Does the Establishment of International Bridges Attract Foreign Firms? A Machine Learning Approach

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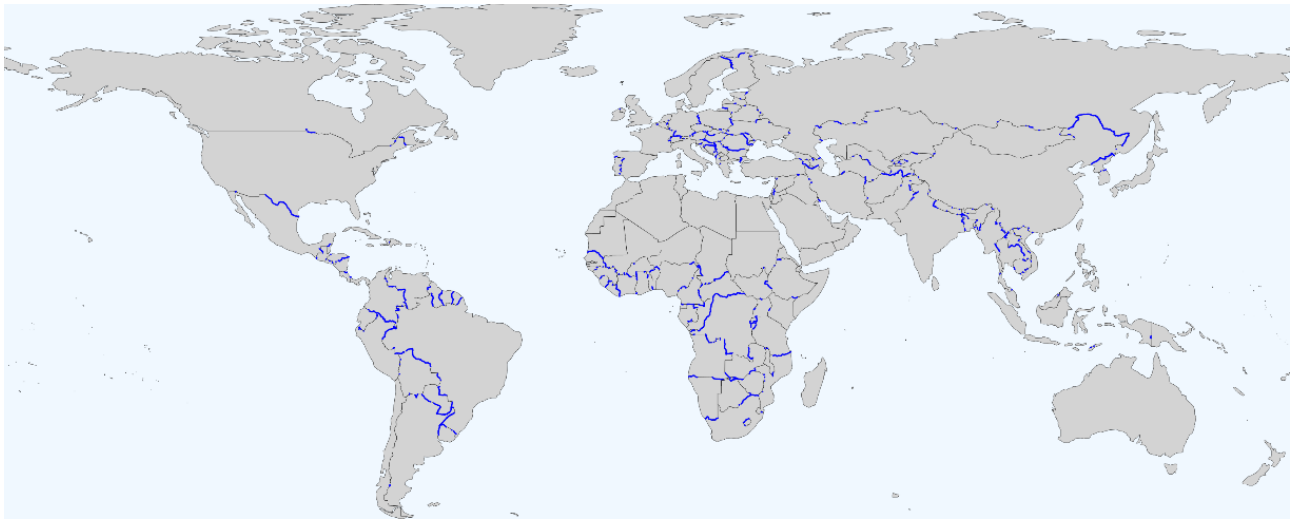
Synopsis

- Participating in a global production network can be a shortcut for developing countries to jumpstart industrialization. However, trade and investment in a land-locked country depends strongly on land connectivity with neighboring countries.
- Border adjacency and land connectivity differ because of geographic conditions such as rugged terrain and rivers. Cross-border infrastructure such as bridges is essential for increasing connectivity in such cases.
- The distances to international bridges or the Mekong Friendship Bridges are important to foreign firms' location in the Lao PDR.
- Districts within 50 km of the bridge are predicted to receive one foreign firm per year after bridge completion. The number of predicted foreign firms declines to about 0.4 for districts 160 km from the bridge.

Developing countries may jumpstart industrialization by participating in international production networks (Kimura and Chang, 2017). Economic growth in East Asia has recently been strongly associated with foreign direct investment (FDI) and trade (Urata, 2001). In the FDI-related legislation introduced in the early 1990s at the initial stages of major economic reforms, by the four new members of ASEAN (Cambodia, Laos, Myanmar, and Vietnam), institutional reform is not a sufficient condition for attracting substantial FDI.

Using UNCTAD's worldwide bilateral FDI data, an empirical analysis by Chen and Lin (2020) finds that physical connectivity such as, air (direct flight), port (liner shipping), railway, and land contiguity has a significant impact on inward FDI flow. However, the use of shared border lines to define land connectivity is ambiguous because adjacency and decent land connectivity often differ between countries. In addition to rugged terrain, rivers are significant border barriers. Fig. 1 shows that rivers constitute a large portion of international borders.

Figure 1. Global Map of River Borders



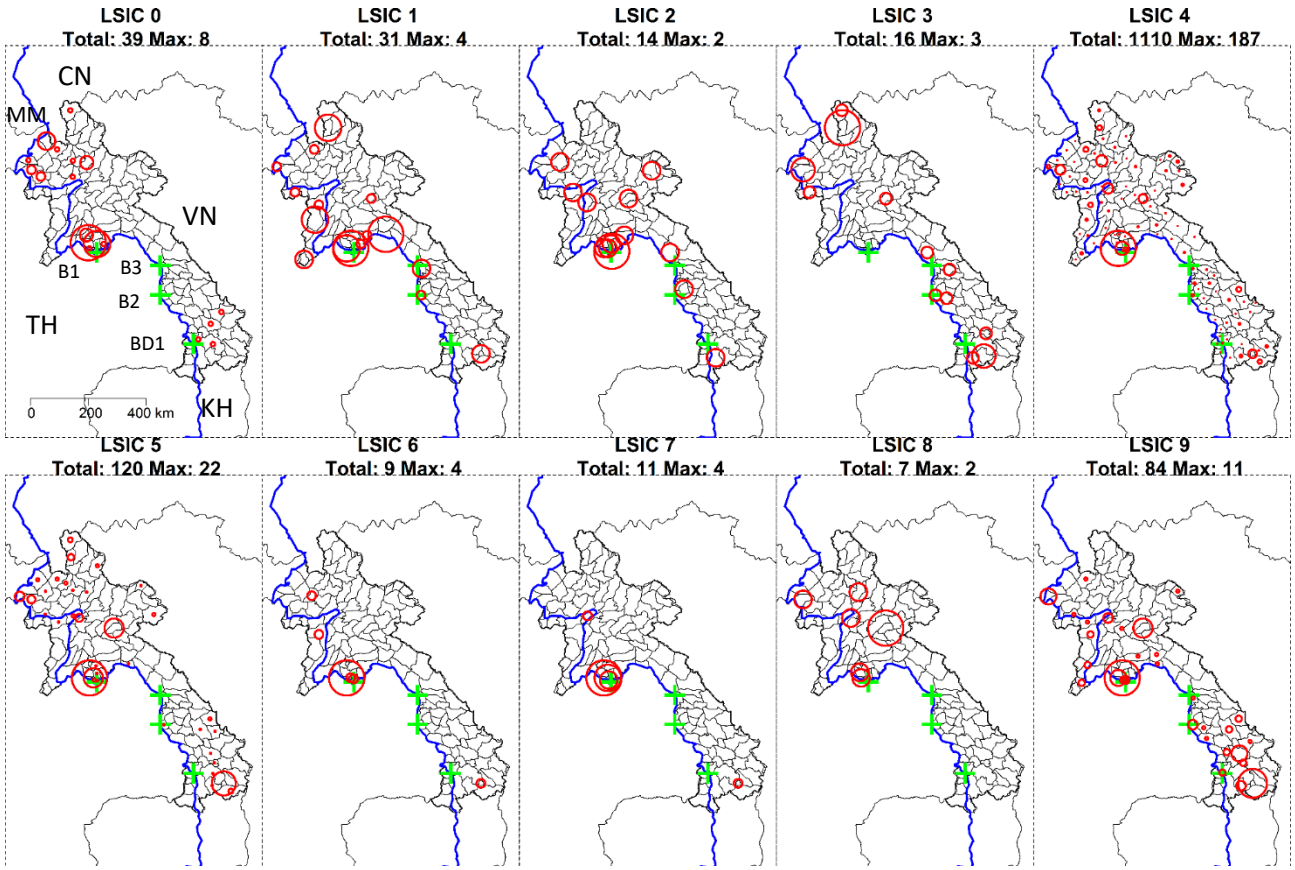
Source: Authors' drawings based on Popelka and Smith (2020) and Global Administrative Unit Layers (FAO). The blue lines represent river borders.

Although Laos has Vietnam in the east, Cambodia in the south, Thailand in the west, Myanmar in the northwest, and China in the north, mountain landscapes span hundreds of kilometers, making international trade with Vietnam and China economically and traditionally unfeasible. Navigating through the Mekong River southwards to Cambodia and then to Vietnam to the sea is impossible because of more than 20 m of high waterfalls spanning more than tens of kilometers. Therefore, Thailand remains the de facto gateway for international trade in Laos.[1] Although the Mekong River accounts for only approximately half of the border with Thailand, all four major cities in Laos are located on its eastern bank. Therefore, international and domestic Mekong bridges are prerequisites for on-land access to the nearest seaport near Bangkok, the capital of Thailand, for foreign firms located in major cities in Laos.

Foreign firms in developing countries rely on importing locally unavailable inputs and exporting processed or final products to foreign markets. Thus, the Mekong Bridge is critical for foreign firms in Laos, which rely on cross-border logistics. Four Mekong international bridges between Laos and Thailand were constructed and opened for traffic in 1994, 2006, 2011, and 2013 (Fig. 2). The first international bridge between Laos and Myanmar was constructed in 2015. The fifth international bridge between Laos and Thailand will be under construction by 2022. The sixth international bridge between Thailand and Laos is in the advanced planning stage, and discussions on the seventh international bridge are reported to have started. Concurrently, Laos opened again to FDI, especially from the Western world, at the end of the 1980s, as part of the transition from a stagnant centrally planned to a market-oriented economy. According to the second economic census held in 2013, approximately 1,500 active foreign firms could be categorized into ten industrial activities in nearly 140 districts in Laos.

[1] However, this situation is changing rapidly with the development of international freight trains that started services on the Lao-Chinese railway in December 2021.

Figure 2. Location of Foreign Firms and the four Mekong Bridges in Laos in 2013



Source: Authors' compilation based on Economic Census 2013 (Ministry of Planning and Investment) and Global Administrative Unit Layers (FAO).

Notes: LSIC is the Laos standard industrial classification. The circles denote the number of firms, where the largest is Max for each LSIC. The plus signs denote the locations of the Mekong Bridge. CN, China; KH, Cambodia; MM, Myanmar; TH, Thailand; VN, Vietnam. B1: First International Mekong Bridge, B2: Second Internal Mekong Bridge, B3: Third International Mekong Bridge. BD1: First domestic Mekong Bridge.

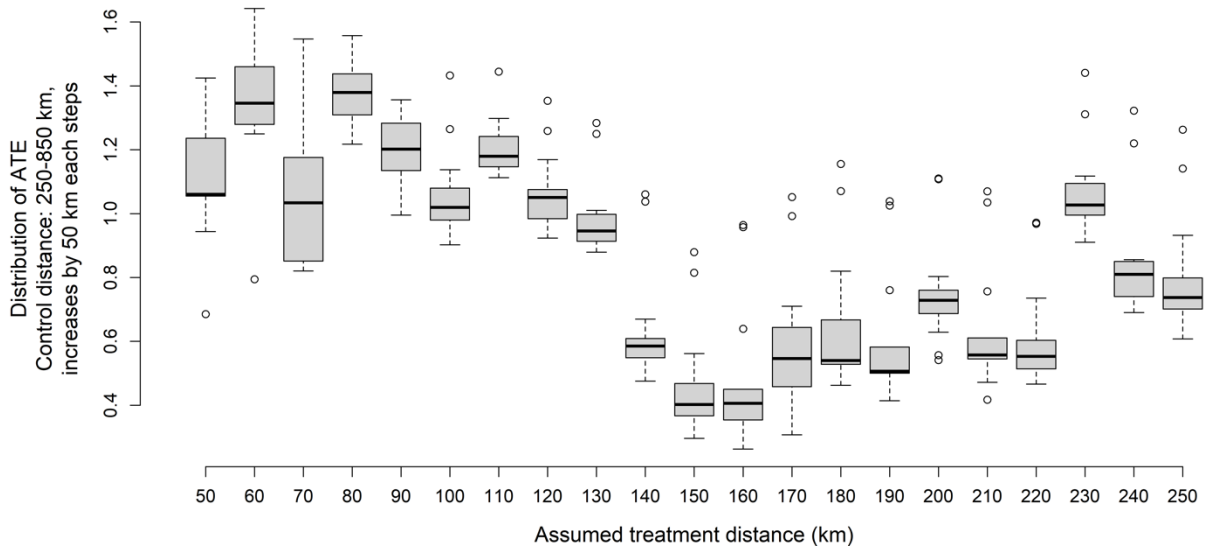
This study identifies the impact of a particular cross-border infrastructure in Laos, a land-locked country, on FDI inflow. Regional statistics, preferably at a lower level, such as districts, are necessary for such studies. However, obtaining time-series data from the district remains very difficult in Laos. In this study, we attempt to overcome these data limitations by generating a set of proxies for district statistics from Earth observation data acquired through satellites. We applied Causal Forest, a machine-learning framework proposed by Wager and Athey (2018), to the data to address endogeneity issues by controlling for district characteristics such as the size of economic activities, locations, accesses, land area, land cover types, and many others.

Although a machine constructs the model using the data, in causal inference with causal forests, a human must still instruct the machine on what the treated and controlled samples are. In contrast to medical trials or subsidies to low-income households, identifying the treated samples is not straightforward. In our case, we do not know which district would benefit from the bridge and therefore be considered a treated sample. We address this

problem by constructing causal trees to vary the assumed treated and controlled samples. We consider a district to be treated if it was within 50 km of the nearest bridges. Then, we increase the distance by 10-km away from the bridge up to 250 km. In contrast, we set the control districts within 250 km by road distance from any completed bridge for each set of controlled districts. The boundary of the control distance increased by 50 km to 850 km from the bridge.

Fig. 3 shows that the median ATE (Average Treatment Effect) varies around 1 and 1.3 for the assumed treated distance of up to 70 km. Note that one means one foreign firm per district per year given our spatial and temporal units of analysis. With some fluctuation, we see that the predicted treatment effect starts at approximately 1 and decreases to 0.4 within 160 km from the bridge. Because transport costs exist, it is intuitive that the treated impact of a bridge declines with distance. The predicted treatment effect rebounded to approximately 0.8 towards 250 km, which may arise from factors other than bridges.

Figure 3. Results by Varying Assumed Treated and Controlled Distances



Source: Authors' computation.

Notes: In this figure, we depict the ATE by changing the range of the treated districts every 10 km by road away from the bridge, starting at 50 km. The control groups were districts with road distances between 250 km and 850 km, increasing by 50 km at each step.

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