# Economic Development in Myanmar's Border Regions: Evidence from Nightlights *

Marius Brülhart[†] Bernhard Nöbauer[‡] Melise Jaud[§]

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**Abstract**

We study the evolution of nightlights in Myanmar's border regions between 2013 and 2019, a period of pronounced trade liberalization. We find towns on busy border crossings with China and Thailand to have grown disproportionately, as did some towns further inland along border crossing road corridors. However, rural areas in border regions between the main towns did not seem to to benefit from the increased trading opportunities, nor did locations situated off the main road corridors. Moreover, border regions with India even saw a reduction in average nightlight intensity, and light growth on the foreign side of border crossings was generally more pronounced than on the Myanmar side. Our findings suggest that political tensions and other constraints might be preventing Myanmar border-region populations from benefiting from the opportunities of cross-border trade.

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[†] University of Lausanne and CEPR. Address: Department of Economics, Faculty of Business and Economics (HEC Lausanne), 1015 Lausanne, Switzerland; email: marius.brulhart@unil.ch.

[‡] University of Lausanne. Address: Department of Economics, Faculty of Business and Economics (HEC Lausanne), 1015 Lausanne, Switzerland; email: bernhard.nobauer@unil.ch.

[§] World Bank. Washington DC, United States; email: mjaud@worldbank.org

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# 1 Introduction

Over the last decade, Myanmar has taken great strides towards opening up its economy to international trade. Merchandise trade as a share of GDP increased from 27% in 2010 to over 50% in 2018. Myanmar's exports diversified away from raw materials (especially natural gas) into industrial goods and consumer products. The stock of inward FDI increased from USD 14bn to USD 31bn over the same period. These developments were accompanied by an increase of GDP per capita from USD 850 to USD 1'310. While causation could run in either direction, it seems highly plausible that at least some of Myanmar's income growth is due to its economy's increased integration into global value chains.

The opening-up of Myanmar's economy was a deliberate policy strategy. Export taxes were lowered and export and import licenses were eliminated for a wide range of goods. Import tariffs are relatively low in international comparison, with an average applied tariff of less than 5% and a maximum tariff rate of 40%. The Myanmar government also overhauled its legislation to support private investment domestically and from abroad.

In this note, we explore to what extent the opening of cross-border economic relations has helped to promote economic activity in Myanmar's border regions. Border regions in Myanmar are both less economically developed than the country's lowland and urbanized interior, and they are prone to violent conflict (Bissinger et al. (2020)). Recent spatial general equilibrium economic models as well as evidence from a number of countries suggest that one effect of opening trade may be to stimulate economic activity in hitherto less developed regions in the proximity of international borders. The aim of the research reported here is to explore whether and in what precise way this phenomenon can also be observed in the case of Myanmar. As a proxy measure for economic activity we resort to fine-grained satellite readings of night-light intensity – a by now widespread tool for analysing the spatial economy in the presence of otherwise sparse data.

Our note is structured as follows. In Section 2, we present our data and estimation methods. Section 3 describes the geographic distribution of economic activity in Myanmar. The core of our analysis is Section 4, in which we document how light gradients in border regions have evolved since Myanmar's opening to trade. Section 5 concludes.

# 2 Data and Methodology

## 2.1 Nightlight Data

Nightlight data can serve as a proxy for economic activity. Levels and changes in nightlight intensity have been shown to be highly correlated with local incomes. For countries in which official statistics about economic activity are scarce or imprecise, nightlight data can offer remarkably precise estimates. (Henderson et al. (2012); Tilottama et al. (2010)) Moreover, nightlight data are available at a very fine geographical scale. This allows us to evaluate spatially heterogeneous effects.

The collection of nightlight data started as a byproduct of measurements by meteorological satellites. In recent years, there have been technological advancements, in particular with regard to the precision and storage capacity of these satellites. This offers more precise data for the more recent years, but it significantly complicates comparisons of measurements before and after changes in the measurement technology.

Specifically, from 1992 until 2013, satellite readings were produced using the *Defense Meteorological Program (DMSP) Operational Line-Scan System (OLS)*.[1] The grid cells underlying these measurements had a resolution of about one square kilometer. Nightlight values were reported as integers, ranging from 0 to 63. The top coding at 63 does not allow to distinguish different light intensities in the brightest places, typically in major cities.[2] Over the years, different satellites were used. As these satellites lacked onboard calibration, there might be differences in the overall level of nightlight intensity across different years (Henderson et al. (2012); Elvidge et al. (2009)). This should, however, affect all areas within Myanmar in a similar fashion.

Since 2012, nightlight data have been collected using the new *Visible Infrared Imaging Radiometer Suite (VIIRS) Day/Night Band (DNB)* technology, with 2013 being the first year for which we have full coverage.[3] With this current technology, data are available in even finer resolution, with grid cells measuring about 420m in length and width.[4] The current system collects data on a continuous scale and without top coding. Onboard calibration allows for a meaningful comparison across years (Elvidge et al. (2017); Shi et al. (2014); Chen and Nordhaus (2015)). For our years of interest (2013 and 2019), the data are reported as monthly averages. In order to obtain annual values, we computed averages of the monthly files, weighted by the amount of cloud free observations per month.[5]

## 2.2 Border Crossings and Road Data

With the grid cells of the nightlight data as our units of observations, we need a way of categorizing those units in terms of their proximity to the border. A simple solution would be to consider the geodesic distance of each grid cell to the closest point at the border. This, however, would ignore the realities of topography and transport infrastructure. We therefore define proximity to the border as the road distance to border-crossing points.

We take our road data from the *Myanmar Information Management Unit (MIMU)*.[6] In order to be able to process them with GIS software, we cleaned the file, mostly by connecting apparent gaps that obviously belong to the same road. Whenever possible, we validated our interpolations with Google Maps or ArcGIS basemaps.

From the Ministry of Commerce in Myanmar, we received two lists of border crossings. We refer to border posts that figure on one of those two lists as "major crossings".[7] Moreover, we manually verified all points at which a road intersects with a country border. This was done using Google Maps and ArcGIS basemaps. Whenever there is a road large enough to cross the border by car, we marked that point as a "minor crossing". We did not categorize points as minor crossings that involve water crossings without a visible bridge. It is not clear to what extent the border-crossing roads we identify correspond to legal border-crossing points. To the extent that the minor crossings are not in fact open to formal

[1] The data can be accessed at `https://eogdata.mines.edu/dmsp/downloadV4composites.html` (last accessed: 28.06.2020).
[2] This is a more severe problem when the focus of a study lies on variations within the bigger and richer urban areas of the world.
[3] For 2013, data were collected using both the old and the new satellite technology.
[4] Accessible via `https://eogdata.mines.edu/download_dnb_composites.html` (last accessed: 28.06.2020).
[5] For the year 2016, the data are available on an annual as well as on a monthly basis. Our aggregation method matches one of the annual composites.
[6] Data available at `http://geonode.themimu.info/layers/geonode%3Ammr_rdsl_250k_mimu` (last accessed: 28.06.2020).
[7] We dropped some border posts that are on the lists but are located far away from the border. This includes for example border posts and trading zones at sea ports.

cross-border traffic, they could nonetheless be used for informal trade. We perform all our analyses for the two categories of crossings combined, as well as for major crossings and for minor crossings separately.

| | Thailand | China | India | Bangladesh | Laos | Total |
|---|---|---|---|---|---|---|
| Major | 6 | 4 | 2 | 1 | 1 | 14 |
| Minor | 10 | 18 | 4 | 1 | 0 | 33 |
| All | 16 | 22 | 6 | 2 | 1 | 47 |

Table 1: Number of border crossings

Table 1 shows the number of crossings identified in our data, per category and neighbor country. Figure 1 shows the geographical location of these crossing points, as well as the road network that we use to measure the distance from a grid cell to the nearest crossing.

Our analysis focuses on border regions along road corridors, defined as grid cells located within 10 kilometers from a road and within 200 kilometers from the nearest border crossing, along that road (following Brülhart et al. (2019)). Grid cells are matched to the border post they are closest to (road distance). Figure 2 shows the grid cells that fulfill these criteria. They are located along road corridors that connect border crossings with the interior of the country.

Table 2 provides summary statistics on our basic lights data. We consider a total of 988,700 grid cells. The overwhelming majority of those grid cells (94% in 2013 and 88% in 2019) were essentially dark, which we define as having a light intensity below 0.25. In the last two columns of Table 2, we compute average distances to the nearest border crossing for grid cells in each nightlight interval. Interestingly, the average distance to the border of the most brightly lit grid cells (nightlight intensity $> 2$) increased over our sample period. This is *prima facia* evidence against the hypothesis that trade liberalization has attracted economic activities towards the borders.

| | # Observations | | Mean Distance[a] | |
|---|---|---|---|---|
| Nightlight Intensity | 2013 | 2019 | 2013 | 2019 |
| Smaller than 0.25 | 925,882 | 868,143 | 109.89 | 110.44 |
| Between 0.25 and 0.5 | 40'036 | 90,611 | 111.35 | 105.66 |
| Between 0.5 and 1 | 15'573 | 20,037 | 110.05 | 107.11 |
| Between 1 and 2 | 4'906 | 5,842 | 109.26 | 112.50 |
| Between 2 and 5 | 1'906 | 2,683 | 110.74 | 114.61 |
| Larger than 5 | 397 | 1,384 | 95.34 | 99.52 |
| Total | 988,700 | 988,700 | 109.94 | 109.94 |

a) Mean Distance = average(road distance to border + geodesic distance to road) in kilometers

Table 2: Grid cells

Additional descriptive statistics are provided in Table 3, where we report average nightlight intensities of grid cells along road corridors to different neighboring countries. In panel (a) of Table 3, we report averages across all grid cells, and in panel (b) we show averages only across grid cells that were not essentially dark across both sample years (i.e. with a nightlight intensity of $> 0.25$ in both years). We see that Myanmar has on average got brighter, consistent with economic growth. When we focus on the 'non-dark' grid-cells summarized in panel (b), we find that border regions with Bangladesh experienced the strongest increase in night lights, followed by those with China and those with Thailand. Border

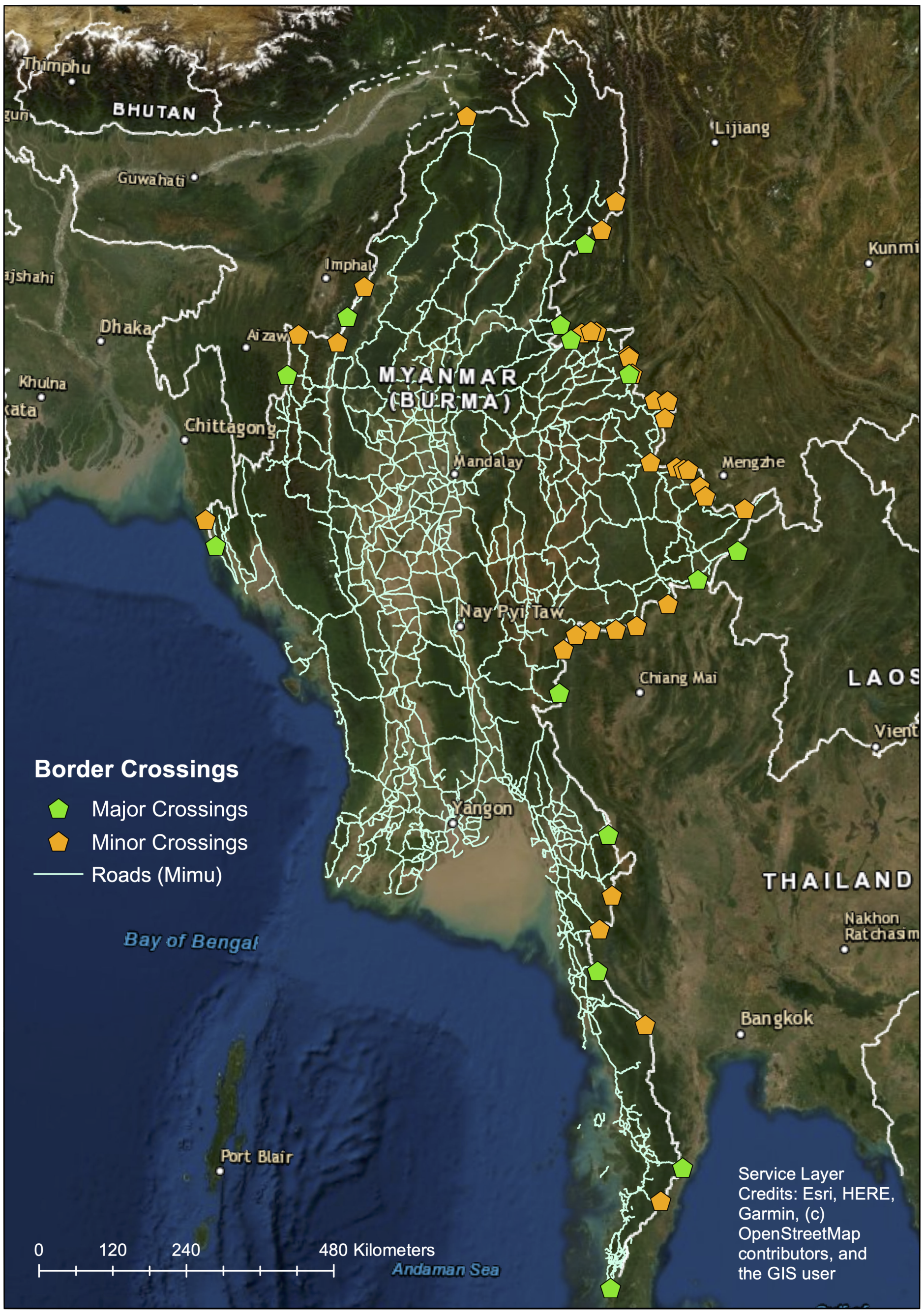
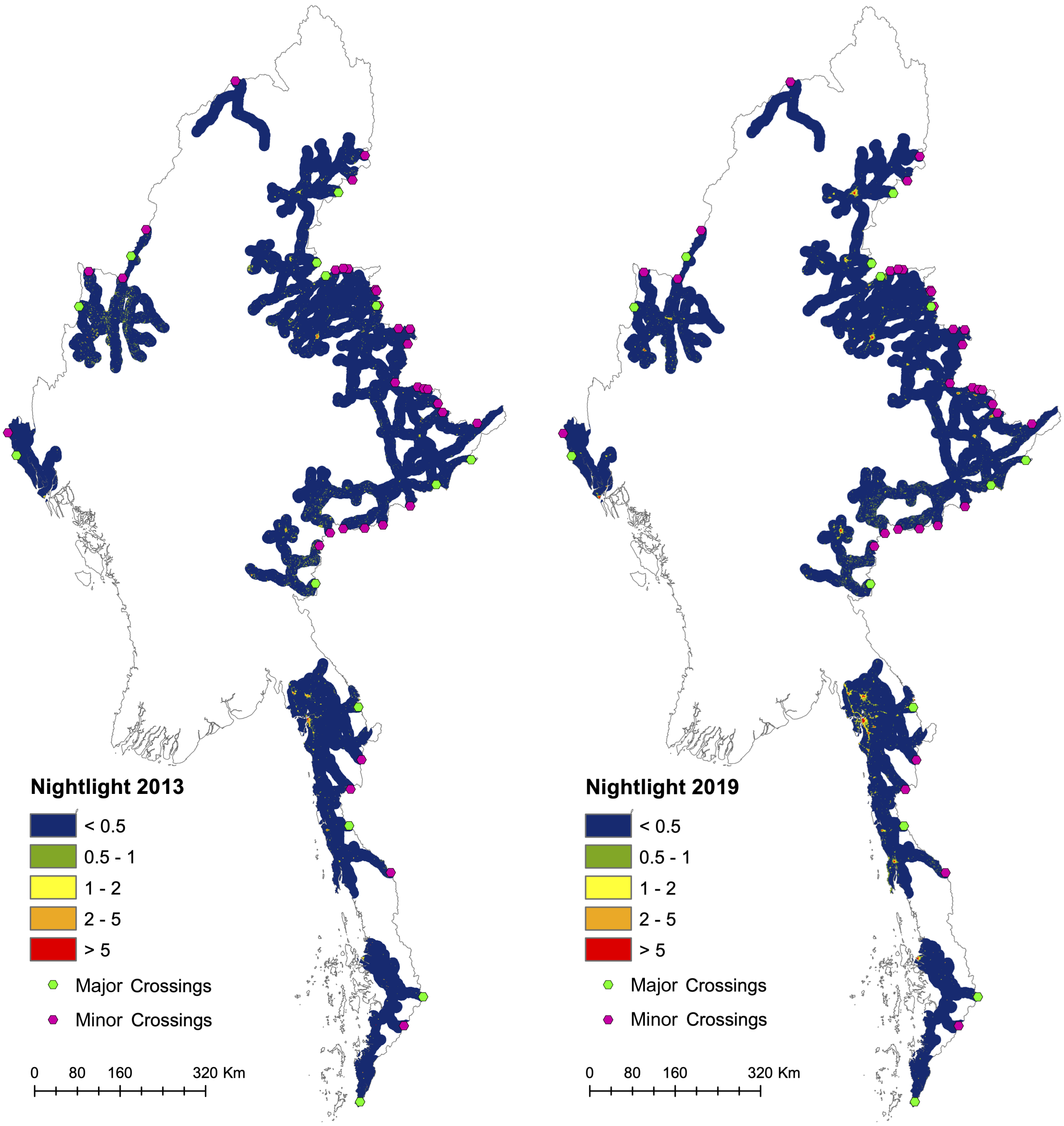



Figure 1: Border crossings




(a) 2013 (b) 2019

Figure 2: Myanmar's border-region road corridors

Source: VIIRS vcm annualized. Earth Observation Group, Payne Institute for Public Policy.
Notes: "Major Crossings" indicate customs posts as communicated by the Myanmar authorities. "Minor Crossings" indicate border-crossing roads as visible on Google Maps. Nightlight is measured on a continuous scale. Within the border road corridors that we study, the brightest grid cell in 2013 has a nightlight intensity of 37.09, while in 2019, the brightest intensity is 96.15.