The effect of highway access on firms' inventory investment in China

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Motivation I

- **The National Trunk Highway System (NTHS) in 1992**
  - It is aimed to construct seven east-west and five north-south routes, to connect all the provincial capitals, municipalities, all other cities with above one million urban registered population and 93% of cities with a population above 500,000.

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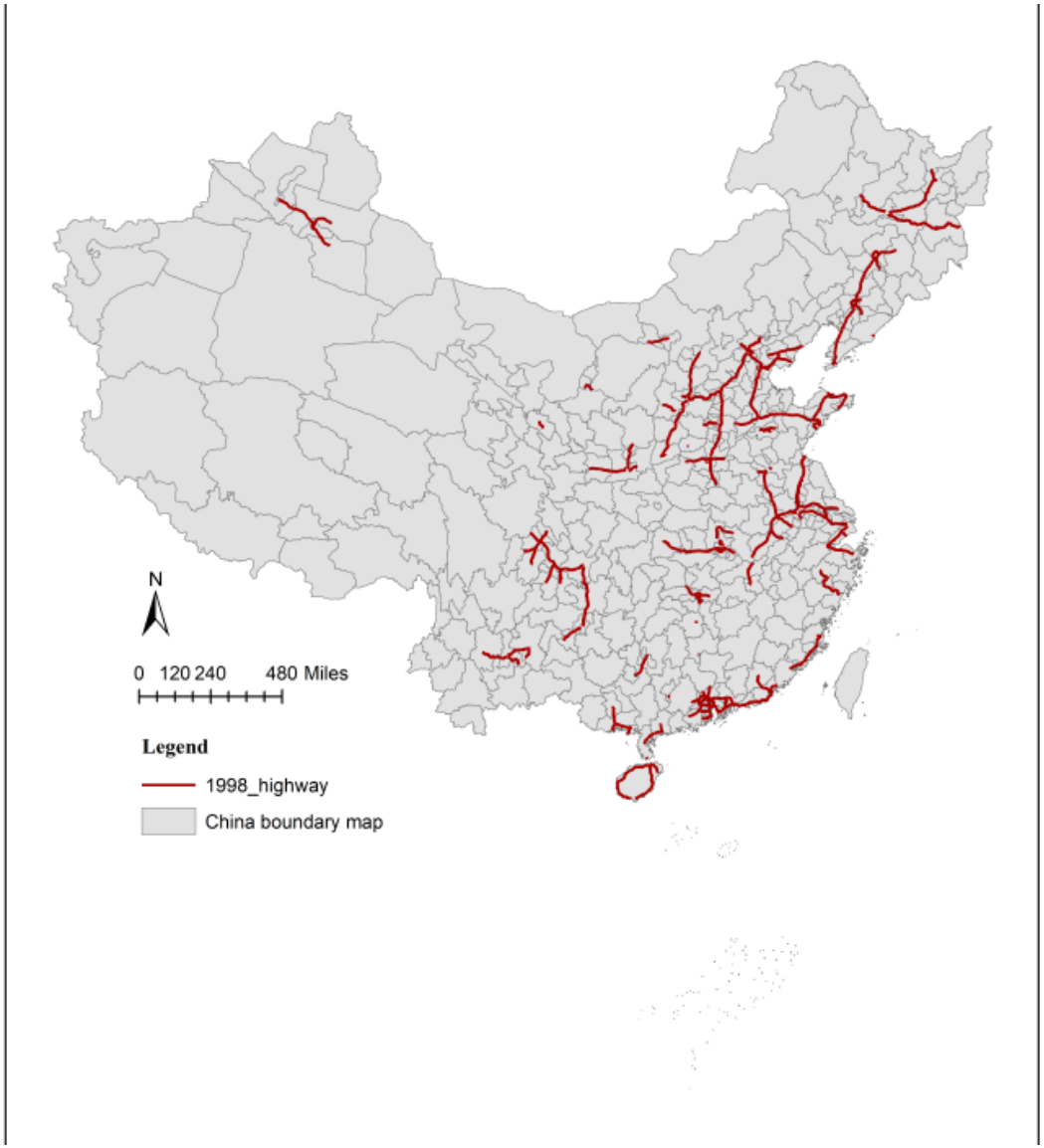
- **National Expressway Network (NEN) in 2004**
  - It is aimed to construct a highway network of 7 capital radial, 9 north-south vertical and 18 east-west horizontal lines, with a planned total length of 85,000 km.
  - It is targeted to interconnect provincial capitals and all cities with a population of over 200,000.

Time changing highway network



Motivation II

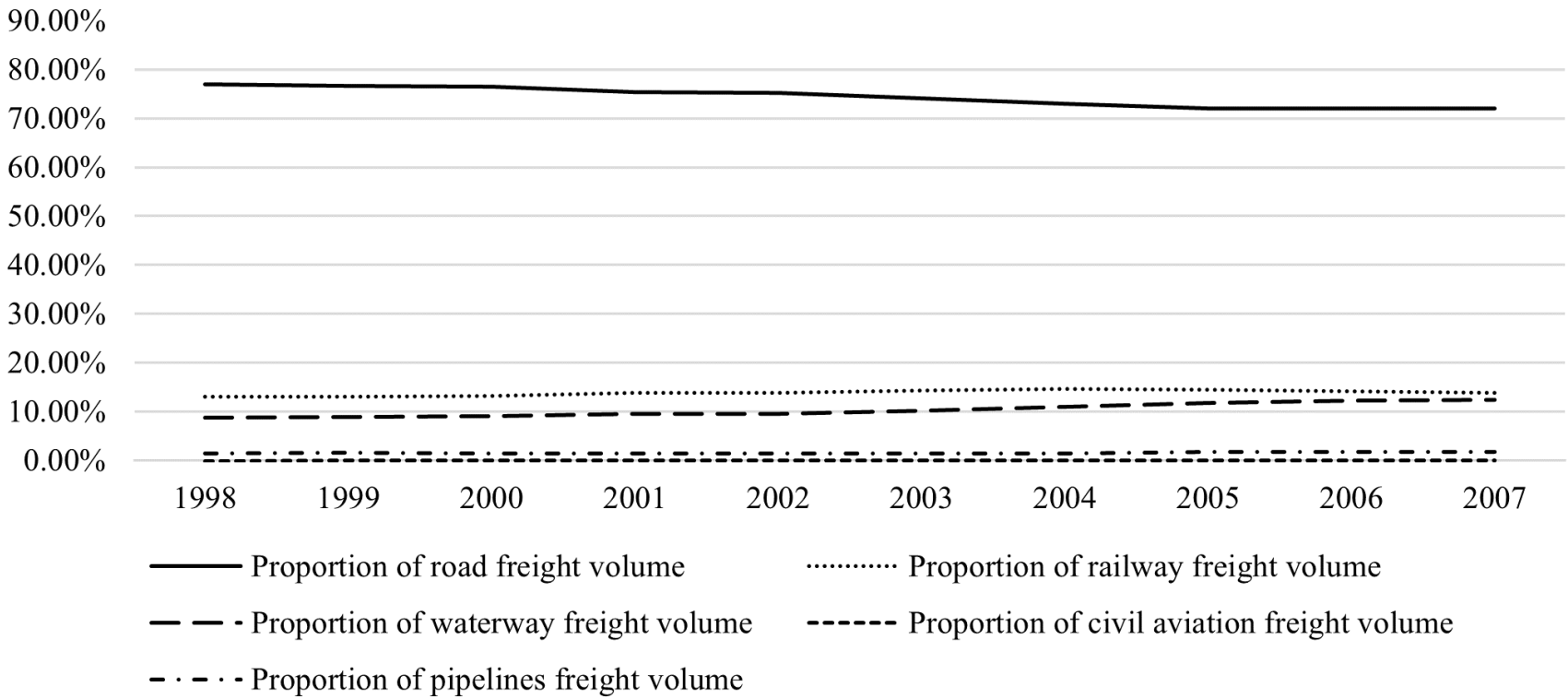


Figure: The proportion of freight volume among various transportation infrastructures

Source: China Statistical Yearbook

Contribution

- First, unlike previous studies that only use the provincial road stock as the proxy of transportation development (for example, in Li and Li, 2013; Lin et al., 2019), we construct several measures of firm-level highway accessibility based on the geo-coded firms' location and highway network over the period of 1998-2007.

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- The second contribution is to develop a more convincing method to address the endogenous issue.

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- The second contribution is to develop a more convincing method to address the endogenous issue.
- Third, we provide some mechanisms though which highway infrastructure affects inventory from different aspects such as ownership, transportation reliance, supply chain position, inventory structure, main supplier's location, and regional difference.

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Empirical literature

- Empirical research on highway infrastructure:
  - Regional level: employment (Linneker and Spence, 1996); suburbanization (Baum-Snow, 2007); trade (Duranton et al., 2014); regional productivity (Zhang and Ji, 2019); GDP growth (Banerjee et al., 2012); economic geography (Faber, 2014).
  - Firm-level: innovation (Wang et al., 2018); export (Liu et al., 2018); productivity (Holl, 2016); fixed investment (Aiello et al., 2012).

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  - Firm-level: innovation (Wang et al., 2018); export (Liu et al., 2018); productivity (Holl, 2016); fixed investment (Aiello et al., 2012).
- **Transportation infrastructure and firm inventory investment:**
  - International: Shirley and Winston (2004); Datta (2012)
  - China-specific: Li and Li (2013); Cui and Li (2019)

Theoretical literature and hypotheses

- Theories on firm-level inventory investment:
  - Models for raw materials and intermediate goods: the traditional EOQ model and its extensions of (Q, r) model and (S, s) model.
  - Models for finished goods: the EPQ model, ROQ model etc.

Theoretical literature and hypotheses

- Theories on firm-level inventory investment:
  - Models for raw materials and intermediate goods: the traditional EOQ model and its extensions of (Q, r) model and (S, s) model.
  - Models for finished goods: the EPQ model, ROQ model etc.
- **Two hypotheses**
  - The improvement of highway may encourage firms to lower their input inventory level.
  - Output inventory would be less affected by the highway improvement.

Data

- **Annual Survey of Industrial Firms (ASIF) database**
  - Firm-level panel data over the period 1998-2007, collected by the National Bureau of Statistics (NBS) of China
  - All stated-owned enterprises (SOEs) and other types of enterprises with annual sales above RMB 5 million (about $0.65 million)

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  - ACASIAN Data Centre at Griffith University in Brisbane
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- Other data
  - China's Geo-spatial Data Cloud; Climate Change Initiative-Land Cover (CCI-LC) database
  - Harvard WorldMap
  - Provincial data are obtained from the China Statistical Yearbooks
  - Input-Output Table from NBS
  - Chinese Academy of Social Sciences (CASS) survey

Key variables

- Measurement of inventory
  - the logarithm of total inventory, the logarithm of input inventory and the logarithm of output inventory
- Measurement of highway accessibility
  - Highway proximity, calculated as the inverse of distance (km), as the main highway access measure.
  - The logarithm of distance to the nearest highway
  - Relative highway proximity (RHP)

$$RHP_{i,j,k,t} = \frac{min_{i \in j,k,t}(lnhighway(m)_{i,j,k,t})}{lnhighway(m)_{i,j,k,t}} \tag{1}$$

Baseline specification

$$Inventory_{i,j,k,t} = \alpha_0 + \alpha_1 Highway_{i,j,k,t} + \alpha_2{}' X_{i,j,k,t} + \alpha_3{}' Z_{k,t} + \varepsilon_i + \varepsilon_j + \varepsilon_k + \varepsilon_t + \varepsilon_{i,j,k,t} \quad (2)$$

- Firm-level controls: sales, firm size, firm age, leverage and export ratio.
- Provincial controls: road congestion, other roads' density, waterway density and rail density.
- Fixed effects: firm/industry/province/time fixed effect.

Baseline FE result

VARIABLES	(1) Total inventory	(2) Input inventory	(3) Output inventory
Highway proximity	0.001	-0.006***	0.005**
	(0.61)	(-2.58)	(2.04)
Ln (sales)	0.271***	0.241***	0.265***
	(83.49)	(52.11)	(55.85)
Size	0.349***	0.364***	0.376***
	(87.12)	(63.89)	(63.39)
Age	0.086***	0.063***	0.136***
	(25.94)	(12.66)	(26.11)
Leverage	-0.001***	-0.001***	-0.001***
	(-48.13)	(-36.53)	(-34.04)
Export ratio	0.001***	0.001***	0.001***
	(8.92)	(9.47)	(6.79)
Congestion	0.002***	0.005***	0.001***
	(16.25)	(26.75)	(5.45)
Other roads density	-0.037***	0.063***	-0.060***
	(-2.60)	(2.99)	(-2.70)
River density	-0.281	7.723***	-5.661***
	(-0.97)	(17.98)	(-11.05)
Rail density	1.349**	4.540***	-0.601
	(2.10)	(4.75)	(-0.50)
Constant	0.609	0.299	1.274*
	(1.24)	(0.40)	(1.70)
Observations	1,856,417	1,856,417	1,856,417
R-squared	0.051	0.024	0.023
Number of firms	492,490	492,490	492,490
Company/Year/Industry/Province FE	YES	YES	YES

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Endogeneity

- Type 1: The endogenous highway construction
  - The distribution of highways is not random (reverse causality).
  - There may be some omitted variables explaining both the highway proximity and firm's inventory decisions.

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  - The distribution of highways is not random (reverse causality).
  - There may be some omitted variables explaining both the highway proximity and firm's inventory decisions.
- Type 2: The endogenous issue of new firms and relocation
  - Companies may relocate their location by moving closer to highways in order to benefit from the highway infrastructure.
  - New firms may also choose to locate close to the highways to benefit from the highway access.

Solutions of the endogenous issues

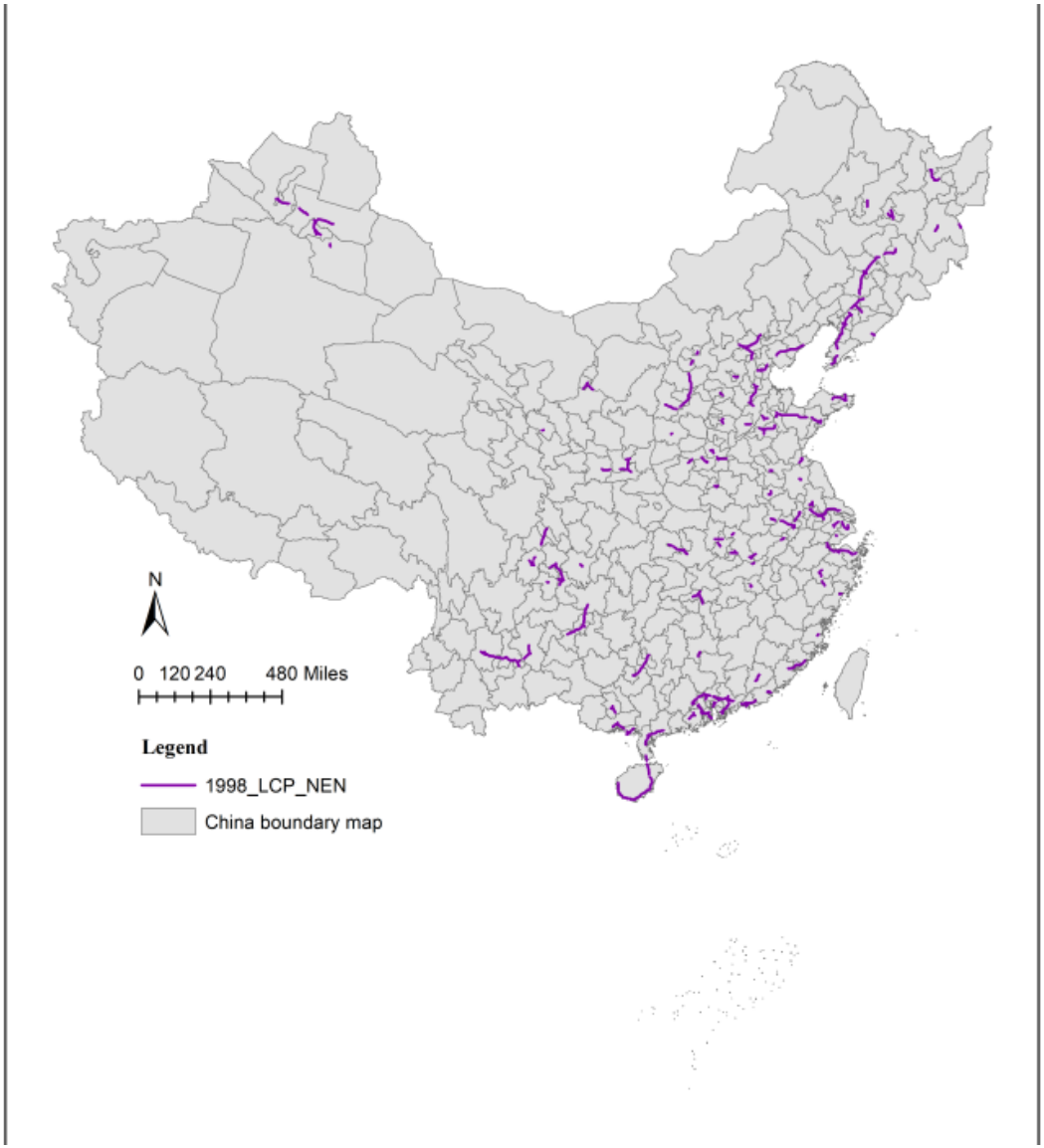
- Type 1: FE-2SLS method: alternative instruments are used
  - Least cost paths go to map
  - Straight lines go to map
  - Historical routes go to map

Solutions of the endogenous issues

- Type 1: FE-2SLS method: alternative instruments are used
  - Least cost paths go to map
  - Straight lines go to map
  - Historical routes go to map
- Type 2: We exclude relocating firms that switched their locations during the sample period and new firms that opened during the sample period.

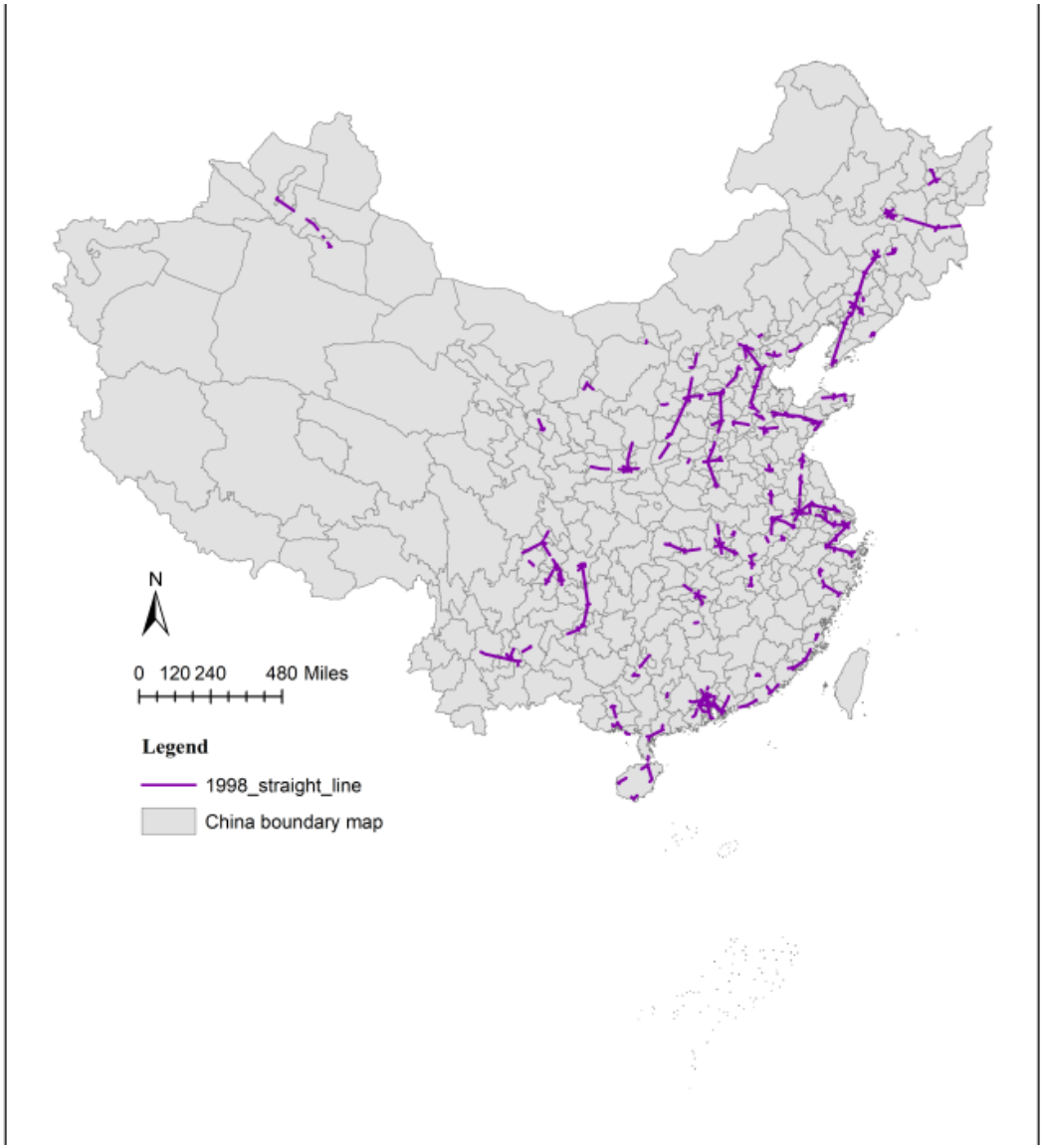
Least cost paths: 2004_NEN

return



Straight lines: 2004_NEN

return



Ming Dynasty (1364-1644) courier routes

return

IV results: first-stage

Dep. Var.: Highway proximity	(1)	(2)	(3)	(4)
Instruments				
Least cost path (2004NEN)	-0.121***			
	(-3.35)			
Least cost path (1992NTHS)		-0.193*		
		(-1.72)		
Ming courier routes			-0.233***	
			(-4.37)	
Straight line routes				-0.091**
				(-2.31)
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	1355.201	153.392	660.331	1136.150

Note: The under-identification test shows the p-value of Kleibergen-Paap rk LM statistic. The Weak-identification test reports the correspondingly robust Kleibergen-Paap rk Wald F statistic when clustered standard error is applied. The critical value to pass the Weak-identification test is 16.38.

IV results: second-stage

VARIABLES	(1) LCP_NEN	(2) LCP_NTHS	(3) Ming_routes	(4) Straight_line
Panel A: total inventory as dependent variable				
Highway proximity	-0.106***	-0.402***	-0.222***	-0.085***
	(-4.58)	(-5.02)	(-6.21)	(-3.32)
R-squared	0.039	-0.022	0.024	0.041
Panel B: input inventory as dependent variable				
Highway proximity	-0.121***	-0.193*	-0.233***	-0.091**
	(-3.35)	(-1.72)	(-4.37)	(-2.31)
R-squared	0.015	0.011	0.009	0.016
Panel C: output inventory as dependent variable				
Highway proximity	-0.029	-0.440***	-0.121**	-0.045
	(-0.80)	(-3.59)	(-2.24)	(-1.10)
R-squared	0.019	-0.013	0.016	0.019
Observations	1,732,900	1,732,900	1,732,900	1,732,900

Note: Control variables and Firm/year/province/industry fixed effects are all included.

FE-TSLS result after controlling the endogeneity of new firms and relocation

VARIABLES	(1) LCP_NEN	(2) LCP_NTHS	(3) Ming_routes	(4) Straight_line
Panel A: total inventory as dependent variable				
Highway proximity	-0.080*	-0.038	-0.079	-0.059
	(-1.95)	(-0.34)	(-1.33)	(-1.37)
R-squared	0.046	0.048	0.046	0.047
Panel B: input inventory as dependent variable				
Highway proximity	-0.208***	0.055	-0.267***	-0.164**
	(-3.15)	(0.32)	(-2.88)	(-2.38)
R-squared	0.012	0.018	0.008	0.014
Panel C: output inventory as dependent variable				
Highway proximity	0.052	0.070	0.064	0.085
	(0.80)	(0.39)	(0.70)	(1.20)
R-squared	0.018	0.018	0.018	0.018
Observations	784,096	784,096	784,096	784,096
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	487.787	79.215	238.511	449.347

Note: Control variables and Firm/year/province/industry fixed effects are all included.

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Mechanisms: heterogeneous patterns

▸ go to tables

1. **Ownership**: private firms vs. SOEs
2. **Transportation reliance**: high transportation reliance vs. low transportation reliance
3. **Production line position**: upstream vs. downstream
4. **Main suppliers' location**: main suppliers located in other provinces vs. main suppliers located in the same province
5. **Inventory structure**: high input inventory ratio vs. low input inventory ratio
6. **Spatial difference**: coastal areas vs. inland areas

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Additional robustness tests

1. Further control the endogenous issue of targeted cities go to table
   - The results are robust when we drop observations which located in the targeted NTHS cities.
2. Historical IVs go to table
   - Result is robust no matter using Ming's routes, Qing's routes, or their combination.
   - The results are also robust if the observations located in these seven provinces are excluded in the IV regression.
3. Using different highway measures go to table
   - Robust results using alternative highway measures of highway distance and relative highway proximity.
4. Alternative buffers go to table
   - The result is still robust when using panel IVs generated based on the 5km's highway buffer.

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Implied savings of inventory

Variable	(1) LCP_NEN	(2) LCP_NTHS	(3) Ming routes	(4) Straight line	(5) Observations
			Firm level		
Annual changes in highway proximity	0.038	0.038	0.038	0.038	1,325,516
Annual saving rate of input inventory	0.455%	0.726%	0.877%	0.342%	1,325,516
Annual saving rate of total inventory	0.399%	1.513%	0.835%	0.320%	1,325,516
Annual input inventory saving	21.464	34.235	41.331	16.142	1,325,516
Annual total inventory saving	30.203	114.542	63.255	24.219	1,325,516
			National level		
Annual saving rate of input inventory	0.486%	0.776%	0.937%	0.366%	9
Annual saving rate of total inventory	0.406%	1.540%	0.850%	0.326%	9
Input inventory saving/highway investment	2.079%	3.317%	4.004%	1.564%	1
Total inventory saving/highway investment	2.926%	11.097%	6.128%	2.346%	1
			Adjusted national level		
Input inventory saving/highway investment	5.198%	8.293%	10.010%	3.910%	1
Total inventory saving/highway investment	6.730%	25.523%	14.094%	12.389%	1

Note: Mean values are reported.

At the adjusted national level, each dollar of highway spending in China during the period of 1998-2007 reduced the input inventory stock by about 3.910-10.010 cents and the total inventory stock by around 6.730-25.523 cents.

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Conclusion

- Our estimates indicate a robust causal effect of highway proximity on the reduction in firm-level total inventories and input inventories.
- Additional results indicate that cost saving benefits of input inventories are unevenly distributed across different firms, sectors and regions.
- Each dollar of highway spending in China during the period of 1998-2007 reduced the input inventory stock by about 3.910-10.010 cents and the total inventory stock by around 6.730-25.523 cents.

Ownership

return

Dep. Var.: ln (input inventory)	(1) LCP_NEN	(2) LCP_NTHS	(3) Ming_routes	(4) Straight_line
		Panel A: SOEs		
Highway proximity	0.271***	0.530***	0.168	0.143
	(2.84)	(2.89)	(1.52)	(1.47)
Observations	154,763	154,763	154,763	154,763
R-squared	0.010	-0.022	0.016	0.018
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	374.965	130.349	226.441	331.775
		Panel B: private firms		
Highway proximity	-0.181***	-0.653***	-0.276***	-0.109**
	(-3.84)	(-3.72)	(-4.16)	(-1.98)
Observations	1,075,124	1,075,124	1,075,124	1,075,124
R-squared	0.011	-0.043	0.005	0.013
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	796.753	72.614	402.836	573.768
Empirical p-value	0.005***	0.000***	0.065**	0.145

Note: Control variables and Firm/year/province/industry fixed effects are all included.

Transportation infrastructure reliance

return

Dep. Var.: ln (input inventory)	(1) LCP_NEN	(2) LCP_NTHS	(3) Ming_routes	(4) Straight_line
Panel A: high infrastructure reliance				
Highway proximity	-0.110**	-0.446***	-0.236***	-0.085*
	(-2.36)	(-2.72)	(-3.33)	(-1.70)
Observations	828,754	828,754	828,754	828,754
R-squared	0.011	-0.015	0.005	0.012
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	851.664	82.676	350.424	719.243
Panel B: low infrastructure reliance				
Highway proximity	-0.094	-0.152	-0.189**	-0.091
	(-1.48)	(-0.75)	(-2.10)	(-1.30)
Observations	841,080	841,080	841,080	841,080
R-squared	0.017	0.015	0.013	0.017
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	494.300	52.637	275.479	428.327
Empirical p-value	0.130	0.015**	0.070*	0.270

Note: Control variables and Firm/year/province/industry fixed effects are all included.

Production line position

return

Dep. Var.: ln (input inventory)	(1) LCP_NEN	(2) LCP_NTHS	(3) Ming_routes	(4) Straight_line
		Panel A: upstream		
Highway proximity	-0.172***	-0.328*	-0.242***	-0.142**
	(-2.99)	(-1.94)	(-3.02)	(-2.32)
Observations	877,914	877,914	877,914	877,914
R-squared	0.012	0.000	0.007	0.013
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	620.270	79.828	345.133	542.993
		Panel B: downstream		
Highway proximity	-0.107**	-0.133	-0.171**	-0.060
	(-2.18)	(-0.80)	(-2.36)	(-1.11)
Observations	811,962	811,962	811,962	811,962
R-squared	0.014	0.013	0.011	0.015
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	681.208	68.197	334.057	564.256
Empirical p-value	0.045**	0.075*	0.045**	0.020**

Note: Control variables and Firm/year/province/industry fixed effects are all included.

Main supplier's location

return

Dep. Var.: ln (input inventory)	(1) LCP_NEN	(2) LCP_NTHS	(3) Ming_routes	(4) Straight_line
Panel A: suppliers outside the province				
Highway proximity	-0.133***	-0.173	-0.231***	-0.078*
	(-3.39)	(-1.56)	(-4.00)	(-1.77)
Observations	1,431,164	1,431,164	1,431,164	1,431,164
R-squared	0.015	0.013	0.009	0.016
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	1138.233	162.199	557.233	896.566
Panel B: suppliers within the province				
Highway proximity	-0.002	-0.088	-0.201	-0.143
	(-0.03)	(-0.15)	(-1.40)	(-1.63)
Observations	296,135	296,135	296,135	296,135
R-squared	0.014	0.013	0.009	0.012
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	196.045	4.881	95.980	244.066
Empirical p-value	0.345	0.290	0.150	0.055*

Note: Control variables and Firm/year/province/industry fixed effects are all included.

Inventory structure

return

Dep. Var.: ln (input inventory)	(1) LCP_NEN	(2) LCP_NTHS	(3) Ming_routes	(4) Straight_line
Panel A: high input inventory ratio				
Highway proximity	-0.112***	-0.287***	-0.141***	-0.071***
	(-5.20)	(-3.34)	(-4.42)	(-3.15)
Observations	634,276	634,276	634,276	634,276
R-squared	0.094	-0.008	0.084	0.105
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	506.422	42.591	250.436	443.287
Panel B: low input inventory ratio				
Highway proximity	-0.074	-0.087	-0.023	0.056
	(-1.22)	(-0.42)	(-0.28)	(0.78)
Observations	625,043	625,043	625,043	625,043
R-squared	0.010	0.010	0.011	0.010
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	637.520	62.744	310.307	489.301
Empirical p-value	0.170	0.030**	0.055*	0.040**

Note: Control variables and Firm/year/province/industry fixed effects are all included.

Spacial difference

return

Dep. Var.: ln (input inventory)	(1) LCP_NEN	(2) LCP_NTHS	(3) Ming_routes	(4) Straight_line
	Panel A: coastal areas			
Highway proximity	-0.150***	-0.361	-0.442***	-0.150***
	(-3.29)	(-1.36)	(-5.35)	(-2.91)
Observations	1,274,821	1,274,821	1,274,821	1,274,821
R-squared	0.014	-0.004	-0.015	0.014
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	677.964	22.689	242.421	527.383
	Panel B: inland areas			
Highway proximity	-0.070	0.061	0.010	0.006
	(-1.25)	(0.62)	(0.14)	(0.10)
Observations	458,071	458,071	458,071	458,071
R-squared	0.017	0.017	0.018	0.018
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	827.955	403.104	606.533	885.606
Empirical p-value	0.065*	0.015**	0.000***	0.005***

Note: Control variables and Firm/year/province/industry fixed effects are all included.

Further control the endogenous issue of targeted cities

return

Dep. Var.: ln (input inventory)	(1) LCP_NEN	(2) LCP_NTHS	(3) Ming_routes	(4) Straight_line
Highway proximity	-0.190***	-0.239***	-0.224***	-0.081*
	(-3.79)	(-2.94)	(-4.30)	(-1.81)
Observations	615,546	615,546	615,546	615,546
R-squared	0.011	0.009	0.010	0.014
Instruments	First-stage results: highway proximity as dependent variable			
Least cost path (2004NEN)	-0.125***			
	(-25.60)			
Least cost path (1992NTHS)		-0.115***		
		(-13.08)		
Ming courier routes			-0.112***	
			(-19.51)	
Straight line routes				-0.120***
				(-27.62)
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	912.921	238.185	530.522	1062.932

Note: Control variables and Firm/year/province/industry fixed effects are all included.

Historical IVs

return

Dep. Var.: ln (input inventory)	(1) Ming	(2) Qing	(3) Ming&Qing
Panel A: full sample			
Highway proximity	-0.233***	-0.405**	-0.203***
	(-4.37)	(-2.35)	(-4.20)
Observations	1,732,900	1,732,900	1,732,900
R-squared	0.009	-0.008	0.011
Under identification test	0.000***	0.000***	0.000***
Weak identification test	660.331	96.418	337.580
Overidentification test	-	-	0.218
Panel B: drop 7 provinces			
Highway proximity	-0.249***	-0.516***	-0.204***
	(-4.62)	(-2.79)	(-4.20)
Observations	1,680,944	1,680,944	1,680,944
R-squared	0.007	-0.024	0.011
Under identification test	0.000***	0.000***	0.000***
Weak identification test	651.894	86.051	334.629
Overidentification test	-	-	0.071

Note: Control variables and Firm/year/province/industry fixed effects are all included. The critical value to pass the Weak-identification test is 16.38 in column (1)-(2) and 19.93 in column (3). Overidentification test reports the p-value of Hanson J statistic. The critical p-value to pass the overidentification test is more than 0.05.

Alternative highway measures: highway distance

next

Dep. Var.: ln (input inventory)	(1) LCP_NEN	(2) LCP_NTHS	(3) Ming_routes	(4) Straight_line
Panel A: full sample				
Ln (highway distance)	0.021***	0.016*	0.034***	0.014**
	(3.36)	(1.74)	(4.43)	(2.32)
Observations	1,732,900	1,732,900	1,732,900	1,732,900
R-squared	0.017	0.017	0.017	0.017
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	5.5e+04	1.9e+04	3.4e+04	4.5e+04
Panel B: drop observations which located in the targeted NTHS cities				
Ln (highway distance)	0.035***	0.055***	0.046***	0.015*
	(3.81)	(3.01)	(4.37)	(1.81)
Observations	615,546	615,546	615,546	615,546
R-squared	0.014	0.014	0.014	0.014
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	3.3e+04	5929.895	2.3e+04	3.5e+04

Note: Control variables and Firm/year/province/industry fixed effects are all included.

Alternative highway measures: relative highway proximity

return

Dep. Var.: ln (input inventory)	(1) LCP_NEN	(2) LCP_NTHS	(3) Ming_routes	(4) Straight_line
Panel A: full sample				
RHP	-0.396***	-0.330*	-0.650***	-0.272**
	(-3.36)	(-1.74)	(-4.43)	(-2.32)
Observations	1,732,900	1,732,900	1,732,900	1,732,900
R-squared	0.017	0.017	0.016	0.017
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	2.1e+04	7592.971	1.5e+04	2.0e+04
Panel B: drop observations which located in the targeted NTHS cities				
RHP	-0.720***	-1.120***	-0.872***	-0.289*
	(-3.81)	(-3.01)	(-4.37)	(-1.81)
Observations	615,546	615,546	615,546	615,546
R-squared	0.014	0.013	0.014	0.014
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	1.0e+04	2124.520	8936.221	1.4e+04

Note: Control variables and Firm/year/province/industry fixed effects are all included.

Alternative buffer (5KM)

Dep. Var.: ln (input inventory)	(1) LCP_NEN	(2) LCP_NTHS	(3) Ming_routes	(4) Straight_line
Panel A: highway proximity as highway variable				
Highway proximity	-0.156***	-0.141**	-0.228***	-0.123***
	(-3.53)	(-2.09)	(-5.15)	(-3.20)
Observations	615,546	615,546	615,546	615,546
R-squared	0.012	0.012	0.009	0.013
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	1043.096	308.993	636.172	1272.641
Panel B: highway distance as highway variable				
Ln (highway distance)	0.032***	0.037**	0.053***	0.025***
	(3.54)	(2.11)	(5.25)	(3.22)
Observations	615,546	615,546	615,546	615,546
R-squared	0.014	0.014	0.014	0.014
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	4.2e+04	7796.665	2.8e+04	4.1e+04
Panel C: highway proximity to the frontier as highway variable				
RHP	-0.637***	-0.748**	-0.983***	-0.491***
	(-3.54)	(-2.11)	(-5.25)	(-3.22)
Observations	615,546	615,546	615,546	615,546
R-squared	0.014	0.014	0.014	0.014
Under identification test	0.000***	0.000***	0.000***	0.000***
Weak identification test	1.2e+04	2523.466	1.0e+04	1.6e+04

Note: Control variables and Firm/year/province/industry fixed effects are all included.

Demand proxies

- the logarithm of sales
- sales surprise dummy
- sales growth
- excess sales growth, calculated as sales growth minus the mean value of four-digit industry-level sales growth in each year.

$$Lnsales_{i,t} = \gamma_0 + \gamma_1 Lnsales_{i,t-1} + \varepsilon_i + \varepsilon_t + \varepsilon_{i,t} \tag{3}$$

$$Sales\_surprise_{i,t} = \frac{Lnsales_{i,t}}{\widehat{Lnsales_{i,t}}} \tag{4}$$

The mechanism of demand

Highway may indirectly affect firms' inventories through the channel of demand.

$$\begin{aligned} Inventory_{i,j,k,t} = \gamma_0 + \gamma_1 Highway_{i,j,k,t} + \gamma_2 Highway_{i,j,k,t} * Demand_{i,j,k,t} + \\ \gamma_3 Demand_{i,j,k,t} + \gamma_4{}' X_{i,j,k,t} + \gamma_5{}' Z_{k,t} + \theta_i + \theta_j + \theta_k + \theta_t + \theta_{i,j,k,t} \end{aligned} \tag{5}$$

The demand proxies include the logarithm of sales, sales surprise dummy, sales growth, excess sales growth, respectively.

IV result: demand channel

VARIABLES	(1) Total inventory	(2) Total inventory	(3) Input inventory	(4) Input inventory	(5) Output inventory	(6) Output inventory
Highway proximity	-0.968***	-0.113***	-0.894***	-0.130***	-0.656***	-0.020
	(-9.19)	(-4.70)	(-5.75)	(-3.53)	(-4.23)	(-0.54)
Highway proximity*lnsales	0.090***		0.081***		0.065***	
	(8.48)		(5.06)		(4.08)	
lnsales	0.228***		0.203***		0.234**	
	(38.14)		(22.93)		(26.90	
Highway proximity*SSD		0.055***		0.060**		-0.001
		(3.37)		(2.33)		(-0.03)
Sales surprise dummy (SSD)		0.138***		0.102***		0.175***
		(15.05)		(7.09)		(12.39)
Observations	1,732,900	1,732,900	1,732,900	1,732,900	1,732,900	1,732,900
R-squared	0.036	0.032	0.014	0.013	0.018	0.016
Under identification test	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
Weak identification test	546.694	660.322	546.694	660.322	546.694	660.322

Note: Control variables and Firm/year/province/industry fixed effects are all included. The interaction terms of highway proximity and sales growth/ or excess sales growth are insignificant.