5
INFRASTRUCTURE
Beyond boosting growth, investment in infrastructure helps to improve equality of opportunity. Major infrastructure upgrades boost economic activity. Significant coordinated investment in highways across Turkey in the 2000s, for example, led to a major increase in both exports and domestic trade between provinces. Crucially, once more remote and economically disadvantaged regions became better connected to the rest of the country, outward migration from these areas declined and employment increased, as inter-regional infrastructure connections helped to create job opportunities locally.
As middle-income economies develop, certain policies can simultaneously boost their growth prospects and strengthen equality of opportunity among their residents. For instance, improving infrastructure connections to relatively disadvantaged regions can boost trade, both domestically (between regions) and internationally.

Transport is the largest beneficiary of infrastructure investment in both middle-income economies and advanced economies.\(^1\) Transport links play a vital role in modern market economies, facilitating domestic and international trade, enabling the smooth functioning of global value chains and maintaining the economic rhythm of modern cities. A number of studies document the sizeable impact of improvements in transport infrastructure on economic development, spanning various projects in a number of countries, including the introduction of the US interstate highway system and the construction or surfacing of roads in middle-income countries.\(^2\)

This section illustrates the impact of infrastructure on economic growth and inclusion by drawing on a study of large-scale, coordinated upgrades to Turkey’s road infrastructure.

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1 See EBRD (2017).

2 See, for example, Limao and Venables (2001), Duranton et al. (2014), Allen and Arkolakis (2014) and Faber (2014).
undertaken in the 2000s.\textsuperscript{3} The study finds that the trade effects of infrastructure upgrades can be large. Moreover, as economic opportunities improve in regions that used to be poorly connected, local employment rises and outward migration declines, contrary to the common assumption that better transport links facilitate an exodus from less developed regions.

While Turkey’s road infrastructure was substantial prior to these upgrades, the country’s road capacity had long been considered inadequate. In 2005, Turkey’s 81 provincial centres were connected by an extensive paved road network (see thin lines in Chart 5.1). However, dual carriageways (divided multi-lane highways and expressways) made up only a small percentage of that network (see thick lines in Chart 5.1).

Consequently, the Turkish authorities launched a large-scale public investment programme in 2002 “to ensure the integrity of the national network and address capacity constraints that lead to road traffic accidents”.\textsuperscript{4} That investment programme resulted in a significant percentage of existing single carriageways (undivided two-lane roads) being turned into dual carriageways. By 2015, numerous arterial routes had been upgraded (see Chart 5.2) and the share of inter-provincial dual carriageways had risen to 35 per cent from 10 per cent in 2002 (see Chart 5.3).

In this section of the report, we analyse the extent to which this major increase in road capacity has affected Turkey’s domestic trade and regional economic outcomes. High transport costs impede market access in isolated regions, both in terms of firms’ ability to reach out to potential customers and to buy the production inputs they need. Thus, investment in transport infrastructure can improve growth prospects by facilitating both domestic and international trade. Coşar and Demir (2016), for instance, report that improvements made to Turkey’s transport infrastructure in the 2000s significantly enhanced international market access for Turkish regions located a long way from the country’s ports.

But what were the overall trade gains as a result of the improved roads? To answer this question, we first measure the impact of infrastructure upgrades on travel times between each pair of provinces and then link changes in travel times to changes in regional income levels, employment and migration patterns.

**UPGRADES TO THE ROAD NETWORK HAVE GREATLY IMPROVED TRANSPORT OUTCOMES**

While dual carriageways account for slightly more than a third of Turkey’s total road stock, around 80 per cent of total traffic is estimated to use dual carriageways.\textsuperscript{5} Spending on road upgrades from 2003 to 2010, when the bulk of the investment was undertaken, totalled US$ 12.7 billion (in constant 2010 prices), or 1.7 per cent of Turkey’s 2010 GDP. Following the upgrades, road safety improved greatly, with the number of annual fatalities per kilometre travelled declining by 62 per cent as of 2015.

The increase in road capacity has allowed vehicles to travel more consistently at higher speeds, reducing accident rates and making arrival times more predictable. The average travel time between pairs of cities has been reduced by 1.5 hours (see Chart 5.4), from 6.5 hours in 2005 to five hours in 2015.\textsuperscript{6}

\textsuperscript{3} The analysis in this section is based on Coşar et al. (forthcoming).

\textsuperscript{4} See GDH (2014).

\textsuperscript{5} See Grand National Assembly of Turkey (2016).

\textsuperscript{6} See EBRD (2017) for details of these calculations.
The time savings are larger for cities located further apart – as much as five hours in the case of cities separated by a road distance of 1,500 kilometres or more.

**TRANSPORT AND DOMESTIC TRADE**

In this section, we explore the impact that these time savings have had on trade within Turkey. We use firm-to-firm transaction data provided by the Turkish Ministry of Industry, based on value added tax (VAT) declarations by Turkish firms. Bilateral trade flows between provinces have been constructed by aggregating the data on sales and purchases provided by individual firms.\(^7\) Information on the road network is taken from the official road maps published by the Turkish General Directorate of Highways for 2005 and 2015. The digitised maps of single and dual carriageways shown in Charts 5.1 and 5.2 have been used to calculate the fastest possible routes between the 81 provincial centres using geographic information system (GIS) software. Data on provincial employment are from the Ministry of Industry, while migration data and information on provincial income per capita are from the Turkish Statistical Institute.

We would expect the reduced travel times resulting from the improvements made to Turkey’s transport infrastructure in the decade to 2015 to have increased bilateral domestic trade flows between the Turkish provinces. The impact is estimated using the gravity model of trade, which relates changes in the volume of bilateral trade to changes in the economic size of trading partners and changes in the cost of bilateral trade (see Annex 5.1 for details).

Based on the results in Annex 5.1, a one-hour reduction in travel time between two provincial centres increases bilateral trade between those provinces by about 6 per cent. This effect is highly statistically significant and translates into an increase of US$ 4.6 million per annum in trade flows for a typical pair of provinces.

This corresponds to a fairly large return on Turkey’s investment. To see why, consider a hypothetical route the length of the average distance between the various pairs of cities. Assume that all 755 kilometres of this route was on an undivided single-carriageway road in 2006, resulting in a total travel time of approximately 12 hours. To reduce this travel time by one hour, around 30 per cent of the route (234 kilometres) would need to be transformed into a divided dual carriageway, at an estimated cost of US$ 26 million per year for 10 years (based on figures reported by the Turkish authorities). The ratio of the increase in annual trade flows to the estimated per annum cost of upgrades is 0.18 implying that US$ 1 of investment in roads generates an extra US$ 0.18 in annual domestic trade between a pair of provinces. In addition, road upgrades bring about other benefits, such as increased international trade, fewer traffic-related fatalities and reductions in travel costs.

**IMPACT ON INCOME, EMPLOYMENT AND DOMESTIC MIGRATION**

We now investigate the impact of the road improvements on provincial income, employment and domestic migration. First, we look at whether provinces in geographical regions that have experienced greater improvements in market access as a result of better roads have also posted stronger (nominal) income growth.\(^8\) We measure improvements in market access by calculating an average of the reduction in travel times experienced by a province when selling goods/services to other provinces, weighted by the GDP of its trading partners (see Annex 5.1 for details).

Improvements in market access tend, on average, to be associated with stronger income growth, although the effect is not statistically significant. Estimates obtained separately for each quintile of the distribution of improvements in market access do not show statistically significant effects either. This is consistent with earlier findings on provincial income growth in China.\(^9\)

However, improvements in domestic market access have a positive impact on regional employment (see Chart 5.5). A one-hour reduction in average travel times from one provincial centre to other provincial centres in Turkey increases employment in that province by 0.6 per cent. With 22 of Turkey’s 81 provinces (accounting for 4.5 per cent of initial employment) seeing average time savings of one hour or more, the impact on regional job opportunities is substantial. Furthermore, in the poorly connected provinces that saw the greatest improvements in market access, the estimated impact on employment is 40 per cent above the average, equivalent to about 0.9 percentage points.

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\(^{7}\) See EBRD (2017), Chapter 3.

\(^{8}\) Turkey is divided into seven geographical regions, each made up of multiple provinces: Aegean, Black Sea, Central Anatolia, Eastern Anatolia, Marmara, Mediterranean and South-eastern Anatolia.

\(^{9}\) See Banerjee et al. (2012).
CHAPTER 5 INFRASTRUCTURE

CHART 5.6. Road infrastructure upgrades prompted a decline in emigration from previously poorly connected regions between 2007 and 2015

Change in immigration (per cent)

Quintiles 2 to 5 of the distribution of weighted time savings

Estimate

90 per cent confidence interval

Source: GDH, Turkish Statistical Institute and authors’ calculations.

Internal migration is one of the channels that could potentially lead to employment gains in hitherto poorly connected provinces. Indeed, we find that improved connectivity is associated with large reductions in outward migration from such regions (see Chart 5.6, right-hand panel). The impact on outward migration is particularly pronounced in the 40 per cent of regions with the largest amounts of travel time saved.

This suggests that better road links create employment opportunities that slow the depopulation of poorly connected regions. In contrast, there is no statistically significant evidence of any effect on inward migration (see the left-hand panel of Chart 5.6) or labour-force participation. This suggests that local job creation in response to the road improvements and the curbing effect this has had on outward migration are the main reasons for the change in employment patterns.

In sum, then, better infrastructure can help to enhance the economic prospects of underperforming regions. The objective of improving livelihoods in less developed regions tends to be high on policymakers’ agendas in both middle-income and advanced economies. Regional policy, for example, is the single largest item in the European Union’s (EU) budget for 2014 to 2020 (€352 billion, or around one-third of the total).\(^\text{10}\)

A significant percentage of those funds is allocated to transport infrastructure, “for the proper functioning of the internal market and for facilitating the circulation of people and goods within and beyond the EU”\(^\text{11}\) and to spur “growth in sparsely populated areas and the outermost regions of the EU.”\(^\text{12}\) Evidence from Turkey, a large country with sizeable spatial income differentials, suggests that such policies can be effective in facilitating regional convergence, thus improving equality of opportunity across the economy.

BUILDING SUSTAINABLE CITIES TO FACILITATE ECONOMIC AGGLOMERATION

While we have focused here on improvements in inter-city transport infrastructure, municipal infrastructure (water, wastewater, refuse collection and recycling, urban transport) is another example of long-term investment that can boost growth and equality of opportunity. Such infrastructure helps to create sustainable cities, shaping a country’s environmental footprint and people’s livelihoods for centuries to come.

High-quality urban infrastructure supports economic clustering, enabling the greater agglomeration of people and firms within commuting distance of an economic centre. Clustering plays a major role in supporting the development of many sectors of an economy, as it increases the size of the markets to which firms can sell their goods and ideas and broadens the pool of talent from which they can recruit.\(^\text{13}\)

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13 See EBRD (2018).
ANNEX 5.1
REGRESSION ANALYSIS

BILATERAL TRADE AND TRAVEL TIMES
The calculation of the long-term growth rate of bilateral domestic trade flows between 2006 and 2015 takes the large increase in the extensive margin into account – a situation where a trading relationship is established between provinces that had not traded with each other before. The mid-point growth formula defines change in trade between a source province \( s \) and a destination province \( d \) as

\[
\text{Change in Trade} = \frac{\text{Trade}_{sd}^{2015} - \text{Trade}_{sd}^{2006}}{\text{Trade}_{sd}^{2006}}
\]

where \( \text{Trade}_{sd}^{2015} \) and \( \text{Trade}_{sd}^{2006} \) denote the values of trade between the source province and the destination province in 2015 and 2006, respectively. This measure is constrained between -2 and 2. Less than 3 per cent of the well-defined pairs of provinces for which the ratio is calculated exhibit declines in bilateral trade between 2006 and 2015.

Our initial analysis of bilateral trade between provinces employs a gravity-type model using changes in trade flows (first-difference regression). In this regression, the dependent variable is the growth rate of bilateral domestic trade flows between Turkish provinces from 2006 to 2015. The savings on travel times between pairs of provinces are the independent variable. First-difference estimation eliminates all time-invariant characteristics of the source province and the destination province. It also eliminates pair characteristics that affect bilateral trade, such as the distance between provincial capitals, and takes into account province-level characteristics that affect changes in trade in each province (with \( c_s \) and \( c_d \) representing fixed source and destination effects, respectively):

\[
\text{Change in Trade}_{sd} = \beta_0 + \beta_1 \text{Time Savings}_{sd} + c_s + c_d + \epsilon
\]

Standard errors are clustered at the source and destination levels (two-way clustering).

To test for non-linear effects, the continuous variable for time savings in equation (1) is replaced by indicator variables for each quintile of its distribution. Estimates are obtained in respect of trade flows within provinces (the omitted category). The results are reported in Table A.1 (column 1).

EXTENSIVE MARGIN OF TRADE
To examine the effect of road upgrades on the establishment of new trade links, a similar relationship is estimated for the probability of observing positive trade effects on a pair of provinces in 2015, where the pair had conducted zero trade in 2006. The results (reported in column 2 of Table A.1) are qualitatively similar to those obtained for increases in trade volumes.

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### TABLE A.5.1.1. Results of regression analysis

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Change in bilateral trade flows, 2005-15</th>
<th>New trade links in 2015</th>
<th>Change in GDP per capita</th>
<th>Change in employment</th>
<th>Change in immigration</th>
<th>Change in emigration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time savings (hours)</td>
<td>0.061*** (0.011)</td>
<td>0.072*** (0.010)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time savings weighted by GDP</td>
<td></td>
<td></td>
<td>0.001 (0.001)</td>
<td>0.006* (0.003)</td>
<td>0.001 (0.002)</td>
<td>-0.003* (0.002)</td>
</tr>
<tr>
<td>Fixed effects</td>
<td>Source and destination</td>
<td>Source and destination</td>
<td>Region</td>
<td>Region</td>
<td>Region</td>
<td>Region</td>
</tr>
<tr>
<td>No. of observations</td>
<td>5,781</td>
<td>6,561</td>
<td>81</td>
<td>81</td>
<td>81</td>
<td>81</td>
</tr>
<tr>
<td>R^2</td>
<td>0.217</td>
<td>0.222</td>
<td>0.169</td>
<td>0.461</td>
<td>0.089</td>
<td>0.190</td>
</tr>
</tbody>
</table>

Source: GDH, Turkish Ministry of Industry, Turkish Statistical Institute and authors’ calculations.
Note: All regressions are estimated using ordinary least squares. Robust standard errors with two-way clustering at the source and destination provincial level are indicated in parentheses. *, ** and *** denote values that are statistically significant at the 10, 5 and 1 per cent levels, respectively.

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14 See Davis et al. (1996).
DELVING DEEPER: INCOME GROWTH, EMPLOYMENT AND MIGRATION

In the next section, we look at whether provinces that experienced greater improvements in market access as a result of upgrades to roads also recorded stronger income or employment growth. We also assess whether patterns of domestic migration to and from these provinces were different. Improvements in market access at the province level are measured by calculating a weighted average of the reductions in travel times experienced by firms in a given province when selling goods to customers in other provinces. The time savings for each province $s$, trading with a destination province $d$, are weighted on the basis of destination provinces’ GDP figures for 2005, as follows:

$$ WTimeSaving_{sd} = \sum_{d=1}^{n} \frac{GDP_{d,2005}}{TimeSaving_{sa}} $$ (3)

The following equation is estimated for each outcome variable (such as income growth or migration flows):

$$ Change[OUTCOME]_s = \delta_0 + \delta_1 WTimeSaving_{sa} + \alpha_s + \epsilon_s $$ (4)

where $\alpha_s$ denotes fixed effects at regional level (aggregating multiple provinces).

Non-linear effects can be examined using a set of quintile indicator variables for the distribution of weighted time savings, as in the previous exercise. Data on provincial labour-force participation are only available for 2008 to 2013 and this analysis fails to find any impact on labour-force participation as a result of changes in market access. As data on bilateral migration flows are not available, this analysis uses data on changes in population flows in and out of each individual province. The results are reported in Table A.1, columns 3 to 6.

A ONE-HOUR REDUCTION IN THE AVERAGE TRAVEL TIME BETWEEN ONE TURKISH PROVINCIAL CENTRE AND ANOTHER INCREASES EMPLOYMENT IN THE PROVINCE BY 0.6%