Appendix
Alternate IV Specifications

Dense Enough To Be Brilliant: Patents, Urbanization, and Transportation in Nineteenth Century America

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November 5, 2015

Contents

References

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Local Transportation Access

Table 1: Instrumental Variables: Patents per Capita vs. the Percent of the County within 1.5 Miles of Transportation

	IV: 1830-1900					
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	First Stage	IV	OLS	First Stage	IV
	Patents per	Percent Trans	Patents per	Patents per	Percent Trans	Patents per
VARIABLES	10K People	1.5 Miles	10K People	10K People	1.5 Miles	10K People
Line Instrument		0.0154**			0.00616**	
		(0.00242)			(0.00236)	
% within 1.5 miles of transport	5.340**		36.06**	1.000*		37.92+
	(0.521)		(9.814)	(0.437)		(21.95)
log Total Pop				-0.0272	0.00330**	-0.148+
				(0.0469)	(0.000903)	(0.0888)
T-Squared		40.60			6.809	
Wald Stat.			44.86			7.540
Years	1790-1900	1790-1900	1790-1900	1790-1900	1790-1900	1790-1900
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Pre-trends	Yes	Yes	Yes	Yes	Yes	Yes
County Controls	No	No	No	Yes	Yes	Yes
Counties	1250	1250	1250	1250	1250	1250
Observations	13,249	13,249	13,249	13,249	13,249	13,249
R-squared	0.660	0.889	0.233	0.793	0.908	-1.000

Robust standard errors in parentheses, standard errors clustered by county.
** p<0.01, * p<0.05, + p<0.1

Sources: Patent data as described in the text, U.S. Census Data is from Haines (2010) (county boundaries harmonized to 1840 as in Hornbeck (2010)), transportation data from Atack (2013).

Table 2: Instrumental Variables: Patents per Capita vs. the Percent of the County within 1.5 Miles of Transportation, Alternate Instrument, 1840-1870

VARIABLES	(1) OLS Patents per 10K People	(2) First Stage Percent Trans 1.5 Miles	(3) IV Patents per 10K People	(4) OLS Patents per 10K People	(5) First Stage Percent Trans 1.5 Miles	(6) IV Patents per 10K People
Port Instrument		0.0110**			0.00463	
		(0.00416)			(0.00374)	
% within 1.5 miles of transport	7.600**		31.45*	1.860+		49.00
	(1.084)		(15.86)	(1.033)		(41.94)
log Total Pop				-0.870	-0.00498	-0.637
				(0.797)	(0.00440)	(0.764)
T-Squared		6.987			1.530	
Wald Stat.			9.334			2.057
Years	1840-1870	1840-1870	1840-1870	1840-1870	1840-1870	1840-1870
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Pre-trends	Yes	Yes	Yes	Yes	Yes	Yes
County Controls	No	No	No	Yes	Yes	Yes
Counties	1250	1250	1250	1250	1250	1250
Observations	4,995	4,995	4,995	4,995	4,995	4,995
R-squared	0.655	0.875	0.318	0.784	0.901	-0.945

Robust standard errors in parentheses, standard errors clustered by county.
** p<0.01, * p<0.05, + p<0.1

Sources: Patent data as described in the text, U.S. Census Data is from Haines (2010) (county boundaries harmonized to 1840 as in Hornbeck (2010)), transportation data from Atack (2013).

Table 3: Instrumental Variables: Patents per Capita vs. the Percent of the County within 1.5 Miles of Transportation, Alternate Instrument

VARIABLES	(1) OLS Patents per 10K People	(2) First Stage Percent Trans 1.5 Miles	(3) IV Patents per 10K People	(4) OLS Patents per 10K People	(5) First Stage Percent Trans 1.5 Miles	(6) IV Patents per 10K People
Port Instrument		0.0153**			0.00804**	
		(0.00292)			(0.00276)	
% within 1.5 miles of transport	5.340**		33.72**	1.000*		28.21+
	(0.521)		(12.17)	(0.437)		(16.78)
log Total Pop				-0.0272	0.00317**	-0.116+
				(0.0469)	(0.000901)	(0.0683)
T-Squared		27.45			8.503	
Wald Stat.			30.33			9.417
Years	1790-1900	1790-1900	1790-1900	1790-1900	1790-1900	1790-1900
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Pre-trends	Yes	Yes	Yes	Yes	Yes	Yes
County Controls	No	No	No	Yes	Yes	Yes
Counties	1250	1250	1250	1250	1250	1250
Observations	13,249	13,249	13,249	13,249	13,249	13,249
R-squared	0.660	0.889	0.271	0.793	0.908	-0.539

Robust standard errors in parentheses, standard errors clustered by county.
** p<0.01, * p<0.05, + p<0.1

Sources: Patent data as described in the text, U.S. Census Data is from Haines (2010) (county boundaries harmonized to 1840 as in Hornbeck (2010)), transportation data from Atack (2013).

Table 4: Instrumental Variables: Patents per Capita vs. the Percent of the County within 5.0 Miles of Transportation

VARIABLES	(1) OLS Patents per 10K People	(2) First Stage Percent Trans 5.0 Miles	(3) IV Patents per 10K People	(4) OLS Patents per 10K People	(5) First Stage Percent Trans 5.0 Miles	(6) IV Patents per 10K People
Line Instrument		0.0390**			0.0161**	
		(0.00526)			(0.00519)	
% within 5 miles of transport	1.904**		18.49**	0.398*		13.24+
	(0.169)		(4.304)	(0.166)		(7.481)
log Total Pop				-0.0265	0.00566**	-0.0974
				(0.0468)	(0.00209)	(0.0640)
T-Squared		54.95			9.671	
Wald Stat.			60.71			10.71
Years	1790-1900	1790-1900	1790-1900	1790-1900	1790-1900	1790-1900
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Pre-trends	Yes	Yes	Yes	Yes	Yes	Yes
County Controls	No	No	No	Yes	Yes	Yes
Counties	1250	1250	1250	1250	1250	1250
Observations	13,249	13,249	13,249	13,249	13,249	13,249
R-squared	0.637	0.880	0.116	0.792	0.896	-0.564

Robust standard errors in parentheses, standard errors clustered by county.
** p<0.01, * p<0.05, + p<0.1

Sources: Patent data as described in the text, U.S. Census Data is from Haines (2010) (county boundaries harmonized to 1840 as in Hornbeck (2010)), transportation data from Atack (2013).

Table 5: Instrumental Variables: Patents per Capita vs. the Percent of the County within 5.0 Miles of Transportation, Alternate Instrument, 1840-1870

VARIABLES	(1) OLS Patents per 10K People	(2) First Stage Percent Trans 5.0 Miles	(3) IV Patents per 10K People	(4) OLS Patents per 10K People	(5) First Stage Percent Trans 5.0 Miles	(6) IV Patents per 10K People
Port Instrument		0.0232*			0.00465	
		(0.0100)			(0.00930)	
% within 5 miles of transport	2.662**		18.86*	0.727*		49.26
	(0.452)		(8.980)	(0.335)		(87.03)
log Total Pop				-0.858	-0.0126	-0.247
				(0.801)	(0.00980)	(1.392)
T-Squared		5.332			0.250	
Wald Stat.			7.124			0.336
Years	1840-1870	1840-1870	1840-1870	1840-1870	1840-1870	1840-1870
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Pre-trends	Yes	Yes	Yes	Yes	Yes	Yes
County Controls	No	No	No	Yes	Yes	Yes
Counties	1250	1250	1250	1250	1250	1250
Observations	4,995	4,995	4,995	4,995	4,995	4,995
R-squared	0.642	0.862	0.121	0.783	0.887	-5.799

Robust standard errors in parentheses, standard errors clustered by county.
** p<0.01, * p<0.05, + p<0.1

Sources: Patent data as described in the text, U.S. Census Data is from Haines (2010) (county boundaries harmonized to 1840 as in Hornbeck (2010)), transportation data from Atack (2013).

Table 6: Instrumental Variables: Patents per Capita vs. the Percent of the County within 5.0 Miles of Transportation, Alternate Instrument

VARIABLES	(1) OLS Patents per 10K People	(2) First Stage Percent Trans 5.0 Miles	(3) IV Patents per 10K People	(4) OLS Patents per 10K People	(5) First Stage Percent Trans 5.0 Miles	(6) IV Patents per 10K People
Port Instrument		0.0236**			0.00609	
		(0.00631)			(0.00595)	
% within 5 miles of transport	1.904**		29.60**	0.398*		37.23
	(0.169)		(9.980)	(0.166)		(38.76)
log Total Pop				-0.0265	0.00546**	-0.230
				(0.0468)	(0.00208)	(0.227)
T-Squared		14.02			1.050	
Wald Stat.			15.49			1.162
Years	1790-1900	1790-1900	1790-1900	1790-1900	1790-1900	1790-1900
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Pre-trends	Yes	Yes	Yes	Yes	Yes	Yes
County Controls	No	No	No	Yes	Yes	Yes
Counties	1250	1250	1250	1250	1250	1250
Observations	13,249	13,249	13,249	13,249	13,249	13,249
R-squared	0.637	0.879	-0.502	0.792	0.896	-4.694

Robust standard errors in parentheses, standard errors clustered by county.
** p<0.01, * p<0.05, + p<0.1

Sources: Patent data as described in the text, U.S. Census Data is from Haines (2010) (county boundaries harmonized to 1840 as in Hornbeck (2010)), transportation data from Atack (2013).

Market Access

Table 7: Instrumental Variables: Patents per Capita vs. Estimated Market Access, 1840-1870

	(1) OLS	(2) First Stage	(3) IV	(4) OLS	(5) First Stage	(6) IV
VARIABLES	Patents per 10K People	MA	Patents per 10K People	Patents per 10K People	MA	Patents per 10K People
Line Instrument		0.0842**			0.0526*	
		(0.0239)			(0.0222)	
log Market Access with	0.510		0.741	0.00768		3.767
Own Pop ($\theta = 3.8$)	(0.314)		(1.919)	(0.141)		(2.682)
log Total Pop				-1.016	0.416**	-2.572+
				(0.759)	(0.0438)	(1.319)
T-Squared		12.37			5.632	
Wald Stat.			16.53			7.573
Years	1840-1870	1840-1870	1840-1870	1840-1870	1840-1870	1840-1870
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Pre-trends	Yes	Yes	Yes	Yes	Yes	Yes
County Controls	No	No	No	Yes	Yes	Yes
Counties	1250	1250	1250	1250	1250	1250
Observations	4,995	4,995	4,995	4,995	4,995	4,995
R-squared	0.620	0.947	0.373	0.782	0.962	-0.221

Robust standard errors in parentheses, standard errors clustered by county.
** p<0.01, * p<0.05, + p<0.1

Sources: Patent data as described in the text, U.S. Census Data is from Haines (2010) (county boundaries harmonized to 1840 as in Hornbeck (2010)), transportation data from Atack (2013).

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Table 8: Instrumental Variables: Patents per Capita vs. the Percent of the County within 5.0 Miles of Transportation

	(1) OLS	(2) First Stage	(3) IV	(4) OLS	(5) First Stage	(6) IV
VARIABLES	Patents per 10K People	MA	Patents per 10K People	Patents per 10K People	MA	Patents per 10K People
Line Instrument		0.0664**			0.0412*	
		(0.0189)			(0.0183)	
log Market Access with	0.491**		2.747	0.107+		5.991+
Own Pop ($\theta = 3.8$)	(0.0717)		(2.806)	(0.0652)		(3.486)
log Total Pop				-0.130	0.531**	-3.252+
				(0.0865)	(0.0204)	(1.843)
T-Squared		12.34			5.077	
Wald Stat.			13.64			5.622
Years	1790-1900	1790-1900	1790-1900	1790-1900	1790-1900	1790-1900
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Pre-trends	Yes	Yes	Yes	Yes	Yes	Yes
County Controls	No	No	No	Yes	Yes	Yes
Counties	1250	1250	1250	1250	1250	1250
Observations	13,249	13,249	13,249	13,249	13,249	13,249
R-squared	0.616	0.939	0.338	0.792	0.968	-1.055

Robust standard errors in parentheses, standard errors clustered by county.
** p<0.01, * p<0.05, + p<0.1

Sources: Patent data as described in the text, U.S. Census Data is from Haines (2010) (county boundaries harmonized to 1840 as in Hornbeck (2010)), transportation data from Atack (2013).

Table 9: Instrumental Variables: Patents per Capita vs. the Percent of the County within 5.0 Miles of Transportation, Alternate Instrument 1840-1870

	(1) OLS	(2) First Stage	(3) IV	(4) OLS	(5) First Stage	(6) IV
VARIABLES	Patents per 10K People	MA	Patents per 10K People	Patents per 10K People	MA	Patents per 10K People
Port Instrument		0.0630*			0.0148	
		(0.0269)			(0.0253)	
log Market Access with	0.510		2.635	0.00768		19.06
Own Pop ($\theta = 3.8$)	(0.314)		(2.568)	(0.141)		(28.71)
log Total Pop				-1.016	0.413**	-8.902
				(0.759)	(0.0439)	(12.02)
T-Squared		5.475			0.344	
Wald Stat.			7.315			0.462
Years	1840-1870	1840-1870	1840-1870	1840-1870	1840-1870	1840-1870
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Pre-trends	Yes	Yes	Yes	Yes	Yes	Yes
County Controls	No	No	No	Yes	Yes	Yes
Counties	1250	1250	1250	1250	1250	1250
Observations	4,995	4,995	4,995	4,995	4,995	4,995
R-squared	0.620	0.947	0.334	0.782	0.962	-6.164

Robust standard errors in parentheses, standard errors clustered by county.
** p<0.01, * p<0.05, + p<0.1

Sources: Patent data as described in the text, U.S. Census Data is from Haines (2010) (county boundaries harmonized to 1840 as in Hornbeck (2010)), transportation data from Atack (2013).

Table 10: Instrumental Variables: Patents per Capita vs. the Percent of the County within 5.0 Miles of Transportation, Alternate Instrument

	(1) OLS	(2) First Stage	(3) IV	(4) OLS	(5) First Stage	(6) IV
VARIABLES	Patents per 10K People	MA	Patents per 10K People	Patents per 10K People	MA	Patents per 10K People
Port Instrument		0.0561*			-0.0392+	
		(0.0249)			(0.0233)	
log Market Access with	0.491**		3.464	0.107+		-6.372
Own Pop ($\theta = 3.8$)	(0.0717)		(3.603)	(0.0652)		(4.696)
log Total Pop				-0.130	0.531**	3.307
				(0.0865)	(0.0204)	(2.491)
T-Squared		5.066			2.831	
Wald Stat.			5.597			3.135
Years	1790-1900	1790-1900	1790-1900	1790-1900	1790-1900	1790-1900
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Pre-trends	Yes	Yes	Yes	Yes	Yes	Yes
County Controls	No	No	No	Yes	Yes	Yes
Counties	1250	1250	1250	1250	1250	1250
Observations	13,249	13,249	13,249	13,249	13,249	13,249
R-squared	0.616	0.939	0.270	0.792	0.968	-1.281

Robust standard errors in parentheses, standard errors clustered by county.
** p<0.01, * p<0.05, + p<0.1

Sources: Patent data as described in the text, U.S. Census Data is from Haines (2010) (county boundaries harmonized to 1840 as in Hornbeck (2010)), transportation data from Atack (2013).

Table 11: Instrumental Variables: Speed of Word Arrival vs. Local Transportation Access, 1840-1870

	(1) OLS	(2) First Stage	(3) IV	(4) OLS	(5) First Stage	(6) IV
	Speed 10 Years	Percent	Speed 10 Years	Speed 10 Years	Percent	Speed 10 Years
VARIABLES	All Counties	Trans	All Counties	All Counties	Trans	All Counties
	Percent within 1.5 miles of Transportation					
Line Instrument		0.00635			0.00630	
		(0.00499)			(0.00472)	
% within 1.5 miles of transport	0.0256+		-0.220	0.0104		-0.214
	(0.0148)		(0.271)	(0.0113)		(0.251)
log Total Pop				0.00254	-0.00573	0.00121
				(0.00350)	(0.00784)	(0.00331)
Wald Stat.			2.431			2.710
	Percent within 5.0 miles of Transportation					
Line Instrument		0.0198+			0.0163	
		(0.0116)			(0.0111)	
% within 5 miles of transport	0.00192		-0.0467	0.00260		-0.0721
	(0.00339)		(0.0728)	(0.00344)		(0.0908)
log Total Pop				0.00453	-0.00807	0.00388
				(0.00350)	(0.0176)	(0.00301)
Wald Stat.			4.384			3.303
Years	1850-1870	1850-1870	1850-1870	1850-1870	1850-1870	1850-1870
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Pre-trends	Yes	Yes	Yes	Yes	Yes	Yes
County Controls	No	No	No	Yes	Yes	Yes
Counties	1250	1250	1250	1250	1250	1250
Observations	3,753	3,753	3,753	3,745	3,745	3,745

Robust standard errors in parentheses, standard errors clustered by county.
** p<0.01, * p<0.05, + p<0.1

Sources: Patent data as described in the text, U.S. Census Data is from Haines (2010) (county boundaries harmonized to 1840 as in Hornbeck (2010)), transportation data from Atack (2013).

Table 12: Instrumental Variables: Speed of Word Arrival vs. Local Transportation Access, 1850-1870

	(1) OLS	(2) First Stage	(3) IV	(4) OLS	(5) First Stage	(6) IV
	Speed		Speed	Speed		Speed
	All Years	Percent	All Years	All Years	Percent	All Years
VARIABLES	All Counties	Trans	All Counties	All Counties	Trans	All Counties
Percent within 1.5 miles of Transportation						
Line Instrument		0.00635			0.00630	
		(0.00499)			(0.00472)	
% within 1.5 miles of transport	0.108**		-0.397	0.0192		-0.147
	(0.0237)		(0.488)	(0.0182)		(0.331)
log Total Pop				0.0140*	-0.00573	0.0131*
				(0.00690)	(0.00784)	(0.00563)
Wald Stat.			2.431			2.710
Percent within 5.0 miles of Transportation						
Line Instrument		0.0198+			0.0163	
		(0.0116)			(0.0111)	
% within 5 miles of transport	0.0349**		-0.0601	0.00332		-0.0274
	(0.00618)		(0.122)	(0.00623)		(0.122)
log Total Pop				0.0156*	-0.00807	0.0153**
				(0.00692)	(0.0176)	(0.00551)
Wald Stat.			4.384			3.303
Years	1850-1870	1850-1870	1850-1870	1850-1870	1850-1870	1850-1870
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Pre-trends	Yes	Yes	Yes	Yes	Yes	Yes
County Controls	No	No	No	Yes	Yes	Yes
Counties	1250	1250	1250	1250	1250	1250
Observations	3,753	3,753	3,753	3,745	3,745	3,745

Robust standard errors in parentheses, standard errors clustered by county.
** p<0.01, * p<0.05, + p<0.1

Sources: Patent data as described in the text, U.S. Census Data is from Haines (2010) (county boundaries harmonized to 1840 as in Hornbeck (2010)), transportation data from Atack (2013).