Roadways and Nepal's Economic Transformation, 1971–2011

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Draft Version: 30 October 2026

Abstract

I examine how employment shifted away from agriculture as Nepal's road network expanded between 1971 and 2011. I combine five censuses covering 74 districts with reconstructed transport networks, including highways, tracks, trails and connections through India and to Indian markets. First highway arrival is associated with a 4.87-percentage-point increase in the share of employment outside agriculture among 41 later-connected districts, mainly in the hills and mountains. Employment trends differed before connection, limiting how confidently this increase can be attributed to roads. Across all 74 districts, improvements in access to markets have a negative but imprecise association with growth in this share over each decade. Differences in market access narrowed, while percentage-point gaps between districts in employment shares outside agriculture widened.

JEL codes: O12, O15, O18, R12, N75.

1 Introduction

Modern roads are not mere paths. They come slowly and unevenly, but once built, they change how people reach markets and one another. In Nepal, road building carried the expectation that development could reach places long separated from the country's economic centers (Rankin et al., 2017). This paper asks how district employment changed as that network expanded between 1971 and 2011. Better transport can make production viable in places that had been difficult to reach, while also exposing local producers to competition from established centers. Cheaper journeys are a gain in themselves, but they need not bring the same changes in employment to every place the network reaches.

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I find that first highway arrival is associated with a 4.87-percentage-point increase in the nonagricultural employment share in the staggered DiD comparison. Broad manufacturing and services contribute nearly equally, at 2.43 and 2.44 points, mostly through manufacturing proper and personal and community services. In the decadal market-access comparison, a 10% increase in access is associated with about 0.10 percentage points less growth in the nonagricultural share, an imprecise estimate that changes little with the population basis used to measure markets. The nonagricultural pretreatment evidence does not support parallel trends, limiting the causal interpretation of the arrival estimate.

Road infrastructure is especially important in Nepal because settlements separated by steep hills, river valleys and mountains depended on slow and costly journeys to reach markets and public services. Nepal's national road network took shape relatively late compared with neighboring India, while difficult terrain and monsoon rains made its subsequent expansion slow and uneven (International Bank for Reconstruction and Development, 1965a; Rankin et al., 2017).

I reconstruct transport networks from 1961 onward and link them to employment in five censuses from 1971 to 2011, using 74 districts with harmonized boundaries. This record follows employment through decades of network expansion, including changes in manufacturing and services that a single nonagricultural total would conceal. Primary roads appear alongside the tracks and trails recorded in early maps, accounting for the costly connections districts already had before a highway arrived. The market-access measure also includes routes through the adjoining Indian plains and selected Indian destination markets, while the employment outcomes remain those of Nepal's districts.

For first highway arrival, I use staggered group-time difference-in-differences following Callaway and Sant'Anna (2021), comparing connected districts with those not yet connected and adjusting for development and access measured in 1971. Arrival is the preferred timing measure, with later completion providing supplementary information. I also relate employment-share changes to changes in market access over each census interval. Following Donaldson and Hornbeck (2016), I measure access by weighting destination populations by the cost of reaching them. A district's market access can continue to improve after its first highway arrives, through upgrades to existing roads or new connections elsewhere in the network.

Asher and Novosad (2020) find that new feeder roads reduce the agricultural employment share in Indian villages by about nine percentage points, with little accompanying expansion of employment in village firms. My 4.87-point nonagricultural estimate is smaller, but concerns highway arrival in districts over several census intervals, rather than village feeder roads observed on average four years after completion. In both settings, however, a shift in

residents' employment need not imply that jobs grew within the place itself.

Within Nepal, Jacoby (2000) and Shrestha (2020) study roads through agricultural land values and participation in markets, while Fafchamps and Shilpi (2003) examine the division of labor around towns. The closest historical comparison is Pokharel et al. (2021), who reconstruct intercity transport accessibility and relate it to city growth and regional development. I extend this history beyond the cities by following employment in districts whose connections often depended on tracks, trails and journeys through India before a highway arrived. The question here is how widely the movement out of agriculture extended as these districts became better connected. It places Nepal's road-building history within the study of structural transformation, without treating market integration and the spread of nonagricultural employment as the same process.

Section 2 describes the historical setting. Sections 3 and 4 present the data and empirical strategy, followed by the results in Section 5. Sections 6 and 7 discuss the findings and conclude.

2 Historical Background

2.1 Transport Before the National Road Network

Before the 1950s, public infrastructure was rather limited in Nepal. Hills, river valleys and mountains made journeys between nearby places costly, while the Terai opened more directly onto the Indian plains. People and goods moved along trails and trade routes on foot, by pack animal or by bullock cart. Local motor roads, short railways in the Terai and a freight ropeway into Kathmandu provided geographically limited exceptions (Consing, 1963; International Bank for Reconstruction and Development, 1965a).

These connections were also seasonal. The Fourth Plan described villages becoming isolated during the rains as landslides and floods interrupted travel, and still treated improvements to mule and foot tracks as necessary alongside road construction (National Planning Commission, Nepal, 1970). Even after highways began to arrive, journeys from the hills and mountains could combine a long walk with a motor road farther along the route.

Before reliable east–west connections, journeys between parts of Nepal could require travelling south through India and returning north (Consing, 1963). The Indian plains provided both transit routes between Nepali places and destination markets. A district could have access to a local border road long before it joined a highway corridor within Nepal.

2.2 Planning, Construction and Uneven Arrival

The fall of the Rana regime in 1951 changed the outlook toward public provision. Road building became one of the clearest expressions of the new government's presence, supported by foreign technical and financial assistance (Whelpton, 2005; Skerry et al., 1991). The Tribhuvan Highway established the first motorable connection from Kathmandu to the Indian plains in 1956 (International Bank for Reconstruction and Development, 1965a, p. 18). Slowly, development plans were charted, and transport became central to ambitions in agriculture, industry and public services. These ambitions survived the political reversal of 1960, when King Mahendra established the partyless Panchayat regime. The East–West Highway would link regions that had remained distant from one another (Rankin et al., 2017).

The Fourth Five-Year Plan outlined four development regions, with north–south growth axes following river basins and existing trade routes. Its hub-and-axis strategy would connect the distant hills and mountains to the towns of the Terai, with the East–West Highway linking the regions. Growth centers were expected to serve their hinterlands, with trade, labor and capital linking the hills and the plains (Rankin et al., 2017, pp. 64–67). In deciding where to build, the Plan sought to narrow regional disparities while concentrating limited resources in places with greater development potential, taking existing transport facilities into account (National Planning Commission, Nepal, 1970).

Construction often stretched over decades. A 1993 road-sector review identified 11 government-financed projects that had already continued for more than a decade and would require at least another decade at the prevailing funding rate (World Bank, 1993, p. 25). New connections also competed for funds with the repair and maintenance of existing routes. Initial motorable access could thus precede completion by many years, with further improvements needed to keep the road in use.

3 Data and Descriptive Evidence

3.1 Districts, Census Employment and Harmonization

Nepal was divided into 75 districts in 1961, and Jumla and Tibrikot were later restructured into Kalikot and Jumla. To account for their changing boundaries, I use 74 harmonized districts for 1971–2011. The further division of two districts in 2017 falls outside the study period. The five censuses provide 370 district-year observations.

Census records of Nepal are made available by the National Statistics Office, previously known as the Central Statistics Board. Despite a history of censal data collection in Nepal from as early as 1911 A.D., the first two census after the fall of the Rana rule, namely 1952-54

and 1961, don't contain the 74 or 75 district-level unit measurements. Hence, these can not be used for extensive pre-trends checks or to expand the study period.

Census harmonization across 1971–2011 requires several adjustments, beyond the inconsistent publication formats and layouts. Appendix Table A1 summarizes these issues and how I dealt with them.

For all 74 districts in each of the five censuses, the panel contains population totals, age-sex distributions, urban and rural populations, the urban population share, literacy counts and rates, economically active population, and employment by industry and sub-sector. Employment-status counts and shares distinguish employers, employees, the self-employed and unpaid family workers. The main outcome here is structural transformation, measured by the nonagricultural employment share:

$$E_{id} = L^A_{id} + L^M_{id} + L^S_{id}, \qquad s^{NA}_{id} = \frac{L^M_{id} + L^S_{id}}{E_{id}}, \tag{1}$$

where L^A_{id}, L^M_{id} and L^S_{id} are employment counts in agriculture, manufacturing (including mining and construction), and services, respectively, for district i in census period $d \in \{1971, 1981, 1991, 2001, 2011\}$. E_{id} is total employment classified in these three sectors, and s^{NA}_{id} is the share of that employment in nonagricultural activities.

These employment totals can be further divided into sub-sectors after harmonization. Broad manufacturing includes manufacturing proper, mining and quarrying, and construction. Services include electricity, gas and water utilities, commerce including hospitality, transport and communication, finance and business services, and personal and community services.

I obtain district mean elevation from the CGIAR hole-filled SRTM data, collected in 2000 and distributed at 30-arcsecond resolution (Jarvis et al., 2008). From the same grid, I calculate mean terrain ruggedness using the index of Riley et al. (1999). Rainfall is mean annual precipitation for 1931–1960, drawn from the Climatic Research Unit's CRU TS4.09 dataset at 0.5-degree resolution (Harris et al., 2020). I also use district area, calculated from the reference polygons in an equal-area projection, and the census classification of districts into Mountain, Hill and Terai (Central Bureau of Statistics, 2002, Table 1).[1]

3.2 First Primary-Road Connection: Extensive Margin

The Department of Roads records Nepal's roadbuilding history in its Statistics of Strategic Road Networks reports for 2004, 2017/18, 2020/21, and 2022/23. I focus on primary highways because they connect districts to national markets through long-distance, interregional travel.

[1]Terrain and rainfall are area-weighted district means.

Nepal's Road Standards distinguish these main arterial routes from feeder roads, which connect district and zonal headquarters to the highway network (Nepal Department of Roads, 2045 B.S., secs. 3.1.1–3.1.2). From these reports and supplementary historical sources, I construct two timing series: the arrival of a primary highway in a district and its completion. Arrival records the selected first highway-access year, which is based on documented best estimates and, in some cases, construction-start dates used as proxies. The completion year marks when construction, paving or other improvement works on the highway section serving the district were finished.[2]

For each series, I assign a district to the first census at or after the selected year. For example, a district receiving a road in 1986 enters the 1991 arrival cohort, and the completion cohort is assigned similarly using the completion year. The two series can therefore produce different treatment cohorts and comparison samples: across the 74 harmonized districts, the selected completion year falls an average of 8.0 years after arrival, with a median gap of 5 years. Using completion moves 46 of these districts to a later census cohort or beyond the 2011 study period.

I use arrival as the preferred definition of primary highway exposure, or the **Extensive Margin** of transportation improvement. Primary-road arrival could facilitate the government's presence in a district, as poor transport had long constrained the provision of public goods and services (Skerry et al., 1991). Using arrival also allows employment responses during the long construction period to enter the analysis. I present estimates around completion years as additional information.

3.3 Transport Costs and Market Access: Intensive Margin

3.3.1 Historical Networks and Travel Costs

To reconstruct transport costs for each census, I use the historical maps listed in Appendix Table A2. The SSRN reports are available only for selected years after 2000. Since the historical maps do not always coincide with the census dates, I use their recorded route status as an approximation of the corresponding census network, without separately adjusting each road section to its opening date. In particular, the maps used for 1981 and 2001 date from 1985/86 and 2004 (published in 2005), respectively, so these networks may include occasional additions or upgrades made after the census.

[2]Unfortunately, these dates do not represent the same physical stage in every district, although attempt has been made to standardize the arrival moment. Similarly, completion does not necessarily establish uninterrupted all-weather access as there are numerous instances of just-completed roads in dire repairs again. Comprehensive documentation regarding the arrival and completion year selections are available upon request.

I digitize the tracks and trails in the UN's 1961 map of Nepal and retain them in subsequent decades, accounting for stretches that were later upgraded. Later maps give these routes less attention, despite their importance for moving goods in a country where motorable roads were slow to arrive. Including them allows me to estimate least-cost travel and changes in market access even for districts that had yet to receive a primary road. Changes in these costs and access measures provide the **Intensive Margin** of transportation improvement.

Early motor services had limited reach as Nepal Transport Service began hauling freight between Kathmandu and Amlekhganj in March 1959 and introduced a daily bus service on the same route that July. At Amlekhganj, passengers could continue their journey by rail (Transportation History, 2022). A local bus service between Kathmandu and Patan followed in September of the same year (Agrawal and Koirala, 2021; Prajapati et al., 2025). Even in 1963, porters and pack animals remained the only means of transport in most of Nepal (Consing, 1963).

The IBRD's 1965 transport study reports average freight prices of NRs 1.3 per ton-mile by truck, NRs 4 by bullock cart and NRs 15 by porter (International Bank for Reconstruction and Development, 1965a, p. 20). I use these as benchmarks for primary roads, tracks and trails, respectively. To calculate route costs, I multiply each segment's length by its assigned transport-cost weight. I hold these relative weights fixed across census years, allowing costs to change as routes are added or upgraded, without imposing an unobserved change in freight rates. Normalizing porterage to one gives per-kilometre weights of approximately 0.0867 for primary roads, 0.2667 for tracks and 1 for trails. Appendix 8.3 gives the calculation and the assumptions behind this correspondence alongside other GIS configurations for the transportation network.

I extend the network into the adjoining Indian plains, incorporating major roads and railways used for journeys between parts of Nepal as well as travel to Indian markets.[3] Appendix Table A2 also lists the maps used for the India extension. For Indian roads, I retain earlier mapped routes as later maps add coverage and carry the 1991 reconstruction forward to 2001 and 2011. I reconstruct railways from each year's source, supplemented by historical links documented in the appendix.

Figure 1 shows the reconstructed Nepal–India networks used to measure extended-markets access at the beginning and end of the panel, along with the selected Indian destination

[3]Kathmandu had long served as an entrepot between Tibet and the Indian plains, although political changes in the mid-twentieth century disrupted its trans-Himalayan trade (Mulmi, 2022, ch. 1). Along the southern border, whose formation followed the Anglo-Nepalese War of 1814–1816, cross-border movement continued during Rana rule and long predated the 1950 treaty (Warner, 2014). Article 7 of the Treaty of Peace and Friendship granted reciprocal privileges concerning movement, residence and participation in trade and commerce, but it did not mark the beginning of these cross-border ties (Governments of India and Nepal, 1950, art. 7).

markets.

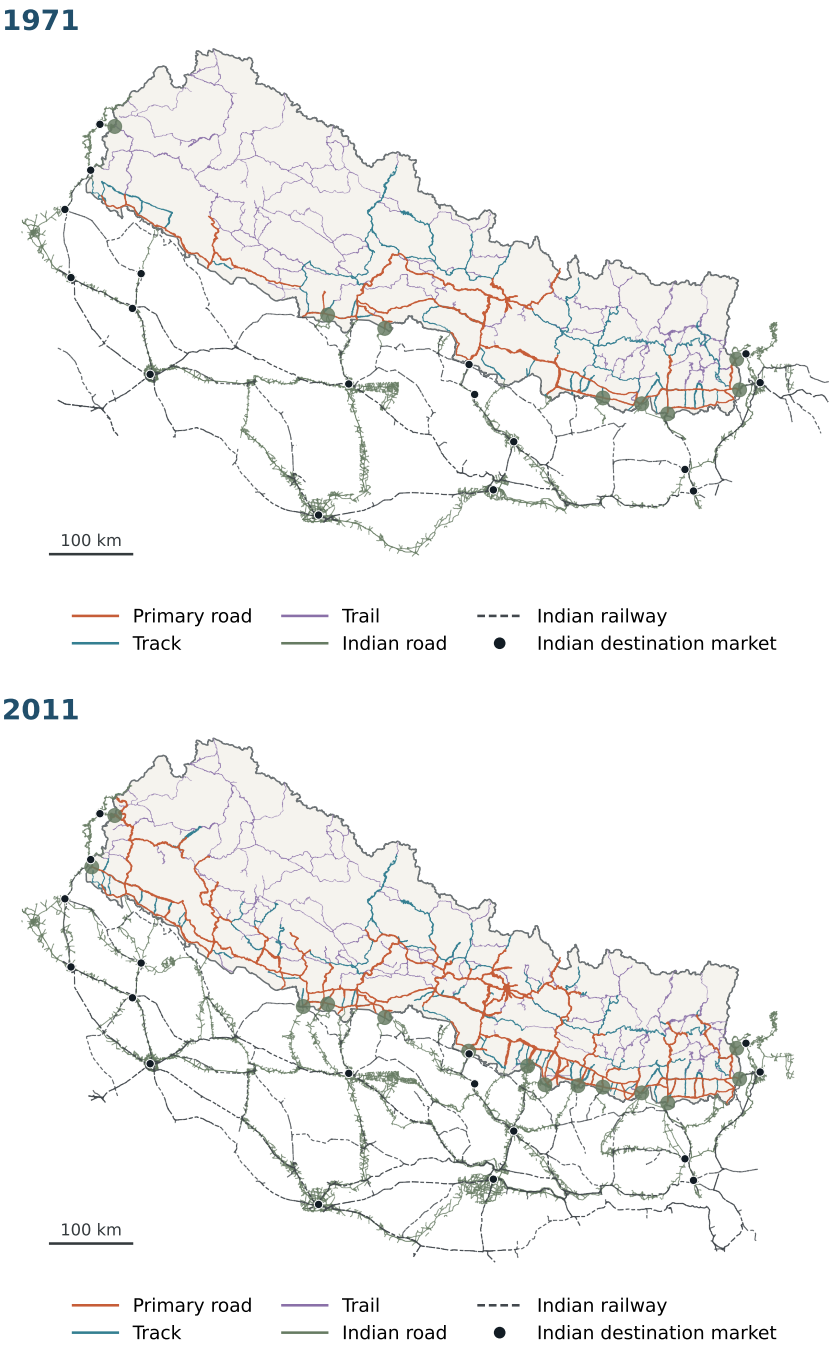


Figure 1: Reconstructed Nepal–India Transport Networks, 1971 and 2011

Notes: Nepal's national outline shown. Source-map dates are listed in Appendix Table A2.

3.3.2 Market Access

I measure each Nepal district's access to markets using the reconstructed transport networks in Nepal and the adjoining Indian plains. The main specification uses the extended-markets approach: Indian routes can facilitate travel between places in Nepal, and selected Indian towns and cities enter as additional destination markets. Employment outcomes remain restricted to Nepal's districts. I set additional border-crossing and road–rail transfer charges to zero as a benchmark, so the reconstructed costs reflect travel along the routes without these additional frictions. Following the market-access approximation in Donaldson and Hornbeck (2016), I sum destination populations, giving less weight to places that are costlier to reach:

$$MA_{id}^{b} = \sum_{j \in \mathcal{J}, j \neq i} P_{j,b} \left(1 + \frac{C_{ijd}}{c_0}\right)^{-3.8}, \qquad b \in \{1971, d\}. \tag{2}$$

where i denotes a Nepal district, j a destination and d the census period. The destination set $\mathcal{J}$ includes Nepal's districts and the selected Indian markets, and the sum excludes the origin itself. $P_{j,b}$ is destination population, held at 1971 levels when $b = 1971$ or measured contemporaneously when $b = d$. C_{ijd} is the normalized least monetary transport cost between i and j on the reconstructed Nepal–India network, and c_0 is the median positive interdistrict cost in the 1971 network restricted to Nepal, held fixed across years and population bases.[4] The parameter θ governs how sharply destination weights decline with normalized transport costs. I set $\theta = 3.8$, drawing on the earlier colonial Indian agricultural-trade estimate reported by Donaldson and Hornbeck (2016, p. 832, n. 55). Appendix 8.5 defines the alternatives that restrict network or destination coverage.

Holding destination populations at 1971 levels isolates changes in measured market access attributable to the reconstructed network, while contemporaneous populations additionally incorporate changes in destination size.

3.4 Descriptive Statistics

Table 1 reports district averages for employment and access in 1971 and 2011, followed by baseline characteristics across highway-arrival cohorts. Figure 2 shows how arrival timing and nonagricultural employment are distributed across districts.

Panel A shows a substantial shift away from agriculture over the study period: the average

[4] I use the baseline median as a common scale for the index, rather than as the value of goods shipped. This differs from Donaldson and Hornbeck (2016), who express freight costs relative to the average value of transported agricultural goods. With the $1 + C/c_0$ transformation, the choice of c_0 affects destination weights and is a modeling assumption.

district's nonagricultural employment share rises from 5.1% in 1971 to 28.0% in 2011, with most of the increase occurring in services. Over the same period, mean log market access rises from 14.20 to 14.91 when destination populations are held at 1971 levels, and to 15.88 when they vary with each census.

Panel B shows that highway arrival is associated with distinct district characteristics. Districts connected by 1971 are, on average, more populous, smaller in area and lower in elevation than those connected later. Their average population is 229,300, area is 1,385 km^2 and elevation is 839 metres, compared with 118,200, 2,237 km^2 and 2,205 metres for the 2001 arrival cohort. The four districts still unconnected in 2011 have the lowest average population and the largest areas and highest elevations. These contrasts suggest selective road placement and raise concerns about endogenous treatment timing. The early-connected group's higher 1971 nonagricultural employment share, 9.5% compared with 1.6–3.6% among later-connected cohorts, may reflect both initial differences and adjustment following road arrival. I therefore account for observed district characteristics in the OLS comparisons and use the arrival-based difference-in-differences model to examine employment changes among districts with an observed preconnection period.

With DiD, I compare changes in employment shares, so the districts do not have to start at the same level. For a causal interpretation, their employment shares would need to have changed similarly without highway arrival, after accounting for the 1971 development and access indices used in the model. Geography and earlier development could shape the pace of employment change as well as the timing of roads, so including these controls does not settle whether the districts provide a credible comparison. I therefore examine the available changes before connection alongside the estimates after arrival.

Table 1: District employment, access and baseline characteristics

Panel A. Employment and access, 1971 and 2011

	1971 ($N = 74$)		2011 ($N = 74$)	
	Mean	SD	Mean	SD
Population (thousands)	156.2	78.9	358.0	283.4
Nonagricultural employment (%)	5.1	7.1	28.0	14.3
Manufacturing employment (%)	1.2	1.5	7.6	4.4
Services employment (%)	3.9	5.9	20.4	10.7
Log market access, 1971 population	14.20	1.29	14.91	0.79
Log market access, current population	14.20	1.29	15.88	0.80
Kathmandu accessibility	−3.99	1.07	−3.57	0.90

Panel B. 1971 characteristics by highway-arrival cohort

Arrival cohort	Districts	Population (thousands)	Area (km^2)	Elevation (metres)	Nonagricultural employment (%)
By 1971	25	229.3	1,385	839	9.5
1981	13	147.8	1,968	1,207	3.4
1991	11	120.2	1,807	1,545	3.6
2001	17	118.2	2,237	2,205	1.6
2011	4	122.5	2,508	2,846	3.0
Not connected by 2011	4	20.4	4,877	4,452	4.3
All districts	74	156.2	1,996	1,626	5.1

Notes: The sample consists of 74 harmonized districts. Panel A reports unweighted district means and sample standard deviations. Panel B reports district counts and unweighted means. Employment shares are based on employment classified into agriculture, manufacturing and services. Manufacturing includes mining and construction, while services include electricity, gas and water utilities, commerce including hospitality, transport and communication, finance and business services, and personal and community services. Market access uses the extended-markets network, $\theta = 3.8$ and the zero border/transfer-penalty. Two versions of Market Access use fixed 1971 or contemporaneous destination populations. Kathmandu accessibility is $A_{iKd} = -\log(1 + C_{iKd})$, where C_{iKd} is the transport cost of reaching the capital. The index increases as that cost falls. Arrival cohorts correspond to the first census at or after the selected highway-arrival year.

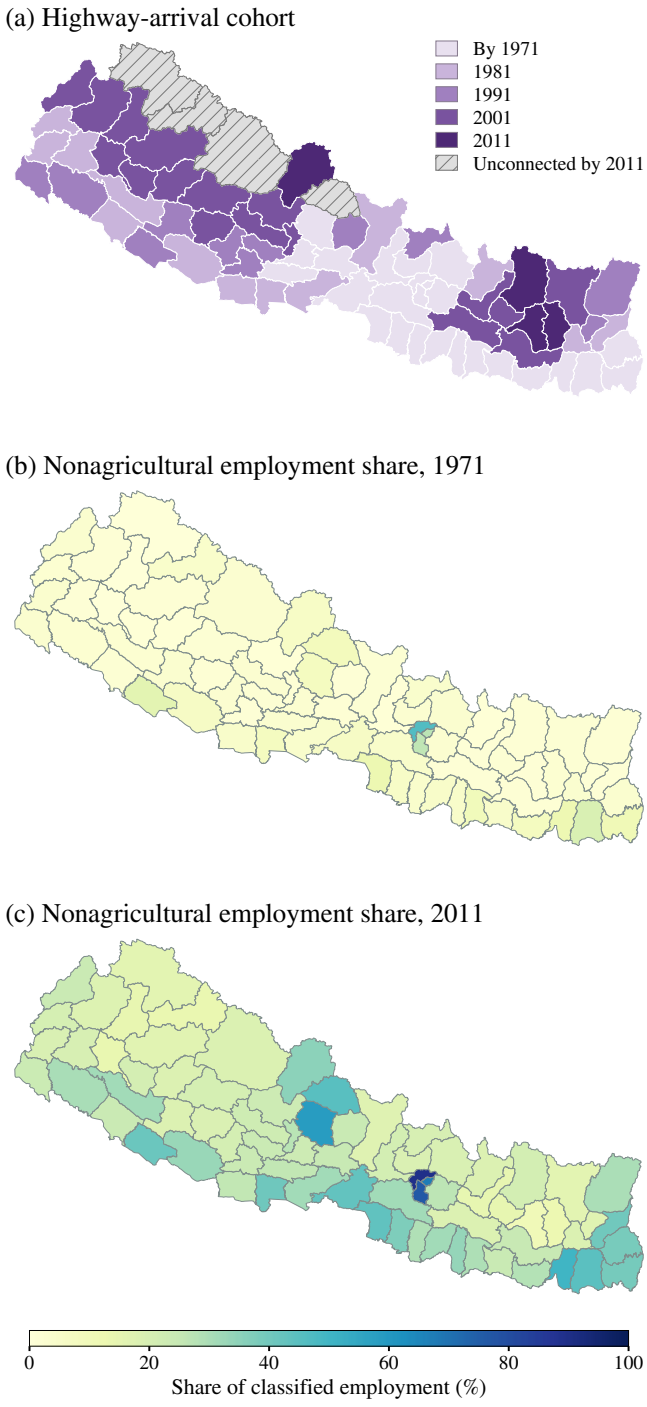


Figure 2: Highway-Arrival Cohorts and Nonagricultural Employment

Notes: All panels use the 74 harmonized districts, with Jumla and Kalikot combined. Panel (a) assigns the selected highway-arrival year to the first census at or after it, hatching marks districts unconnected through 2011. Panels (b) and (c) show nonagricultural employment as a percentage of classified employment in 1971 and 2011, using the same colour scale.

4 Empirical Strategy

4.1 Employment Around First Connection

I study structural transformation through changes in the nonagricultural employment share, then examine manufacturing, services and their sub-sectors. I begin with an OLS comparison:

$$s_{id}^{k} = \alpha_{kd} + \beta_{kd} D_{id} + \boldsymbol{\gamma}_{kd}' \mathbf{X}_i + \varepsilon_{id}^{k}, \qquad D_{id} = \mathbf{1}\{G_i \leq d\}. \tag{3}$$

where s_{id}^{k} is the employment share in sector k, beginning with nonagricultural employment, and D_{id} indicates whether district i has received its first primary-road connection by census period d. G_i is the first census year at or after the selected highway-arrival year, and $\mathbf{X}_i$ contains the controls. Connection throughout this subsection refers to arrival, following the preferred exposure definition above. I estimate this equation separately for each census year, with heteroskedasticity-robust (HC3) standard errors. The coefficient β_{kd} describes the conditional difference between connected and unconnected districts.

I also compare employment changes over the full period using a long-difference OLS regression:

$$s_{i,2011}^{k} - s_{i,1971}^{k} = \alpha_{k}^{LD} + \beta_{k}^{LD} D_{i,2011} + \boldsymbol{\gamma}_{k}^{LD\prime} \mathbf{X}_i + u_i^{k}. \tag{4}$$

Here, $D_{i,2011}$ records whether a district is connected by 2011. The OLS specifications successively add district area, ecological-belt indicators, and development-region indicators together with the sector's 1971 employment share and log population in 1971. These controls form $\mathbf{X}_i$, with district area entering in levels. Unlike the staggered comparison below, this regression retains districts already connected in 1971. Its coefficient therefore compares long-period employment changes by connection status in 2011, without distinguishing when the road arrived. I use HC3 standard errors. The separate census-year OLS results are reported in Appendix Table A4.

For staggered highway arrival, I estimate cohort-specific effects:

$$ATT^{k}(g,d) = E\Big[s_{id}^{k}(g) - s_{id}^{k}(\infty) \mid G_i = g\Big], \qquad d \geq g. \tag{5}$$

where d indexes census periods and g identifies treatment cohorts by the census period assigned to first highway arrival. $s_{id}^{k}(g)$ is district i's potential employment share in period d if it first connects in period g, and $s_{id}^{k}(\infty)$ is its share if it remains unconnected through d. Thus, $ATT^{k}(g,d)$ is the average effect in period d for cohort g, defined by $G_i = g$. I estimate these effects using the doubly robust estimator of Callaway and Sant'Anna (2021),

comparing changes from the census immediately before connection and adjusting for the 1971 development and access indices through outcome regression and propensity-score weighting.

Districts already connected by 1971 are excluded from the staggered difference-in-differences analysis because the panel contains no observation of their employment before connection. For districts connected later, I compare employment changes with those in districts that had not yet received a primary road, including those still unconnected at the end of the study period. The latter are untreated through 2011, rather than necessarily remaining unconnected thereafter.

Road investment was selective, and districts receiving connections at different times differed in geography and development. A causal interpretation requires that, conditional on these characteristics, employment shares in the two groups would have followed parallel trends in the absence of connection. It also requires no employment response before the assigned arrival period and that improvements elsewhere in the network do not differentially alter the comparison districts' employment trajectories. These conditions are demanding in this setting: construction was gradual, and districts could benefit from nearby roads before receiving their own connection. I report the available pretreatment comparisons and specification checks alongside the estimates in Section 5.

4.2 Employment Change with Continuous Access

The intensive margin relates employment composition to market access as the transport network changes. I first estimate a separate cross-sectional OLS regression for each census period:

$$s_{id}^{k} = \alpha_{kd} + \beta_{kd} \log MA_{id}^{b} + \boldsymbol{\gamma}_{kd}' \mathbf{X}_i + \varepsilon_{id}^{k}. \tag{6}$$

Here, s_{id}^{k} is the employment share in sector k for district i in census period d, and $\mathbf{X}_i$ denotes the selected time-invariant district controls, using the same notation as in the extensive-margin models. MA_{id}^{b} is extended-markets access under destination-population basis b, as defined above. I estimate the fixed-1971 and contemporaneous-population versions separately and suppress the population-basis index on the coefficients for readability. The coefficient β_{kd} describes the conditional association between log market access and employment composition across districts in census period d. I use heteroskedasticity-robust (HC3) standard errors.

The full-period OLS in Table 2 relates the 2011 employment share to the cumulative change in log market access from 1971 to 2011:

$$s_{i,2011}^{k} = \alpha_{k}^{EP} + \beta_{k}^{EP} \left(\log MA_{i,2011}^{b} - \log MA_{i,1971}^{b} \right) + \boldsymbol{\gamma}_{k}^{EP\prime} \mathbf{Z}_{i}^{k,b} + u_{i}^{k}. \tag{7}$$

The control sequence starts with no additional controls, adds the sector's 1971 employment share and 1971 log market access, then adds district area and ecological-belt indicators. These controls form $\mathbf{Z}_i^{k,b}$. The outcome remains the employment share in 2011, and I use HC3 standard errors. Appendix Table A5 reports the separate census-year OLS comparisons.

The main intensive-margin specification pools changes between adjacent censuses:

$$\Delta s_{id}^k = \alpha_{kd} + \beta_k \Delta \log MA_{id}^b + \boldsymbol{\gamma}_{kd}' \mathbf{X}_i + u_{id}^k, \quad d \in \{1981, 1991, 2001, 2011\}. \tag{8}$$

where $\Delta s_{id}^k = s_{id}^k - s_{i,d-10}^k$ and $\Delta \log MA_{id}^b$ is the change in log market access over the same ten-year interval. With contemporaneous population weights, each endpoint uses that census's destination populations, while both endpoints use 1971 populations with fixed weights. The intercept α_{kd} captures the common change in sector k during the interval ending in d, while $\boldsymbol{\gamma}_{kd}$ allows the coefficients on the fixed district controls to vary across intervals. These controls enter in levels: differencing time-invariant geography itself would produce zeros. Time-invariant district intercepts are removed by differencing, and standard errors are clustered by district. The benchmark reported in Table 2 includes interval effects without additional district controls. The geographic-control specifications remain supplementary.

The coefficient β_k is a common slope across the four census intervals, estimated separately for each sector and population basis using extended-markets access. For employment shares measured as fractions, a 10% increase in market access corresponds to $100\beta_k \log(1.10)$ percentage points of employment-share change, holding the controls and interval fixed. I interpret this slope as a conditional association between access improvements and employment adjustment. Levels specifications with district and census-period fixed effects provide a supplementary within-district comparison.

4.3 Employment Change with Access to Kathmandu

Kathmandu's prominence in Nepal's urban system grew over the study period: the two-city primacy index rose from 2.54 in 1971 (Basyal and Khanal, 2001, p. 209, Table 8) to 3.79 in 2011 (Ministry of Urban Development, 2017, Table 1.3).[5] I therefore examine how changes in district employment shares are associated with improved access to the capital.

Let C_{iKd} denote the normalized least monetary transport cost from district i to Kathmandu, indexed by K, in census period d on the same Nepal–India network used for market access. I define accessibility as $A_{iKd} = -\log(1 + C_{iKd})$, which increases as this cost falls. A positive

[5]The two-city primacy index is $P_{(1)}/P_{(2)}$, the population of the largest city divided by that of the second largest.

change in the index therefore indicates improved access to the capital. The addition of one retains Kathmandu's zero self-cost. Using the same census intervals and control structure as equation (8), I estimate

$$\Delta s_{id}^{k} = \alpha_{kd}^{K} + \beta_{k}^{K} \Delta A_{iKd} + \boldsymbol{\gamma}_{kd}^{K\prime} \mathbf{X}_{i} + u_{id}^{k,K}. \tag{9}$$

Here, $\Delta A_{iKd} = A_{iKd} - A_{iK,d-10}$. The coefficient β_{k}^{K} measures the conditional association between improved access to the capital city and decadal employment-share changes, with standard errors clustered by district.

5 Results

5.1 Employment Adjustment Following First Connection

Panel A of Table 2 shows a positive employment adjustment around highway arrival. The staggered DiD estimate for nonagricultural employment is 4.87 percentage points (standard error 1.86), with nearly equal contributions from broad manufacturing, 2.43 points, and services, 2.44 points. These estimates use the 49 districts not connected by 1971 and average seven supported post-arrival comparisons for the 1981, 1991 and 2001 cohorts. The long-difference OLS coefficients are less stable across control sets: the nonagricultural estimate ranges from −4.05 to 6.68 points and is imprecise throughout, while the positive unadjusted manufacturing association is no longer distinguishable from zero after controls are added. Figure 3 shows positive post-arrival point estimates for all three outcomes. The largest estimates occur twenty years after the first treated census, but this horizon contains only the 1981 cohort and cannot establish that adjustment grows over time for all cohorts.

The joint pretreatment test rejects for nonagricultural employment ($p = 0.029$), so the available evidence does not support the parallel-trends assumption required for a causal interpretation. The corresponding p-values are 0.766 for manufacturing and 0.071 for services. With only five censuses, the tests contain three nonreference pretreatment comparisons. The 1981 cohort has only its reference census before arrival. This sparse history limits the assessment of separate cohort trends but does not remove the rejection. I therefore read the arrival estimates as employment adjustment around connection.

Table 2: Transport Connectivity and Employment Adjustment

Panel A. Extensive margin: highway arrival

	Long-difference OLS, 1971–2011				Staggered DiD
	(1)	(2)	(3)	(4)	(5)
Nonagricultural	4.17	−3.06	−4.05	6.68	4.87***
	(6.99)	(9.33)	(9.45)	(6.76)	(1.86)
R^2	0.011	0.080	0.134	0.496	—
Pretrend p	—	—	—	—	0.029
Manufacturing	3.55***	0.43	−0.34	2.07	2.43***
	(0.53)	(1.92)	(1.42)	(2.21)	(0.65)
R^2	0.054	0.137	0.293	0.599	—
Pretrend p	—	—	—	—	0.766
Services	0.62	−3.50	−3.70	3.68	2.44**
	(6.68)	(9.29)	(9.29)	(7.65)	(1.14)
R^2	0.000	0.041	0.053	0.318	—
Pretrend p	—	—	—	—	0.071
District area		X	X	X	
Ecological-belt indicators			X	X	
Development-region indicators				X	
1971 outcome share				X	
1971 log population				X	
1971 development index					X
1971 access index					X
Districts	74	74	74	74	49
Observations	74	74	74	74	245

Notes: Each outcome is estimated separately. Coefficients and standard errors (in parentheses) are in percentage points. Employment shares use employment classified into agriculture, manufacturing and services. Manufacturing includes mining and construction, and services include utilities. Arrival is assigned to the first census at or after the selected highway-access year. X marks an included control; district area enters in levels. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

OLS regresses the 1971–2011 share change on connection status in 2011. It retains all 74 districts, including 25 connected by 1971; 70 are connected by 2011 and four remain unconnected. Columns (1)–(4) successively add the controls shown; the 1971 outcome share is sector-specific. All columns include an intercept and weight districts equally. OLS standard errors are HC3, and stars use two-sided t-tests.

The doubly robust Callaway–Sant'Anna DiD adjusts for the 1971 development and access indices and uses not-yet-connected controls, with the census before arrival as reference. Its eligible sample excludes the 25 districts connected by 1971, leaving 49 districts and 245 district–census observations. The overall ATT averages available post-arrival estimates within cohorts, then weights the cohort averages by treated-district counts. It contains seven post-arrival comparisons for the 1981, 1991 and 2001 cohorts, with weights 13/41, 11/41 and 17/41. The 2011-cohort ATT and the 2011 effects for the 1981 and 1991 cohorts are unavailable. Standard errors use 999 district multiplier-bootstrap draws. DiD stars use two-sided, pointwise normal-reference Wald tests based on these standard errors, without adjustment across outcomes. The saved 95% bootstrap intervals also exclude zero for all three outcomes. Pretrend p-values test the three available nonreference pretreatment comparisons.

Table 2: Transport Connectivity and Employment Adjustment (continued)

Panel B. Intensive margin: extended-markets access

	Fixed 1971 population			Contemporaneous population		
OLS: 2011 employment share on 1971–2011 change in log access						
	(1)	(2)	(3)	(4)	(5)	(6)
Nonagricultural	−8.11***	1.25	3.66	−8.11***	1.17	3.52
	(2.08)	(1.58)	(2.21)	(2.10)	(1.55)	(2.16)
Manufacturing	−2.53***	0.85	0.41	−2.52***	0.78	0.26
	(0.59)	(0.58)	(0.78)	(0.59)	(0.56)	(0.75)
Services	−5.57***	0.29	2.75	−5.59***	0.25	2.70
	(1.54)	(1.42)	(1.87)	(1.56)	(1.40)	(1.82)
1971 outcome share		X	X		X	X
1971 log market access		X	X		X	X
Area and ecological belt			X			X
Observations / districts	74	74	74	74	74	74
Decadal first differences, 1971–1981 to 2001–2011						
Nonagricultural		−1.09			−0.98	
		(0.78)			(0.78)	
Manufacturing		−0.69			−0.67	
		(0.44)			(0.44)	
Services		−0.39			−0.31	
		(0.49)			(0.48)	
Census-interval effects		X			X	
Additional controls		None			None	
Observations		296			296	
Districts		74			74	
Fixed 1971 population	X	X	X			
Contemporaneous population				X	X	X

Notes: Coefficients and standard errors (parentheses) are percentage points per natural-log unit of access. Multiply by log(1.10) for a 10% access increase. Employment shares use classified employment; manufacturing includes mining and construction, and services include utilities. Extended-markets access includes the Nepal–India network and selected Indian markets, with $\theta = 3.8$, constant relative transport-cost weights and zero additional border/transfer penalties. Both population bases use 74 harmonized Nepal districts with equal observation weights. X marks the population basis or an included control.

OLS relates the 2011 employment share to the 1971–2011 change in log access, with an intercept and HC3 standard errors. Columns successively add the sector's 1971 share and log access, then district area in levels and ecological-belt indicators. First differences relate adjacent-census share changes to log-access changes, pooling four intervals with interval effects and district-clustered standard errors. This block contains one benchmark estimate per outcome and population basis. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$ follow the saved outputs: t-based HC3 inference for OLS and normal-based clustered inference for first differences. The models retain their different horizons and outcome definitions.

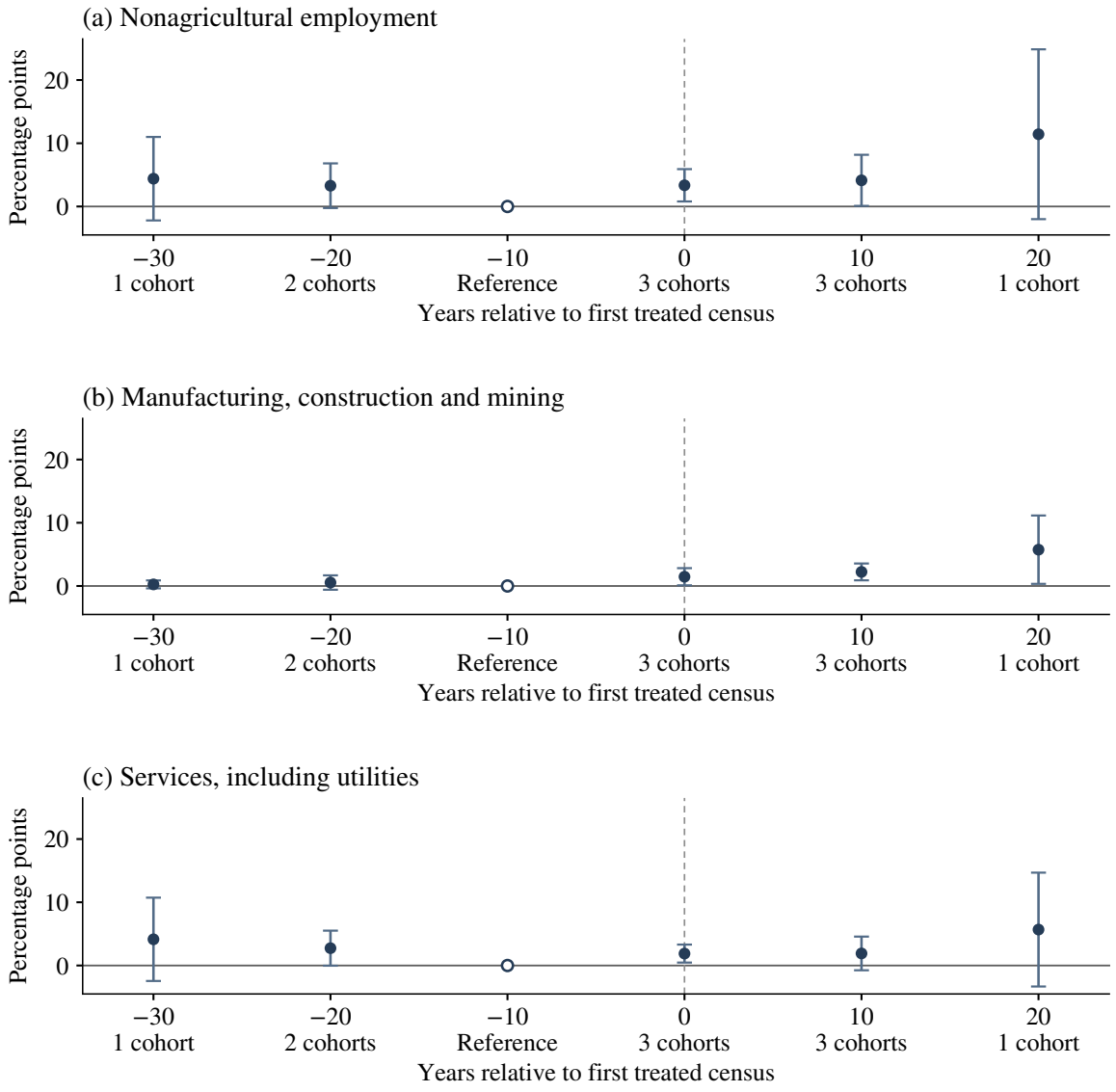


Figure 3: Employment Shares Before and After Highway Arrival

Notes: Formal Callaway–Sant'Anna event-time estimates use arrival cohorts, 1971 development/access controls and not-yet-connected comparisons, on the 49-district sample in Table 2. Outcomes are shares of total classified employment, in percentage points. Broad manufacturing includes construction and mining; services include utilities. Event time is measured from the first treated census; the preceding census (−10) is normalized to zero. Bars are pointwise 95% normal-reference intervals formed from the saved standard errors using 999 district multiplier-bootstrap draws. They are not simultaneous confidence bands. Counts below the axis show contributing cohorts at each estimated horizon. The −30 lead uses the 2001 cohort; −20 uses the 1991 and 2001 cohorts; 0 and +10 use all three supported cohorts; +20 uses only the 1981 cohort. The joint pretreatment tests in Table 2 concern the three underlying nonreference cohort–time comparisons.

5.2 Employment Adjustment as Market Access Improves

Panel B of Table 2 shows a negative but imprecise association between decadal market-access improvements and changes in nonagricultural employment. With destination populations fixed at 1971 levels, the coefficient is −1.09 percentage points per log unit of access, while using contemporaneous populations gives −0.98 points. A 10% increase in access therefore corresponds to about 0.10 percentage points less growth in the nonagricultural employment share under either measure. The manufacturing and services coefficients are also negative, but none of these broad-sector first-difference estimates is distinguishable from zero at the 10% level. These slopes describe differences in employment-share growth across districts, not an absolute decline in nonagricultural employment.

The full-period OLS comparisons are more sensitive to adjustment for initial conditions. The unadjusted nonagricultural coefficient is −8.11 under both population bases, but becomes positive after controlling for the 1971 employment share and initial access. With geography also included, it is 3.66 for fixed populations and 3.52 for contemporaneous populations, and neither estimate is distinguishable from zero at conventional levels. The choice of population basis thus makes little difference to the main pattern in this table. Since these OLS comparisons use the 2011 employment share as the outcome, their magnitudes are not directly comparable with the decadal first differences or the arrival ATT.

5.3 Which Sectors Account for the Employment Pattern?

Table 3 shows that manufacturing proper accounts for almost all of the positive arrival estimate within broad manufacturing: its ATT is 2.38 percentage points, compared with 2.43 points for the broader category. Construction and mining contribute little to that point estimate. Within services, personal and community services account for the largest increase, at 2.40 points. Utilities and finance also have smaller positive estimates, while the estimates for commerce and transport are imprecise. The utilities estimate should be read with the classification changes described in the table notes in mind.

In comparison, the market-access results have a different composition. Manufacturing proper has the largest negative point estimate, about −0.50 percentage points per log unit of access, although it is significant only at the 10% level. Mining, transport and communication, and finance and business services have smaller negative coefficients that are more precisely estimated. Personal and community services have a positive but imprecise coefficient, partly offsetting the other service components in the broad-sector estimate. These patterns change very little between the two population bases. The reported significance levels concern each subsector separately and are not adjusted for the number of comparisons.

Table 3: Subsector Composition of Employment Adjustment

	Arrival	Market access: decadal FD	
	DiD	Fixed 1971 population	Current population
	(1)	(2)	(3)
Components of broad manufacturing			
Manufacturing proper	2.381*** (0.458)	−0.504* (0.282)	−0.490* (0.279)
Construction	0.101 (0.442)	−0.140 (0.194)	−0.136 (0.193)
Mining and quarrying	−0.052 (0.033)	−0.049*** (0.016)	−0.048*** (0.016)
Components of services			
Utilities	0.299*** (0.058)	−0.106 (0.072)	−0.102 (0.071)
Commerce (including hospitality)	−0.379 (0.528)	−0.217 (0.256)	−0.209 (0.258)
Transport and communication	0.021 (0.219)	−0.255*** (0.086)	−0.254*** (0.084)
Finance and business services	0.093** (0.046)	−0.280*** (0.086)	−0.276*** (0.084)
Personal and community services	2.403*** (0.765)	0.465 (0.511)	0.536 (0.512)
Districts / observations	49 / 245	74 / 296	74 / 296

Notes: Outcomes are subsector shares of total classified employment, retaining zeros. Manufacturing proper excludes construction, mining and quarrying. Coefficients and standard errors (parentheses) are percentage points in (1), and percentage points per natural-log unit of market access in (2)–(3). Within each column, component point estimates sum to the broad-sector estimates in Table 2, up to rounding, but standard errors do not.

Column (1) uses doubly robust Callaway–Sant'Anna DiD with arrival cohorts, 1971 development/access controls and not-yet-connected comparison districts, excluding districts connected by 1971. Seven supported post-arrival effects are averaged within cohorts, then weighted by treated-district counts. Standard errors use 999 district multiplier-bootstrap draws. Columns (2)–(3) use extended-markets access (Nepal–India routes and selected Indian markets, with zero additional border/transfer penalties) over four census intervals, 1971–1981 through 2001–2011, with interval effects, no additional controls and district-clustered standard errors. No population weighting is used. Stars use two-sided pointwise normal-reference tests, without adjustment across subsectors: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Utilities include household water and fuel collection in 2001 and broader waste-related activities in 2011; these classification changes limit comparability. Commerce includes hospitality but does not separately identify tourism.

5.4 Employment Adjustment as Kathmandu Accessibility Improves

Table 4 shows a negative unadjusted OLS association for access to Kathmandu. The nonagricultural coefficient is −17.36 percentage points per unit of accessibility, but falls in absolute size to −0.10 after controlling for the 1971 employment share, initial accessibility and geography. Manufacturing and services are also no longer distinguishable from zero after adjustment.

The decadal estimates are −2.64 points for nonagricultural employment, −1.50 for broad manufacturing and −1.14 for services, per unit of the accessibility index. Only manufacturing is distinguishable from zero at the 10% level ($p = 0.076$).

Table 4: Employment Adjustment and Accessibility to Kathmandu

	Full-period OLS		Decadal FD
	Unadjusted	Adjusted	
	(1)	(2)	(3)
Nonagricultural	−17.36***	−0.10	−2.64
	(5.26)	(3.62)	(1.68)
Manufacturing	−5.10***	1.44	−1.50*
	(1.42)	(1.04)	(0.84)
Services	−12.27***	−1.21	−1.14
	(3.97)	(2.86)	(1.12)
1971 outcome share and accessibility		X	
Area and ecological-belt indicators		X	
Census-interval effects			X
Districts	74	74	74
Observations	74	74	296

Notes: Accessibility is $A_{iKd} = -\log(1 + C_{iKd})$, where C_{iKd} is the normalized least transport cost to Kathmandu on the Nepal–India network, with zero additional border/transfer penalties. Higher accessibility means lower cost. Coefficients and standard errors (parentheses) are percentage points per one-unit increase in accessibility. Employment shares use total classified employment; manufacturing includes construction and mining, and services include utilities. The sample includes Kathmandu. Destination populations do not enter this measure, so there is one accessibility series.
OLS relates the 2011 employment share to the 1971–2011 accessibility change. Column (2) adds the sector's 1971 share, 1971 accessibility, district area in levels and ecological-belt indicators. Column (3) relates adjacent-census share changes to accessibility changes over four intervals, with interval effects and no additional controls. All models include an intercept and weight observations equally. Standard errors are HC3 for OLS and district-clustered for first differences. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$, using the saved two-sided t-tests for OLS and normal-reference tests for first differences.

6 Discussion

6.1 Better Access and Uneven Employment Adjustment

I begin the discussion by setting stage as follows. Of the 41 treated districts contributing to the arrival estimate, 25 are in the hills, eight in the mountains and eight in the Terai. All eight Terai districts are in the western half of the country. The 4.87-percentage-point estimate therefore concerns the later expansion of highways, predominantly into the hills and mountains, pooling responses from the 1981, 1991 and 2001 arrival cohorts. The 25 districts already connected by 1971 include 12 Terai, 12 hill and one mountain district. Without observations of their employment before arrival, I cannot include them in the DiD. They remain in the descriptive, OLS and first-difference evidence, but the employment response to Nepal's earliest highways falls outside the arrival comparison.

Across all 74 districts, the standard deviation of log market access fell from 1.29 in 1971 to 0.79 in 2011, with destination populations held at 1971 levels (Table 1; Appendix Table A6 reports all five censuses). This narrowing reflects changes in the reconstructed transport network, with the size of destination markets unchanged. Over the same period, the average district's nonagricultural employment share rose from 5.1% to 28.0%, while its standard deviation increased from 7.1 to 14.3 percentage points. The gap between the 90th and 10th percentiles also grew, from 9.1 to 27.6 percentage points. Hence, access became less dispersed, but the percentage-point differences in employment composition widened.

Relative inequality in employment shares nevertheless fell: the Theil index declined from 0.544 to 0.108.[6] The mean share grew more than fivefold, so larger percentage-point differences could represent smaller differences relative to the average. Each district receives equal weight in these comparisons, whether it is a small mountain district or a populous Terai district. Neither the fall in relative inequality nor the positive arrival estimate establishes that initially isolated districts caught up with earlier-connected places.

The arrival coefficient for the nonagricultural employment share is positive, whereas the decadal market-access coefficients are negative but imprecise. My reading of this contrast is that first access can remove a basic constraint on nonagricultural work, while wider integration also brings competition. For districts receiving their first highway, easier access to inputs, customers and employment could make manufacturing and service activities more feasible. Manufacturing proper and personal and community services account for most of the positive

[6]This index gives each of the 74 districts equal weight and measures inequality in their nonagricultural employment shares, not inequality in household incomes. It is $T = N^{-1}\sum_i (s_i/\bar{s})\log(s_i/\bar{s})$, where s_i is a district's nonagricultural share and $\bar{s}$ is the district mean. A zero share contributes zero. The index is zero when all districts have the same share and is unchanged by a common proportional increase in all shares.

arrival estimate, suggesting that the adjustment extended beyond temporary work on the road itself.

Wider integration also makes it easier for established producers elsewhere in Nepal and India to supply these districts. Local producers may gain customers while losing some of the market that high transport costs had protected. Residents could obtain goods more cheaply without a corresponding expansion of manufacturing employment in their own district. Faber (2014) finds slower industrial-output growth in peripheral Chinese counties connected to the national highway network, providing a precedent for this possibility. In my results, manufacturing proper has the largest negative market-access point estimate, while personal and community services remain positive, though imprecisely estimated. Competition could help explain why better connections support some activities without producing equally strong growth in the district's overall nonagricultural employment share. For access to Kathmandu, the adjusted OLS and decadal estimates are statistically insignificant for the overall nonagricultural employment share, although the decadal broad-manufacturing coefficient is negative and weakly significant ($p = 0.076$).

Finance and business services stand out as the only subsector significant at the 5% level or better in all three columns of Table 3, with a positive arrival estimate and negative estimates under both market-access measures. A first connection could support demand for financial and business services around district centers, while wider network improvements could make providers in larger towns easier for residents and firms to reach. Access to these services might then improve without an equally strong increase in the share of district residents employed in the sector. The category covers several trade and business services that are hallmarks of a modernizing economy.

By 2011, a larger share of Nepal's nonagricultural workers was recorded outside the leading districts, even as percentage-point gaps in districts' employment shares widened. The five districts with the largest counts of nonagricultural workers in each census accounted for 40.2% of the national total in 1971 and 32.4% in 2011. Kathmandu's share fell from 19.5% to 16.0%. This was not a steady decline: both shares rose between 2001 and 2011 (Appendix Figure A1). Over the full period, within-district changes account for 24.61 points of the 28.76-percentage-point increase in the national, employment-weighted nonagricultural share; changing district employment weights account for the remaining 4.16 points (Appendix Table A7). These are accounting contributions, not separate effects of roads.

Among the 49 districts not already connected by 1971, the fixed favored–lagging comparison gives a similar contrast. The gap in mean fixed-population log access narrowed from 1.08 to 0.57, while the nonagricultural employment-share gap widened from 1.59 to 3.40 percentage points (Appendix Table A8). These groups describe initial development, not

early and late road arrival. Nationally, the share of residents in designated urban places rose from 4.0% to 17.1%; this includes changes in designation and cannot be read as migration alone (Appendix Figure A2). District rankings also remained persistent: the 1971–2011 rank correlation is 0.928 for fixed-population access and 0.708 for the nonagricultural employment share (Appendix Table A9).

6.2 Limitations

Roads can change where people work as well as what they do. I observe employment among the people enumerated in each district, so a shift in its employment shares can reflect occupational change, migration, or both. Better roads can also help residents reach jobs outside the district. In Asher and Novosad (2020), for instance, occupational change exceeds the expansion of jobs in village firms. My Kathmandu estimates relate changes in district employment shares to improved access to the capital. To understand how much of this adjustment comes through migration or commuting, I would need information on workers' movements and job locations.

Shrestha (2017) documents the surge in migration to Malaysia and the Persian Gulf alongside longstanding movement to India, identifying conflict at home and labor demand abroad as drivers of migration. Migration can also change the work of those who remain. Lokshin and Glinskaya (2009) find lower market-work participation among women in migrant-sending households. So a household could earn more from employment abroad while its members in Nepal continued farming or took on additional household responsibilities. Remittance-supported consumption could also sustain local services, as discussed in World Bank (2017).

The panel spans the civil war and the unsettled years that followed. Shrestha and Chaudhary (2014) document disruptions to transport and economic activity from general strikes during 2008–2013, overlapping the final census interval. The reconstructed maps record routes but omit interruptions to their use. Incomplete census enumeration and changing industry classifications also affect comparisons between decades, as described in Section 3. The district panel cannot separately identify the contributions of conflict, migration and remittances to the employment changes observed around road improvements.

7 Conclusion

I link Nepal's historical transport networks to five censuses to examine district employment between 1971 and 2011. The arrival comparisons show a 4.87-percentage-point increase in the nonagricultural employment share relative to districts not yet connected, with broad

manufacturing and services contributing nearly equally. The decadal market-access estimates are negative and imprecise, whether destination populations are held at 1971 levels or allowed to change. One possible explanation is that first access opens opportunities for nonagricultural work, while wider integration also brings competition from established producers. The rejection of parallel trends limits a causal interpretation of the arrival estimate.

The reconstruction follows places beyond the established towns, retaining the tracks, trails and routes through India that connected districts before highways arrived. Earlier connections reached more populous and accessible places, while later extensions brought the network into more remote districts. Across the full panel, access became less dispersed and the average district became less agricultural, but absolute differences in employment composition grew.

Linking this network history to household and workplace data would help distinguish local changes in production from access to employment elsewhere. It would also allow me to examine whether livelihoods improved where the local nonagricultural share changed little.

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8 Appendix

8.1 Census Harmonization

Table A1: Census Harmonization: Issues, Treatments and Examples

Issue	**How I dealt with it**	**Examples**
Definitions of employment and economic activity vary across census years.	I retain the published counts and group related activities where possible. Differences in work-duration rules cannot be removed from the district totals alone.	The stated eight-month work requirement in 1971 contrasts with the inclusion of shorter periods of work in 1991.
Industrial classifications vary across census years.	Related sub-sectors are grouped where the tables allow. Manufacturing includes construction and mining, and services include utilities, with hospitality under commerce.	The 2001 census counts household water and fuel collection under utilities and recycling under manufacturing proper. Transport/communication broadens in 2011.
Employment tables do not always use the same denominator.	Sector shares use agriculture plus manufacturing plus services, E_{id}. Workers whose industry is unknown remain outside these three groups.	Nonagricultural share is $(L_{id}^{M} + L_{id}^{S})/E_{id}$. "Other" and "Not stated" are not assigned to services.
Later economic tables are based on samples rather than full enumeration.	I use the published census-weighted estimates, without expanding them again. The district refers to where people were enumerated, not necessarily where they worked.	Industry employment comes from the sample-based 2001 FR2 Table 31 and 2011 Table 56. Both exclude institutional residents.
The 2001 census did not fully enumerate some areas.	I use CBS's official adjusted population totals wherever population enters, including density, population weights and contemporaneous-population market access.	CBS added estimates for 414,489 residents in twelve districts, represented by eleven units in this panel.

Continued on the next page

Issue	How I dealt with it	Examples
These population additions have no corresponding employment estimates.	Employment counts remain as reported. I do not scale them up to match the adjusted population totals.	In affected districts such as Salyan and Jumla–Kalikot, population includes estimated residents whose employment was not enumerated.
The 2001 age tables cover the enumerated population only.	I apply each district's observed age shares separately within sex to its official sex totals, using rounding that preserves those totals. This assumes the observed age distribution also represents missing residents.	Cohort-retention residuals for both 1991–2001 and 2001–2011 inherit this assumption.
Employment-status shares depend on who enters the denominator.	The employee share uses the employment-status total. The separate four-status descriptive table excludes "Not stated" and recalculates shares over the named statuses.	Employers, employees, self-employed and unpaid family workers sum to 100 percent before rounding in that descriptive table.
Literacy tables cover different age groups.	I retain each source table's literacy denominator and record its age coverage, rather than impose a common age cutoff that the available totals cannot supply.	The 1971, 1981 and 2001 tables cover ages six and above, while 2011 starts at five. The 1991 extract uses mixed age denominators.
The places designated as urban change over time.	Urban population follows each census's statutory towns or municipalities. Rural population is the district total less its urban population.	Nepal had 16 designated towns in 1971 and 58 municipalities in 2001 and 2011.
District boundaries do not remain unchanged.	I combine Jumla and Tibrikot in 1971, and Jumla and Kalikot thereafter, to retain 74 panel units.	The combined 1971 population is 132,770, including the relevant Tibrikot population.

The 2001 missed-area population estimates are reported in Central Bureau of Statistics (2003, Table 1.4, p. 11).

8.2 GIS Harmonization

Historical maps establish which routes enter each year's network and the class assigned to them. I use modern OpenStreetMap linework within manually reviewed corridors to refine their alignment, not to establish when they existed. This gives a closer approximation of the route than the historical map alone, but does not recover every change in its alignment.

For the intensive-margin calculations, I include routes marked as under construction at trail cost, rather than treat them as completed motorable roads. This assumes that the corridor permits travel on foot while construction is underway. Routes shown only as planned or proposed do not enter as new links. Any previously documented track or trail along the same corridor remains in the network.

Table A2: Historical Map Sources and Assignment to Network Years

Network year	**Map and source date**	**Use in the reconstruction**
A. Nepal		
1961 baseline	*Nepal*, United Nations Map No. 1292, February 1961 (United Nations Geospatial Information Section, 1961).	Roads, tracks and trails establish the baseline network. Earlier routes are retained in later networks, accounting for subsequent upgrades.
1971	*Nepal General Survey Map with Cities, Transportation and Administrative Divisions*, CIA Map No. 57613, September 1968 (Central Intelligence Agency, Office of Basic and Geographic Intelligence, 1968).	The 1968 roads and tracks approximate 1971, with earlier trails retained. Additions between the map and census dates may be missed.
1981	*Nepal Road Map, 2042 B.S.* (1985/86), Department of Roads Planning Section, in *Nepal Road Statistics: 1985* (Nepal Department of Roads, Planning Section, 1985).	The later map approximates 1981. Mapped additions or upgrades after the census are not separately removed using opening dates.
1991	*Nepal Road Network 1991: Existing, Under Construction, Planned and Proposed*, Department of Roads, July 1991 (His Majesty's Government of Nepal, Department of Roads, 1991).	The source falls in the census year. Route status determines analytical class under the rules described above.

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Table A2 continued

Network year	Map and source date	Use in the reconstruction
2001	*Nepal Strategic Road Network 2004*, Department of Roads; network dated 2004, HMIS/DOR publication mark 2005 (Nepal Department of Roads, Highway Management Information System Unit, 2005).	The 2004 network approximates 2001. Mapped additions or upgrades after the census are not separately removed using opening dates.
2011	*Nepal Strategic Road Network 2011/12*, Department of Roads, published July 2012 (Nepal Department of Roads, Highway Management Information System Unit, 2012).	Fiscal-year 2011/12 coverage approximates 2011 and can include changes after the census.
B. Adjoining Indian plains		
1971	CIA's *Nepal General Survey Map*, September 1968, as listed above (Central Intelligence Agency, Office of Basic and Geographic Intelligence, 1968).	Indian roads and railways within the map's coverage supply the first panel network.
1981	*Nepal 1984*, prepared by Iswor Shrestha and drawn by Rajkumar Singh Bohara, 1984 (Shrestha, 1984).	Roads supplement the 1971 reconstruction, while railways follow this source. The map postdates the census by three years.
1991	*Nepal*, CIA Map No. 801532 (B00750), June 1990 (United States Central Intelligence Agency, 1990).	Roads supplement the 1971 and 1981 reconstructions; railways follow this source.
2001	*Indian Railway Map*, based on Survey of India mapping, Government of India copyright 2001 (Indian Railway Map, 2001).	Railways follow the 2001 map. Roads retain the 1991 reconstruction. Later road additions are not observed.
2011	*Nepal: As of December 2009*, UNHCR, printed 29 December 2009 (United Nations High Commissioner for Refugees, 2009).	Railways follow the 2009 map. Roads again retain the 1991 reconstruction.

Notes: Network years label analytical snapshots, not the opening dates of all roads shown. The 1961 network is a source for later reconstructions, outside the 1971–2011 census panel. Nepal's networks retain earlier routes, with later higher-class designations taking precedence. Indian roads accumulate through 1991; railways use each year's source separately, except for nine manually recovered historical railway links documented for 1971 and retained in all five census years.

8.3 Transport-Cost Calibration

I take the modal freight-price benchmarks from Volume I of the IBRD's 1965 transport study, rather than average the individual route quotations myself. The report summarizes those quotations as NRs 1.3 per ton-mile for trucks, NRs 4 for bullock carts, NRs 7 for pack animals and NRs 15 for porters, while cautioning that journeys of different lengths are not exactly comparable (International Bank for Reconstruction and Development, 1965a, p. 20). The underlying freight quotations appear in Volume III, Table E-11. Table E-12 separately calculates truck operating costs (International Bank for Reconstruction and Development, 1965b, pp. 107–109). I use the freight-price benchmarks together, without mixing them with those operating-cost estimates.

Table A3: Transport-Cost Benchmarks and Network Weights

Network class	Transport mode	NRs per ton-mile	Normalized weight
Primary road	Truck	1.3	$1.3/15 \simeq 0.0867$
Track	Bullock cart	4.0	$4/15 \simeq 0.2667$
Trail	Porter	15.0	$15/15 = 1$

Notes: Source: International Bank for Reconstruction and Development (1965a, p. 20). The correspondence between mapped classes and transport modes is a modeling assumption. Displayed weights are rounded, but routing uses the unrounded ratios. Each weight multiplies segment length in kilometres.

Let p_m be the reported freight price for mode m. Converting both the modal price and the porterage benchmark to a per-kilometre basis gives

$$r_m = \frac{p_m/1.609344}{15/1.609344} = \frac{p_m}{15}. \tag{10}$$

Thus the mile-to-kilometre conversion cancels in the ratio. A segment of length ℓ_e kilometres receives cost $\ell_e r_m$. These costs are measured relative to carrying one ton for one kilometre by porter, not in current rupees. The same reference is retained across years and network scenarios.

Using porterage for trails does not mean that pack animals were absent. The report describes porters as carrying most goods on hill footpaths, including paths usable by pack animals, but identifies exceptions such as Mustang (International Bank for Reconstruction and Development, 1965a, p. 19). I use a uniform porterage benchmark because the maps do not establish the transport mode on every trail. Similarly, assigning the bullock-cart benchmark to tracks is a maintained correspondence, not a route-level observation of cart use. District-to-network feeder links receive the trail weight of one. The calibration does not separately price seasonal closures or improvements within an unchanged road class.

For the Indian extension, I retain the assumptions that major roads have the same cost as Nepal's primary roads and rail has half the major-road cost. These give weights of 1.3/15 for Indian roads and $0.65/15 \simeq 0.0433$ for rail. The latter is not the railway price reported by the IBRD for Nepal. Approved road-gap connectors and physical station-access links use the highway weight. The benchmark imposes no additional border-crossing or road–rail transfer charge. These extension assumptions are distinct from the Nepal freight-price observations.

8.4 Selection, Support and Inference

Table A4 reports the five census-specific OLS comparisons.

Table A4: Census-Year OLS: Employment Shares and Highway Arrival

Employment share	G0	G7	G1
1971			
	6.66***	4.08***	4.91***
Nonagricultural	(2.16)	(1.45)	(1.80)
	1.03**	0.52	0.80**
Manufacturing	(0.45)	(0.37)	(0.38)
	5.63***	3.56***	4.11***
Services	(1.80)	(1.14)	(1.50)
1981			
	5.24***	3.88***	3.58***
Nonagricultural	(1.27)	(1.21)	(1.27)
	0.48***	0.34***	0.37***
Manufacturing	(0.12)	(0.12)	(0.11)
	4.76***	3.55***	3.20***
Services	(1.19)	(1.14)	(1.18)
1991			
	8.96***	5.52**	5.96**
Nonagricultural	(2.48)	(2.46)	(2.55)
	1.31**	0.32	1.11*
Manufacturing	(0.52)	(0.52)	(0.58)
	7.65***	5.20**	4.85**
Services	(2.03)	(2.02)	(2.02)
2001			
	11.43**	4.97	−1.81
Nonagricultural	(4.32)	(5.43)	(8.03)
	6.13***	3.72*	0.90
Manufacturing	(1.50)	(1.88)	(2.76)
	5.30*	1.24	−2.71
Services	(3.04)	(3.78)	(5.38)
2011			
	5.01	−7.77	−9.09
Nonagricultural	(8.70)	(8.04)	(8.34)
	3.11*	−0.86	−2.32
Manufacturing	(1.74)	(1.68)	(1.84)

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Employment share	G0	G7	G1
Services	1.90 (7.00)	−6.91 (6.58)	−6.77 (6.67)
Log area		X	X
Mean elevation			X
Observations per regression	74	74	74

Notes: Each cell reports the coefficient on an indicator for highway arrival by that census, with its HC3 standard error in parentheses. Coefficients and standard errors are in percentage points. Separate OLS regressions are estimated for each census and outcome, giving all 74 harmonized districts equal weight and retaining districts connected by 1971. Arrival is assigned to the first census at or after the selected access year. All regressions include an intercept. G0 has no additional controls, G7 adds log area, and G1 adds log area and district mean elevation. X indicates an included control. Employment shares use employment classified into agriculture, manufacturing and services as their denominator. Manufacturing includes mining and construction; services include utilities. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$, using the saved two-sided t-based HC3 inference. These are conditional cross-sectional associations.

8.5 Continuous-Access and Sector Sensitivity

The main text uses extended-markets access, combining the reconstructed Nepal–India transport network with destinations in Nepal and selected Indian markets. I define two alternatives for comparison here. Nepal-only restricts both the transport network and destination markets to Nepal. Extended-network admits the reconstructed Indian routes but retains only Nepal's destinations, separating access through Indian territory from the addition of Indian destination populations. All three definitions retain Nepal's districts as the outcome sample and use the same cost scale c_0, with fixed-1971 and contemporaneous destination populations considered separately. Extended-network and extended-markets yield identical Kathmandu costs because they share the same transport network; adding destination populations does not change the cost of reaching the capital.

Table A5 reports the corresponding census-specific market-access comparisons.

Table A5: Census-Year OLS: Employment Shares and Extended-Markets Access

	Fixed 1971 populations			Contemporaneous populations		
Employment share	G0	G7	G1	G0	G7	G1
1971						
Nonagricultural	1.75***	0.25	0.74*	1.75***	0.25	0.74*
	(0.52)	(0.51)	(0.41)	(0.52)	(0.51)	(0.41)
Manufacturing	0.25**	−0.05	0.14	0.25**	−0.05	0.14
	(0.10)	(0.15)	(0.16)	(0.10)	(0.15)	(0.16)
Services	1.50***	0.30	0.59*	1.50***	0.30	0.59*
	(0.44)	(0.40)	(0.32)	(0.44)	(0.40)	(0.32)

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	Fixed 1971 populations			Contemporaneous populations		
Employment share	G0	G7	G1	G0	G7	G1
1981						
Nonagricultural	2.44***	1.66***	1.50**	2.42***	1.65***	1.50**
	(0.49)	(0.52)	(0.68)	(0.49)	(0.52)	(0.68)
Manufacturing	0.19***	0.08	0.09*	0.18***	0.08	0.08*
	(0.04)	(0.06)	(0.04)	(0.04)	(0.06)	(0.04)
Services	2.25***	1.58***	1.42**	2.24***	1.57***	1.41**
	(0.46)	(0.49)	(0.67)	(0.46)	(0.49)	(0.67)
1991						
Nonagricultural	4.91***	3.37***	4.19***	4.81***	3.28***	4.11***
	(0.99)	(1.09)	(1.50)	(0.97)	(1.09)	(1.49)
Manufacturing	0.72***	0.12	0.61**	0.70***	0.11	0.59**
	(0.21)	(0.22)	(0.26)	(0.20)	(0.22)	(0.26)
Services	4.19***	3.24***	3.59***	4.12***	3.17***	3.52***
	(0.82)	(0.91)	(1.29)	(0.80)	(0.90)	(1.28)
2001						
Nonagricultural	8.18***	6.79***	5.78***	8.05***	6.65***	5.65***
	(1.43)	(1.82)	(2.08)	(1.42)	(1.82)	(2.08)
Manufacturing	3.17***	2.53***	1.71**	3.12***	2.48***	1.66**
	(0.53)	(0.73)	(0.82)	(0.53)	(0.73)	(0.81)
Services	5.01***	4.26***	4.07***	4.93***	4.17***	3.99***
	(0.96)	(1.18)	(1.36)	(0.95)	(1.18)	(1.36)
2011						
Nonagricultural	7.22***	2.81	5.11*	7.05***	2.61	4.87*
	(1.52)	(2.11)	(2.74)	(1.46)	(2.11)	(2.74)
Manufacturing	2.52***	1.15	1.05	2.47***	1.10	0.98
	(0.47)	(0.70)	(0.69)	(0.46)	(0.69)	(0.68)
Services	4.70***	1.66	4.05*	4.58***	1.52	3.89*
	(1.11)	(1.50)	(2.14)	(1.06)	(1.51)	(2.14)
Fixed 1971 population	X	X	X			
Contemporaneous population				X	X	X
Log area		X	X		X	X
Mean elevation			X			X
Observations per regression	74	74	74	74	74	74

Notes: Each cell reports a separate census-year OLS coefficient on log market access, with its HC3 standard error in parentheses. Units are percentage points per natural-log unit of access. All regressions include an intercept and give equal weight to 74 harmonized Nepal districts. Extended-markets access includes the Nepal–India network and selected Indian markets, with $\theta = 3.8$, constant relative transport-cost weights and zero additional border/transfer penalties. Destination populations are fixed at 1971 or contemporaneous; the two versions coincide in 1971. G0 has no additional controls, G7 adds log area, and G1 also adds mean elevation. X marks inclusion. Shares use classified employment as their denominator. Manufacturing includes mining and construction, and services include utilities. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$ use two-sided t-based HC3 inference. These are conditional cross-sectional associations.

8.6 Spatial Distribution and Supplementary Outcomes

The following exhibits distinguish differences in district employment composition from the distribution of Nepal's workers across districts. They use all 74 harmonized districts, except

for the explicitly restricted favored–lagging comparison. Market access follows the main text's extended-markets definition throughout. These are descriptive comparisons, not estimates of the effects of roads.

The 2001 census requires particular care. Official population totals include estimates for areas missed during enumeration, but the employment counts have no corresponding additions and remain as reported. Missing employment can affect sector shares, national employment weights, concentration and the within–between decomposition, especially for the two intervals adjoining 2001. Appendix 8.1 describes these treatments. The exhibits below do not remove this coverage problem, and an exclusion sensitivity has not yet been reported.

8.6.1 Access and Employment Dispersion

Table A6 places access dispersion alongside differences in nonagricultural, manufacturing and service employment shares. Percentage-point gaps and the Theil index answer different questions: the former measure absolute differences, while the latter scales each district's share by the district mean. Each district has equal weight, irrespective of its population.

Table A6: Market Access and District Employment Dispersion

Measure	1971	1981	1991	2001	2011
Log MA, fixed 1971 population					
Mean	14.20	14.39	14.44	14.63	14.91
Standard deviation	1.29	1.14	1.14	0.98	0.79
90th–10th percentile gap	3.13	2.78	2.66	2.29	1.69
Log MA, current population					
Mean	14.20	14.69	15.00	15.44	15.88
Standard deviation	1.29	1.15	1.15	0.99	0.80
90th–10th percentile gap	3.13	2.79	2.69	2.29	1.69
Nonagricultural employment					
Mean	5.1	5.9	15.0	29.0	28.0
Standard deviation	7.1	6.1	12.5	14.5	14.3
90th–10th percentile gap	9.1	13.9	26.1	35.5	27.6
Theil index	0.544	0.411	0.266	0.115	0.108
Manufacturing employment					
Mean	1.2	0.4	2.2	9.9	7.6
Standard deviation	1.5	0.6	2.6	5.5	4.4
90th–10th percentile gap	1.8	1.0	2.9	13.4	10.5
Theil index	0.517	0.583	0.401	0.149	0.143
Service employment					
Mean	3.9	5.5	12.8	19.2	20.4
Standard deviation	5.9	5.7	10.2	9.6	10.7
90th–10th percentile gap	7.7	13.1	22.6	23.9	20.6
Theil index	0.607	0.414	0.256	0.114	0.110

Notes: All 74 districts receive equal weight. Access uses the extended-markets network with zero additional border/transfer penalties. Access statistics are in natural-log units; employment means and dispersion are in percent and percentage points. SD uses $N - 1$, as in Table 1. Theil indices are unitless and apply to district employment shares, not incomes; zero shares contribute zero. Manufacturing includes mining and construction; services include utilities. See the 2001 coverage qualification in Section 8.6.

8.6.2 Employment Concentration and Reallocation

Figure A1 instead uses each district's count of nonagricultural workers as a share of the national count. The top five are selected separately in each census, rather than fixed at their 1971 membership. Employment refers to residents enumerated in a district, not necessarily jobs located there.

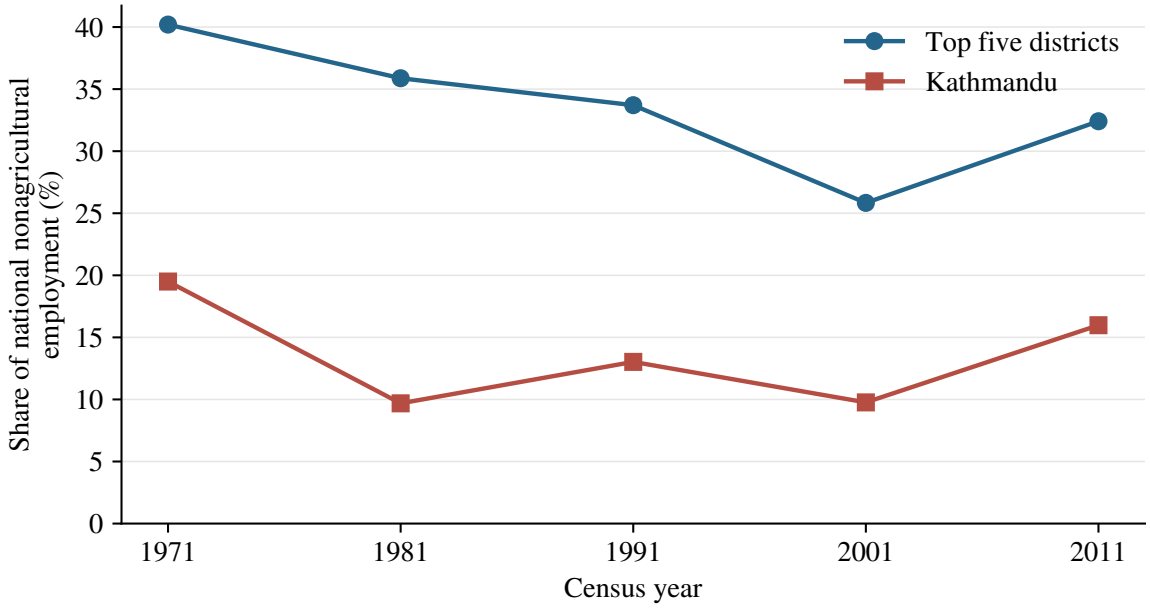


Figure A1: Geographic Concentration of Nonagricultural Employment

Notes: Both series use the national total of manufacturing-plus-service employment as their denominator, with all 74 districts included. The top five can change between censuses. The 2001 counts retain incomplete employment coverage; no adjustment is made using the additional population estimates.

For the decomposition, let $E_{id} = L^A_{id} + L^M_{id} + L^S_{id}$ be classified employment, $w_{id} = E_{id}/\sum_j E_{jd}$ a district's share of national classified employment, and $S_d = \sum_i w_{id} s^{NA}_{id}$ the national nonagricultural share. The exact midpoint identity is

$$\Delta S_d = \underbrace{\sum_i \bar{w}_{id} \Delta s^{NA}_{id}}_{\text{within districts}} + \underbrace{\sum_i \bar{s}^{NA}_{id} \Delta w_{id}}_{\text{between districts}}, \tag{11}$$

where bars denote means of the two endpoints. The between term captures changes in measured employment weights; it does not isolate migration. Table A7 reports contributions in percentage points, avoiding ratios to the small national change in the final decade.

Table A7: Within-District Change and Spatial Employment Reallocation

Period	National change	Within	Between
1971–1981	1.50	0.93	0.57
1981–1991	10.54	10.16	0.38
1991–2001	16.48	14.89	1.59
2001–2011	0.24	-1.86	2.10
1971–2011	28.76	24.61	4.16

Notes: Entries are percentage-point contributions to the national nonagricultural employment share, using the exact midpoint identity in the text. All 74 districts enter each interval. Components sum before rounding. Weights use classified employment, not population. The between component records redistribution of measured employment, not migration alone. Incomplete 2001 enumeration can affect both adjacent intervals; no missing employment has been imputed.

8.6.3 Urban Population Shares

Urbanization provides a further description of where people were recorded, although it is not a direct measure of mobility. Figure A2 compares the national urban population share, $\sum_i U_{id} / \sum_i P_{id}$, with the unweighted district mean of U_{id}/P_{id}. Here, U_{id} is the population of the statutory towns or municipalities within district i, and P_{id} is its total population. Their different weighting explains why the two series need not coincide. Changing municipal designations and boundaries, as well as population change, enter both series.

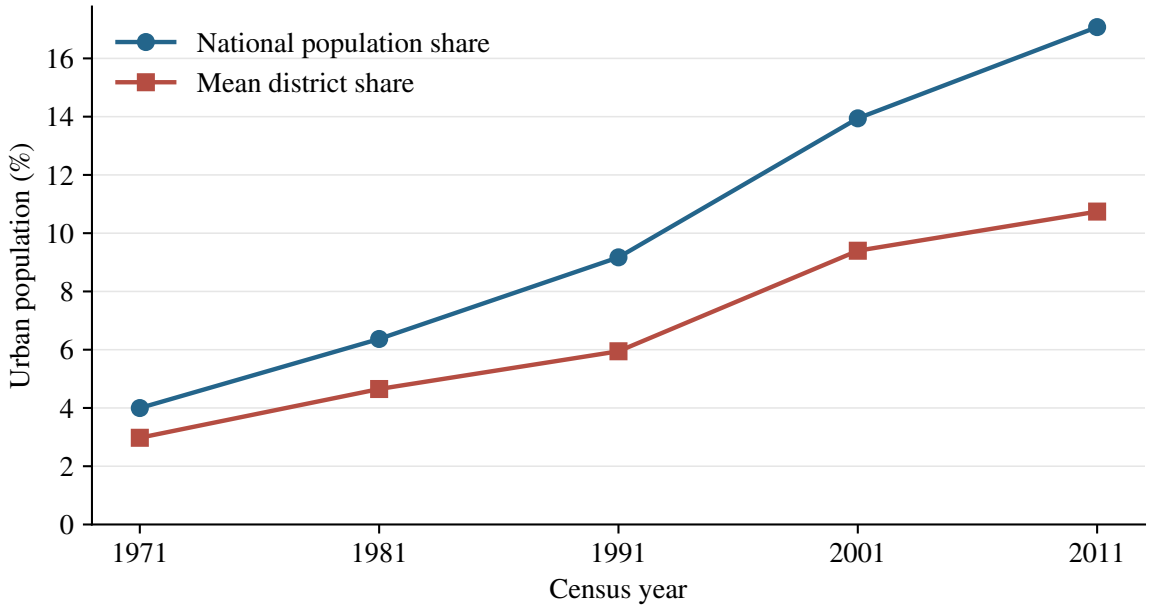


Figure A2: Urban Population Shares, 1971–2011

Notes: The national series pools urban and total population across all 74 districts. The district series gives each district equal weight, including districts with zero recorded urban population. Population totals retain the official 2001 adjustment. Urban areas follow each census's designation; these are not constant-boundary urban populations or estimates of migration.

8.6.4 Initially Favored and Lagging Districts

For Table A8, I retain the existing 1971 development groups among the 49 districts not already connected by the first census. The index averages percentile scores for the nonagricultural employment share, literacy and log population density within this reference sample. Districts at or below its median are initially lagging; the others are initially favored. Membership remains fixed through 2011. This is a comparison of initial development, not a comparison of road-arrival cohorts, and baseline differences in the index's components are partly mechanical.

Table A8: Observed Gaps Between Initially Favored and Lagging Districts

Outcome and year	Favored	Lagging	Lagging − favored
Log MA, fixed 1971 population			
1971	14.28	13.20	-1.08
2011	14.94	14.37	-0.57
Log MA, current population			
1971	14.28	13.20	-1.08
2011	15.91	15.34	-0.57
Nonagricultural employment			
1971	3.67	2.09	-1.59
2011	24.46	21.06	-3.40
Manufacturing employment			
1971	0.98	0.66	-0.33
2011	6.46	5.37	-1.09
Service employment			
1971	2.69	1.43	-1.26
2011	18.00	15.70	-2.30
Urban population share			
1971	1.29	0.00	-1.29
2011	6.63	5.25	-1.37

Notes: Unweighted means for the same 49 districts not already connected by the 1971 census: 24 favored and 25 lagging. The saved groups remain fixed at the baseline classification, using the mean percentile score of 1971 nonagricultural share, literacy and log population density; districts at or below the reference median are lagging. Employment and urban shares are percentages; their gaps are percentage points. MA uses the extended-markets network and is in log units. These are observed differences, not estimated road effects. Baseline differences in index components are partly mechanical. Statutory urban definitions can change between censuses.

8.6.5 District Rank Mobility

Finally, narrower gaps need not mean that districts exchange positions. Table A9 reports the persistence of their ranks and the extent of movement between 1971 and 2011. Figures A3 and A4 show the transitions separately for fixed-population market access and the nonagricultural employment share. Each row refers to a district's initial quintile and sums to 100 percent before rounding. Q1 has the lowest values and Q5 the highest; cells on the diagonal retain the same quintile.

Table A9: Persistence and Mobility of District Ranks, 1971–2011

Measure	Rank correlation	Mean absolute rank change	Changed quintile (%)
Log MA, fixed 1971 population	0.928	8.7	29.7
Log MA, current population	0.924	8.9	29.7
Nonagricultural employment	0.708	16.3	56.8
Manufacturing employment	0.580	21.7	68.9
Service employment	0.694	16.5	54.1
Urban population share	0.567	20.2	—

Notes: Equal weights for 74 districts. Correlation is Spearman's correlation using average ranks for ties. Mean absolute change is in percentile-rank points. Higher values receive higher ranks, without implying that a higher urban share is necessarily better. Quintiles use the ceiling of five times each census's percentile rank, preserving ties; bins need not contain equal numbers. Urban quintile movements are omitted because numerous zero ties can change bins without a change in urban share. Urban ranks also reflect changing designation. Access uses extended-markets measures. Rank mobility is distinct from a change in outcome levels or gaps.



Figure A3: District Rank Transitions in Fixed-Population Market Access

Notes: Extended-markets access with 1971 destination populations, 74 districts. Entries are row percentages, with district counts in parentheses. Quintiles are defined separately in each census using average percentile ranks for ties. This is rank mobility, not a measure of population movements.

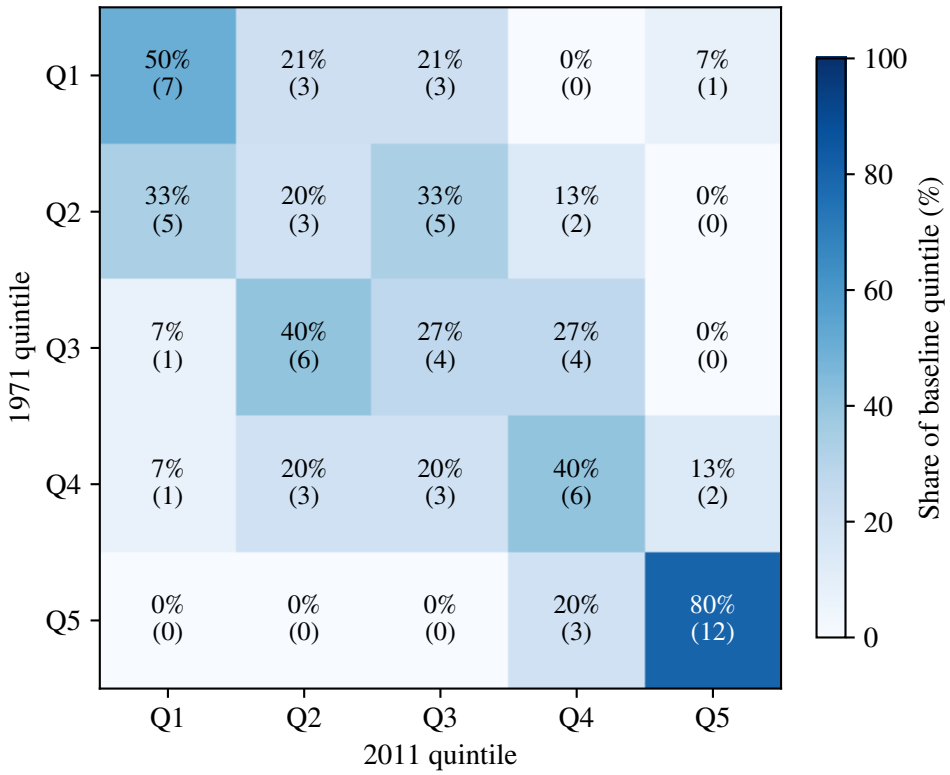


Figure A4: District Rank Transitions in Nonagricultural Employment Shares

Notes: All 74 districts. Entries are row percentages, with district counts in parentheses. The outcome is manufacturing-plus-service employment divided by classified employment within each district, not its share of national employment. Quintiles are defined separately in 1971 and 2011.