length [of the] US–Mexico border … would divert finite security resources away from the ports."[29] Early 2019 provides a small example of the consequences of resource diversion. On 1 April 2019, the Trump administration immediately reassigned 750 customs inspectors away from ports of entry so that they could instead process the flows of migrants attempting to enter the country outside official ports of entry.[30] The effect of this shift was an immediate rise in wait times at the official ports of entry. Prior to this shift, the typical wait time for entering El Paso from Ciudad Juraez was one hour. Following the shift, the wait time surged to approximately eight hours.[31]

Second, wall construction can directly impede the processing of legal goods at the border, even if wall construction does not draw resources away from ports of entry.

25. Glick and Rose 2016.
26. In a related vein, see Akera et al. 2014.
27. Kieck 2010.
28. Wilson, Mann, and Otsuki 2003.
29. "Key Issues" Border Trade Alliance, <https://thebta.org/key-issues/>, accessed 19 February 2019.
30. "Secretary Nielsen Orders CBP to Surge More Personnel to Southern Border, Increase Number of Aliens Returned to Mexico." Department of Homeland Security Press Release, 1 April 2019. Accessed 30 May 2019 from <https://www.dhs.gov/news/2019/04/01/secretary-nielsen-orders-cbp-surge-more-personnel-southern-border-increase-number>.
31. Gretchen Frazee, "Why Cars and Produce Are Taking a Hit from Trump's Latest Border Moves," *PBS News Hour*, 5 April 2019. Accessed 30 May 2019 from <https://www.pbs.org/newshour/economy/making-sense/why-cars-and-produce-are-taking-a-hit-from-trumps-latest-border-moves>.

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Ports of entry are meant to filter the goods and people that enter a country, facilitating legal flows while filtering out illegal flows.[32] At a minimum, filtering involves the need to comply with procedures for commercial goods passing through ports of entry. Filtering also involves occasional searches of containers and goods at ports of entry, which states typically reserve the right to administer.[33] Wall construction is almost always part of a larger policy package of enhanced security along the entire border. This means heightened security measures at the ports of entry where the legal flows of commercial trade are directed. Because border fortifications will induce smugglers to more frequently attempt to move their illicit wares through ports of entry—that is, a "substitution effect"—creating a border wall will only heighten the need to filter illegal goods from legal goods at the port of entry.

For example, a former border patrol agent who later became the Department of Homeland Security attaché to Mexico informed Angie Bautista-Chavez that there is often a tradeoff between the inspection of people and goods at ports of entry, meaning that "when a large group of migrants shows up at the border, agents prioritize the inspection and processing of these individuals, thereby decreasing the quality of the inspection of other goods (thereby enabling the increase of illicit goods). Smugglers (often in the business of smuggling both people and goods) know that agents face this tradeoff, and strategically send people to overwhelm agents at port of entries, with an opportunity to increase the flow of illicit goods."[34] If the usual routes for smugglers become more difficult because of barrier construction and increased security along the border, this increases the incentive to find ways in via ports of entry. If the state is not able or prepared to direct more resources to ports of entry, the result can be the same as diverted resources: a slowing of legal flows of people and goods into a country.

The El Paso-Juarez example in the introduction illustrates border effects of this type. The wall served as a direct disruption to local movements of people, which, in turn, translated into lost economic activity between border communities. Such concerns are what prompted the mayor of McAllen, Texas, to express opposition to a border wall between McAllen and the Mexican city of Reynosa. He feared that the wall would disrupt daily economic exchange between the two communities: "We have tens of thousands of people go back and forth every day. You can't just shut this place down."[35] The increased time firms anticipate it will take to move goods

32. Simmons and Kenwick 2019.

33. For example, see Title 19, section 1467, of the United States Code (19 U.S.C. 1467), which gives Customs and Border Protection the right to examine any shipment crossing a US border.

34. Angie Bautista-Chavez, personal communication with United States Department of Homeland Security Attaché to Mexico, 2018. See also Adriana Candelaria, "People Seeing Wait Times Increase at El Paso Border Ports of Entries," CBS4 News, 15 November 2018, accessed from <https://cbs4local.com/news/local/people-seeing-wait-times-increase-at-el-paso-border-ports-of-entries> for a corroborating story about the expected effects of a migrant "caravan" on wait times in El Paso.

35. Quoted in Mitchell Ferman "In Texas Border Town, Skepticism Ahead of Trump Visit to Push Wall," Reuters, 10 January 2019. Accessed 18 February 2019 from <https://www.reuters.com/article/us-usa-shut-down-mcallen/in-texas-border-town-skepticism-ahead-of-trump-visit-to-push-wall-idUSKCN1P416F>.

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through ports of entry and the increased costs of complying with enhanced regulations will raise costs for shipping goods into a country. The end result is a decline in trade flows.

Third, there is the symbolic importance of the wall. Building a wall can undermine the "good will" underpinning economic activity between localities, while an increase in constructive diplomatic exchanges can facilitate trade between countries.[36] In a 2017 media interview, the mayor of Laredo, Texas, Pete Saenz, expressed opposition to the creation of a border wall between Laredo and Nuevo Laredo (in Mexico). Saenz's view was that the thousands of people and vehicles that move daily across the border of the two communities are a credit to diplomatic efforts, namely "a good-neighbor policy" with Mexico.[37] For that reason, when asked about the effects of a wall, even one directed toward stopping illegal immigration alone, Saenz's response was blunt: "Well, it'll be a disaster, frankly. We're a—based on the numbers that I gave you, we're a transportation, trade, commerce, distribution center, warehousing—so we're a trade town. That's our backbone and our bread and butter frankly. So if the wall is there—and it's very offensive, frankly, to the people that—well, to Mexico primarily. And the people there in Laredo and the border area do business with Mexico."[38]

To be clear, examples beyond the US–Mexico border also illustrate the heightened border effects associated with fortification construction. Consider how the construction of the Berlin wall in 1961 brought to a halt the movement of commuting workers between East and West Berlin.[39] Or consider the recently constructed fortification between Saudi Arabia and Iraq.[40] The barrier along the Iraq border was intended to stop raiding parties associated with the Islamic State of Iraq and Syria (ISIS) from entering Saudi Arabia. But it has also impeded the ability of pilgrims hoping to enter Saudi Arabia for the annual Hajj.[41] This is similar to how Israel's separation barrier affects Palestinian agricultural trade. The barrier reduces the number of points of entry and if the remaining points are unable to efficiently handle the volume of trade that now enters them, trade will be decreased or diverted to other trading partners. For this reason, the World Bank expected a rise in the shipment of herbs into Jordan and away from Israel after completion of a border barrier.[42]

36. Van Bergeijk 2014, 7.

37. Earlier in the interview, Saenz highlighted how Laredo is the number one land port for the Western Hemisphere. Interview between Lourdes Garcia Navarro, host, and Mayor Pete Saenz, National Public Radio, 22 January 2017, available at <https://www.npr.org/2017/01/22/511048769/a-texas-border-town-mayors-take-on-immigration-trade-and-the-wall>.

38. Ibid.

39. Ahlfeldt et al. 2015, 2134.

40. Carter and Poast 2017.

41. See Richard Spencer, "Revealed: Saudi Arabia's 'Great Wall' to Keep Out ISIL," *The Telegraph*, 14 January 2015, accessed 7 August 2018 at <https://www.telegraph.co.uk/news/worldnews/middleeast/saudiarabia/11344116/Revealed-Saudi-Arabias-Great-Wall-to-keep-out-Isil.html>.

42. "An Analysis of the Economic Restrictions Confronting the West Bank and Gaza," World Bank, accessed 18 February 2019 at <http://siteresources.worldbank.org/INTWESTBANKGAZA/Resources/EconomicrestrictionstSept.08.pdf>.

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In short, border fortifications heighten the costs of moving commercial goods across borders, which means neighbors whose border becomes fortified will experience decreased trade flows. Some governments might find the reduction of legal trade an acceptable price for asserting border control, or the appearance of doing so, while others will not. Regardless of how effective border walls are (or are not) in addressing border instability, some governments erect barriers at one or more of their borders knowing that it increases transaction costs. Such leaders could be aware of significant economic costs but view the trade-offs as being worthwhile. In other words, the perception that one is staunching unwanted flows of goods and people either outweighs or balances the costs in terms of cross-border trade flows. This discussion leads to the following empirical implication stated as a hypothesis:

H1: Neighboring countries that fortify their shared border, all else equal, subsequently experience reduced trade flows.

Alternative Explanations

Our discussion emphasizes the negative consequences of border fortification for legal trade. But there are reasons to suspect that the data will exhibit patterns inconsistent with our main hypothesis or its underlying logic: an observed negative relationship could be spurious or there could be no observable relationship between walls and trade flows.

It is always possible that an omitted variable drives both the construction of walls and the reduction in trade. One possibility is a protectionist ideology, where governments that erect barriers intend to reduce *all forms* of economic exchange between the two countries, illegal *and* legal. Thus, the lower trade is not from the wall itself but because the wall's construction coincides with the implementation of formal and informal policies aimed at restricting legal trade. Another troublesome source of spurious correlation is diplomatic hostilities and the threat of heightened conflict. In this case the reason for a decline in trade is a worsening of diplomatic relations, for example, territorial dispute, that need not have anything to do with protectionism.

It is also possible that there is no relationship between walls and trade. For instance, the domestic forces pushing for open trade and economic liberalization might be largely indifferent to whether the state implements restrictive immigration policies.[43] Alternatively, it is also possible that border barriers coincide with trade openness but have little effect on trade because land boundaries are not all that relevant to trade flows. This is somewhat plausible because much commercial trade globally does not rely on crossing a land boundary, but instead is transported by sea and increasingly by air. Hence, the set of states engaging in border fortification and wall building have done so with little consequence for trade simply because their land borders are

43. Peters 2015.

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unimportant for trade—an explanation starkly inconsistent with the assertion that border walls are associated with *general* border security programs that lead to increased costs at ports of entry.

Research Design and Data

To assess the effects of border walls on trade flows, we build on recent developments in the widely used gravity model of trade. The gravity model is nearly ubiquitous in economics and political science in the study of trade. It has produced quite consistent results across numerous studies for decades and has been established as consistent with the most recent advances in trade theory,[44] which makes it a good choice in our application. Given our theoretical focus on the importance of how neighboring states' borders are managed, specifically whether a border wall has been built or not, our initial empirical focus is on trade flows between contiguous states sharing a land boundary. It is well known that contiguous states tend to trade at higher volume than noncontiguous states. Thus, this initial focus on contiguous states facilitates analysis of dyads that are, all else equal, likely to be composed of important trading partners. We subsequently analyze models that include all trading dyads when we probe the logic behind our explanation relative to alternatives.

The baseline gravity model analyzes import flows between pairs of states. The data are in directed dyad format, so we analyze the import flows from state *a* to state *b*, as well as the imports from state *b* to state *a*. As is standard, we log the dependent variable in all specifications where we estimate linear models.[45] We also include directed dyad fixed effects to control for omitted time-invariant characteristics of dyads that affect their trade. We estimate country-year fixed effects in addition to directed dyad fixed effects. Country-year fixed effects measure any time-varying country-level factors that affect a country's trade with all other states. For instance, this ensures that we control for any aspect of either the importing or exporting country's trade policies that can change across time and has effects on trade flows. This high-dimensional fixed effects model is one of the most recent versions of the gravity model suggested by theoretical advances in the trade economics literature[46] and has recently been applied in political science by Gowa and Hicks.[47] The key advantage here is that it controls for all country-level factors that may vary by year and all time-invariant dyadic variables. Thus, the country-year fixed effects measure all country-level factors that are time varying without error and also help us avoid omitting any time-varying country-level factor that is hard to measure.

44. Anderson 2011.
45. We estimate Poisson models when we include all trading dyads because this global directed dyadic data has a large number of zero trade values.
46. Anderson 2011; Baldwin and Taglioni 2006.
47. Gowa and Hicks 2013.

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In our context, these country-year fixed effects also ensure that any country-level changes that are a consequence of or related to the erection of a border wall, for example, an election that puts an anti-immigration government in power, are estimated in the fixed effect. Similarly, the directed dyadic fixed effects measure any time-invariant factors that might affect import flows from state *a* to state *b*, such as distance between capitals, the number of seaports that can be used in trading, or cultural affinity, without error and misspecification. This is a great advantage because it allows us to account for the effects of all of these variables and leaves the effect of time-varying dyadic-level variables on trade to be estimated. Our variables of theoretical interest, that is, the erection of a border wall, are at the dyad level and vary across time.

In the original gravity model, the log of imports is assumed to be a function of the size of the two states' economies, that is, their GDP, and the distance between the countries' capitals. Intuitively, these factors measure the "attraction" of the two countries to each other economically—an analogy to the physical pull of gravity. In the most recent specifications of the gravity model, the distance measure falls out of the specification as it is subsumed by the directed dyad fixed effects, and GDP is also excluded as the country-year fixed effects measure yearly changes in GDP for both countries (in addition to all other country-level variables). We obtain our post-1948 trade data from the Correlates of War,[48] while we use data newly compiled by Gowa and Hicks for 1900 to 1947.[49] The Gowa and Hicks data use historical yearbooks and League of Nations publications for pre-1947 data, which leads to more accurate measurement and much less missing data. The data are in millions of current US dollars for each pair of sovereign states.

Data on Walls

Several recent studies have produced lists of when two countries have walls at their border, the state that constructed the wall, and the year the wall was constructed. Published studies of walls include Carter and Poast, Avdan and Gelpi, and Hassner and Wittenberg.[50] We use our earlier work as our primary source of data, which cover the 1800 to 2014 period. Their use of John Keegan's definition of a strategic defense to identify fortified borders is general enough to capture the variety of border fortifications across the twentieth century.[51] Additionally, our definition of border barriers does not try to condition on what the state building the wall intended to block, which allows us to include walls like the North Korea/South Korea border wall that Hassner and Wittenberg exclude, for example.

48. Barbieri, Keshk, and Pollins 2009.
49. Gowa and Hicks 2013.
50. Carter and Poast 2017; Avdan and Gelpi 2017; Hassner and Wittenberg 2015.
51. Keegan 1993, 142.

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We also check whether the results of our analysis are similar if we also leverage information from the other two data sources. Specifically, we combine the three measures using item response theory (IRT), where we implement a latent trait model for dichotomous data. We also use principal component analysis (PCA) to combine the three measures, which produces a very similar measure to the IRT method (their correlation is close to 1). Finally, we also calculate a simpler measure that calculates the percentage of all sources that code a border as having a wall in a given year. Thus, if all three sources agree, this measure takes a value of 1, while it takes values of 0.333 if only one of the three sources codes a wall, 0.666 if two out of three code a wall, and so on. We use the simple proportion measure because it is correlated with the PCA and IRT at over 0.99, produces very similar results, and has a much more intuitive interpretation.

Other Covariates

We control for several important time-varying dyadic-level variables that measure the nature and quality of two states' political relationship and are commonly found to affect trade flows. The purpose is to try to condition out the general nature of two states' relations so we can more plausibly identify the effect of border walls.[52] Specifically, we include a measure of whether two states are currently in a defensive alliance,[53] whether the trading partners are both democratic,[54] whether the two neighbors are strategic rivals,[55] as well as whether the two states are embroiled in a territorial dispute.[56] We also estimate models with a control for whether the two states have a preferential trade agreement (PTA) in place, which we obtain for 1945 to 2010 from Mansfield and Milner, a measure of whether the two states share a common currency from Glick and Rose, and measures of whether both states are GATT/WTO members from Goldstein, Rivers, and Tomz.[57] We obtain the alliances data from the Correlates of War project, which has been most recently updated through 2012.[58] We consider a dyad to be democratic if both states have Polity scores of at least 7. We measure strategic rivalry using data developed by Thompson.[59] We use data from Paul Huth and coauthors to measure territorial disputes, which allows us to cover the period from 1919 to 2010.[60]

52. Recall that any time-invariant dyadic variables that affect trade are conditioned out by the directed dyadic fixed effects.
53. Gowa 1994.
54. Mansfield, Milner, and Rosendorff 2000.
55. Thompson 2001.
56. Simmons 2005.
57. Goldstein, Rivers, and Tomz 2007; Mansfield and Milner 2012; Glick and Rose 2016.
58. Gibler 2008.
59. Goldstein, Rivers, and Tomz 2007.
60. Carter, Wellhuasen, and Huth 2018; Huth, Croco, and Appel 2011.

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Given that existing work finds that cross-border economic inequality drives the construction of border walls, we also control for this in many of our gravity specifications. This helps us to ensure that any estimated effect of walls on trade are not an artifact of omitting dyadic income inequality, which might drive any effect on trade flows. While by no means a perfect measure, we also view cross-border income inequality as a reasonable time-varying proxy for wealthier states' worries about illicit flows and legal trade relations with a contiguous neighbor. For legal trade relations, one difference between the US–Canada and US–Mexico relationship is that relative to Mexico, a number of politicians and policymakers in the US have expressed worries about how Mexico's significantly lower wages makes competition under free trade "unfair." However, this is a worry that was not really present in the same way for the US's trade relations with Canada, with whom the US has been much closer to parity economically. We follow our recent work in constructing our measure of cross-border income inequality.[61] Specifically, we measure dyadic income inequality with data on GDP per capita using data from Oneal and Russett and Gleditsch.[62] The Gleditsch data are available from 1950 to 2011, while the Oneal and Russett data allow for pre-World War II measurement. We use the Gleditsch data for post-1950 observations because it provides the best coverage post-2000. Given that around half of border walls constructed since 1800 have been built since the end of the Cold War, consistently measured data that cover this period was our paramount concern. The main measure we use is the ratio of two neighboring states' respective GDP per capita. The measure takes the ratio of GDP per capita of the wealthier country over the GDP per capita of the poorer country. Formally, this measure of income inequality is:

$$Income\ Inequality = \frac{max\{GDPpc_A, GDPpc_B\}}{min\{GDPpc_A, GDPpc_B\}},$$

where the A and B subscripts refer to the two (neighboring) countries that share a border. Since our GDP per capita measure is highly right skewed, we take the natural log and then compute the ratio.

Empirical Analysis

The fact that observations are not independent is a notoriously problematic feature of dyadic data.[63] One source of non-independence is from the panel structure of the dyadic data: each dyadic observation is repeated for multiple years (e.g., the US–Mexico 1995 observation is in the data set, as is the US–Mexico 1996 observation). Another source of non-independence is that different dyads can contain the

61. Carter and Poast 2017.
62. Oneal and Russett 2001; Gleditsch 2002.
63. Poast 2016.

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same country (e.g., the US–Mexico 1995 observation and the US–Canada 1995 observation both contain the US). Nicely, the fact that our model includes both directed dyadic and country-year fixed effects helps us to deal with these dependencies.[64] Finally, we note the directed dyadic fixed effects suggest that the estimates of the coefficient for border walls in our gravity models are identified from within-dyad variation in trade. Specifically, the effect of a wall is identified by comparing pre-wall import levels to post-wall import levels, conditional on the country-year fixed effects. Recall that the country-year fixed effects ensure that all estimates reflect the comparison of the trade barriers for each pair of neighbors relative to the average trade barriers that both neighbors face with all their other trade partners. Given that our gravity model entails estimating a linear model with multiple levels of high-dimensional fixed effects, we apply an estimator adapted from Guimarães and Portugal.[65]

Main Results

Table 1 reports the results from estimating a series of models. Consider first model 1, which contains only our measure of whether a border wall has been built at two states' mutual boundary. While this baseline model does not include any other controls, the country-year fixed effects and the directed dyadic fixed effects imply that many of the common variables included in gravity models, for example, each state's GDP, are actually controlled for. Model 1 shows a relatively strong relationship between wall presence and trade flows. The coefficient indicates that a wall reduces trade by approximately 0.7 logged millions of US dollars between two neighboring countries. Since the dependent variable has a range of −19 to 12, this is not a trivial reduction in trade. More precisely, if two countries have trade flows at the median value of the sample (2.7), adding a wall is associated with a 31 percent reduction in the trade flows between the two countries. Of course, in model 1 we have not controlled for any other dyadic variables that measure two states' relations and might be associated with wall building.

Models 2 through 4 progressively add control variables to this baseline model. One can see that the coefficient does vary in magnitude depending on the variables included in the model (from as large as −0.772 to as small as −0.460). The sample size changes depending on which measures are included in the model—inclusion of our measures of Preferential Trade Agreements (PTAs), common currency, or whether the states are GATT/WTO members result in losing all pre-1945 observations. However, the substantive effect is still notable regardless. The relationship remains statistically discernible from 0 at or very close to the 0.95 confidence

64. We also address the problem of dependence within dyadic observations by clustering our standard errors by dyad.

65. Guimarães and Portugal 2010.

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TABLE 1. *Border walls and dyadic trade flows*

	Model 1 (OLS)	*Model 2 (OLS)*	*Model 3 (OLS)*	*Model 4 (OLS)*	*Model 5 (Poisson)*	*Model 6 (Poisson)*	*Model 7 (Poisson)*	*Model 8 (Poisson)*
PHYSICAL BARRIER	−0.740**	−0.772**	−0.662**	−0.460*	−0.111*	−0.121*		
	(0.30)	(0.30)	(0.28)	(0.26)	(0.06)	(0.06)		
COMPOSITE WALLS MEASURE							−0.116*	−0.131*
							(0.07)	(0.07)
DEMOCRATIC DYAD		−0.101	−0.139	−0.122	−0.106**	−0.108**	−0.106**	−0.108**
		(0.11)	(0.11)	(0.12)	(0.04)	(0.04)	(0.04)	(0.04)
DEFENSIVE ALLIANCE		0.201**	0.200**	0.136**	0.423**	0.360**	0.423**	0.360**
		(0.07)	(0.07)	(0.06)	(0.07)	(0.06)	(0.07)	(0.06)
STRATEGIC RIVALRY		−0.247*	−0.239*	−0.182	−0.146**	−0.131**	−0.146**	−0.131**
		(0.14)	(0.13)	(0.13)	(0.05)	(0.05)	(0.05)	(0.04)
TERRITORIAL DISPUTE		−0.229	−0.174	−0.074				
		(0.16)	(0.15)	(0.14)				
INCOME INEQUALITY			−0.104	−0.104	0.013	0.016	0.014	0.016
			(0.07)	(0.06)	(0.03)	(0.03)	(0.03)	(0.03)
PREFERENTIAL TRADE AGREEMENT				0.225**		0.222**		0.222**
				(0.08)		(0.03)		(0.03)
COMMON CURRENCY				0.142		0.082		0.082
				(0.19)		(0.05)		(0.05)
BOTH IN GATT/WTO				0.089		−0.124		−0.123
				(0.11)		(0.08)		(0.08)
Country-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Directed Dyad Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	50,516	47,746	44,140	40,002	1,007,128	897,502	1,007,128	897,502
Years Included	1900–2013	1919–2013	1919–2011	1948–2011	1900–2013	1919–2013	1919–2011	1948–2011

Notes: Standard errors clustered by dyad in parentheses. * $p < .10$; ** $p < .05$.

level. Given that these estimates are the product of a model that also conditions out all country-level variables and all fixed dyadic variables, we have a fair amount of confidence that it is indeed the case that walls are associated with a reduction in trade flows between neighboring countries.

Models 5 to 8 differ from models 1 to 4 in that they analyze models that include all directed dyads globally, rather than focusing solely on contiguous pairs of states. Given that we still include the same set of fixed effects, the estimates for PHYSICAL BARRIER still reflect variation only within the set of contiguous states. A known econometric issue with log-linear gravity models of trade when we include all directed dyads is the potential for zero-trade values to bias inferences. In short, the problem of zero-trade observations is particularly worrisome when there are a relatively high proportion of zero-trade values in the data. In models 1 to 4 this not much of an issue because dyads that share borders tend to be important trading partners and there is a small percentage of zero-trade values. This is no longer the case in the full directed dyadic sample, so we estimate a Poisson model with country-year fixed effects and directed dyadic fixed effects as Silva and Tenreyro suggest to ensure that our estimates are not adversely affected.[66]

The main difference in the Poisson specification is that we no longer log trade flows, but rather estimate a count model on the raw integer values of trade. The estimates for PHYSICAL BARRIER are shown in models 5 and 6 and are substantively similar to the estimates we obtain when we estimate OLS models with the log of trade as our dependent variable. In models 7 and 8 we include a variable that leverages information from all three potential sources of data on border walls as outlined earlier. We include a measure of the proportion of the three data sources for walls that code a border as having a barrier. Thus, this is a measure of the degree to which the three sources agree on codings across all cases. We find that this measure performs quite similarly to the PHYSICAL BARRIER measure because the coefficient is negative, of similar magnitude, and remains statistically significant, although at a lower threshold.

Spurious Correlation: Is It the Wall or Something Else?

The findings address several alternative possibilities, namely that there is no systematic relationship between border barriers and trade. But the most plausible alternative still remains: spurious correlation. Our findings in Table 1 might reflect some unmeasured factor correlated with wall building that is also associated with the implementation of formal and informal restrictions on legal trade. While it is not possible to definitively show that our empirical specification does not suffer from omitted variable bias, we can gain some confidence in our conclusions by conducting additional tests and assessing some more implications of our arguments. We conduct three additional tests to probe our main finding, two of which appear in the appendix.

66. Silva and Tenreyro 2006.

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First, we conduct tests that allow us to put bounds around how sensitive our results are to selection on unobservables. Second, in the appendix we show that walls produce "second order" effects on trade, where they reduce trade between the wall-building country and noncontiguous states. These second-order effects are implied by both the substitution-effect argument and the idea that border barriers in the contemporary era are associated with general security programs that aim to increase filtering at the border.[67] However, second-order effects are harder to explain if the correlation is spurious. Finally, we provide three suggestive pieces of evidence that neighbors with walls trade at relatively normal rates for contiguous states pre-border wall, are in preferential trade agreements at similar rates to other contiguous dyads, share GATT/WTO membership much like other contiguous dyads, and have land borders that are likely important for the cross-border movement of people and goods because they have significantly *less* coastal territory relative to neighbors that do not build walls.

Sensitivity to Selection on Unobservables

Perhaps the most straightforward way to probe how worried we should be about selection on unobservables is to conduct sensitivity analysis. While it does not rule out the possibility that walls are spuriously associated with trade flows, sensitivity analysis does help us to put bounds on how large of an effect an omitted variable would have to have to overturn our central result. Specifically, we implement the formal test proposed by Oster to calculate the degree of selection on unobservables, δ, that would be necessary to reduce our estimated coefficient for BORDER BARRIER to zero.[68] Both of these quantities depend on us specifying a value for how high R^2 could be with the "best possible" specification, or R^2_{max}. Oster examines a sample of results based on economics articles with randomized data to suggest a "rule of thumb" threshold for R^2_{max} above which a result should be considered robust.[69] We use her suggested "rule of thumb" of a baseline R^2_{max} that is equal to 1.3 times the R^2 associated with the fully specified regression but we explore higher values of R^2_{max} as well.

Table 2 contains the results of the tests for sensitivity to selection on unobservables that are based upon the estimates in model 4 in Table 1.[70] The four columns in the table represent the different thresholds for R^2_{max}, where we start with the "rule of thumb" Oster proposed and impose progressively higher thresholds as we move to the right. The main row of the table shows the calculated value of δ, which indicates the

67. In the appendix we also demonstrate that the negative effects of physical barriers on trade have increased across time, and especially during the post-Cold War era, which is consistent with the idea that relatively contemporary walls are associated with general security programs that have deleterious effects on trade.

68. Oster 2017.

69. See Oster 2017, 13–17 for details.

70. See the appendix for analogous tests on additional models.

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TABLE 2. *Oster tests for effect of* BORDER BARRIER *on trade in model 4*

R^2_{max} =	$R^2 \times 1.3$	$R^2 \times 3$	$R^2 \times 5$	$R^2 \times 10$
δ =	47.32	8.85	4.52	2.04

degree of selection on unobservables we would have to have present relative to selection on the observables controlled for in the model to have the coefficient for BORDER BARRIER become 0.

The results in Table 2 suggest that the degree of selection on unobservables would have to be substantial to make the estimated effect of BORDER BARRIER go away. Specifically, when we specify the test as Oster suggests and set $R^2_{max} = R^2 \times 1.3$, the calculated value of $\delta = 47.32$, which indicates that omitted variables would have to account for over forty-seven times as much of the within-directed-dyad variation as the existing control variables included in model 4 in Table 1. As we increase R^2_{max} above the suggested "rule of thumb" robustness threshold, the degree of selection on unobservables that would have to be present to overturn our estimate of BORDER BARRIER remains high. In fact, when we set R^2_{max} to ten times the observed R^2 in the fully specified model, we still recover $\delta = 2.04$, which indicates that the degree of selection on unobservables would have to be around twice as great as the combined power of all of the control variables we include in our model. Given that we estimate substantial effects for variables such as PREFERENTIAL TRADE AGREEMENT and STRATEGIC RIVALRY, these results increase our confidence in the credibility of our main result.

Conclusion

This research is part of a second phase of research on border walls. While the first phase concentrated on the construction and presence of these walls, second-phase research seeks to identify the arguably more pressing topic of what consequences walls have. One such consequence is captured by our core finding: building a border wall is associated with a reduction in trade between the neighboring countries. Anecdotal examples of this phenomenon abound, from the Berlin wall cutting off free movement of people between East and West Berlin, to the border wall between the US and Mexico frustrating daily commerce between the communities of El Paso and Juarez, to the wall between Israel and the West Bank/Gaza complicating (or even outright stopping) exchange between these territories. We have theorized the mechanism by focusing on the increased trade costs associated with border fortifications. We then brought to bear systematic, large-*N* evidence. Our findings show that walls appear to have significant and negative effects on commercial trade. Moreover, we find nontrivial "second-order effects" on trade between noncontiguous states and wall-building states, which provides tentative evidence for the idea that border fortifications lead to some

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substitution of illicit goods to legal ports of entry. Nonetheless, it is still possible that our results reflect border barriers being associated with a host of policies aimed at restricting illegal and legal exchange between neighbors. While it is not possible to rule this out, sensitivity tests suggest that for the effect of border barriers to dissipate under standard thresholds for sensitivity to selection on unobservables, the effect of an omitted policy variable would have to have a greater effect than all of our observables, including observables such as the presence of a preferential trade agreement.

Of course, our research does not speak to the desirability of these negative effects on trade. Reducing trade flows might be the intended goal. Or reducing trade flows might be deemed an acceptable price for eliminating particular negative externalities associated with large levels of cross-border trade. Future research could make use of survey and survey experiments to identify conditions under which such a trade-off is deemed desirable.

Supplementary Material

Supplementary material for this article is available at <https://doi.org/10.1017/S0020818319000353>.

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Borders; border wall; border effects; international trade; gravity model

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