

Berliant, Marcus; Watanabe, Axel H.

Article

A scale-free transportation network explains the city-size distribution

Quantitative Economics

Provided in Cooperation with:

The Econometric Society

Suggested Citation: Berliant, Marcus; Watanabe, Axel H. (2018) : A scale-free transportation network explains the city-size distribution, Quantitative Economics, ISSN 1759-7331, The Econometric Society, New Haven, CT, Vol. 9, Iss. 3, pp. 1419-1451, <https://doi.org/10.3982/QE619>

This Version is available at:

<https://hdl.handle.net/10419/217132>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by-nc/4.0/>

Supplement to “A scale-free transportation network explains the city-size distribution”

(*Quantitative Economics*, Vol. 9, No. 3, November 2018, 1419–1451)

MARCUS BERLIANT

Department of Economics, Washington University

AXEL H. WATANABE

Department of Economics, Concordia University and CIREQ

KEYWORDS. Zipf’s law, city-size distribution, scale-free network.

JEL CLASSIFICATION. L14, R12, R40.

GRAPHIC FILES

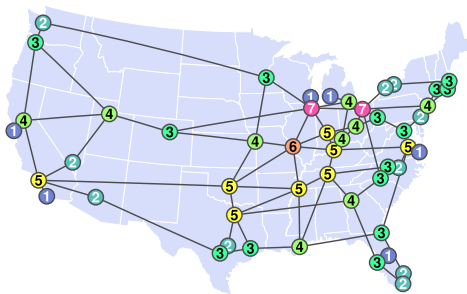


FIGURE 6. The Interstate route map (abridged).

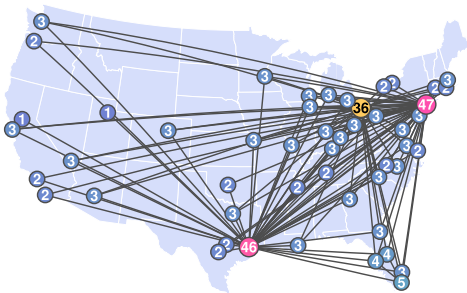
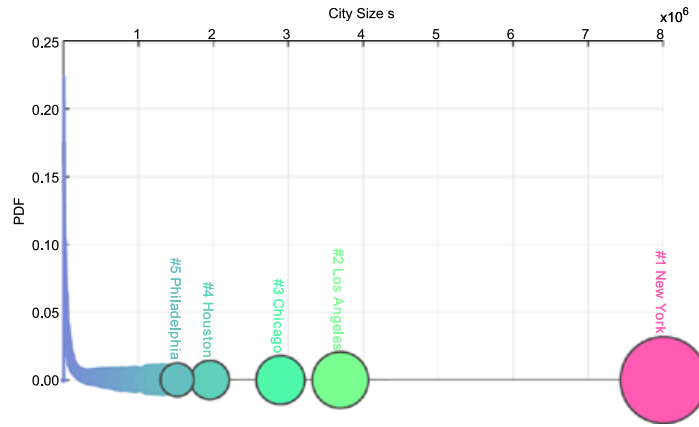


FIGURE 7. A typical airline’s route configuration (premerger Continental Airlines).

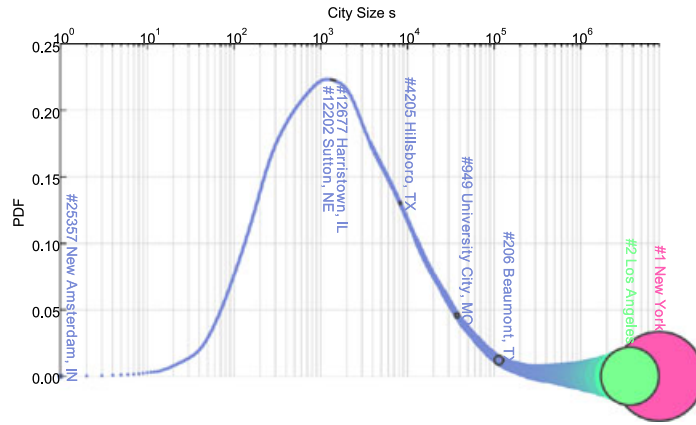
Marcus Berliant: berliant@wustl.edu

Axel H. Watanabe: axel.watanabe@concordia.ca

© 2018 The Authors. Licensed under the [Creative Commons Attribution-NonCommercial License 4.0](https://creativecommons.org/licenses/by-nc/4.0/).
Available at <http://qeconomics.org>. <https://doi.org/10.3982/QE619>



(a) Linear Scale



(b) Log Scale

FIGURE 8. Frequency plot of the city-size distribution. Dots are size proportionate. See Table 1 for explanation of the cities selected in the figure. *Data source*: US Census 2000.

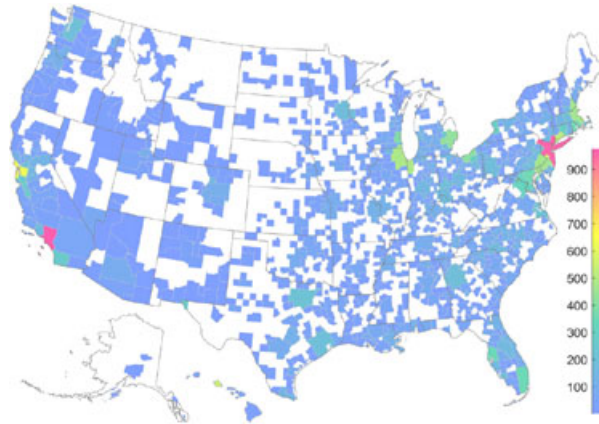


FIGURE 9. Population density by CBSA (persons/km²). *Data source*: Census 2000.

TABLE 2. Model comparison.

Data	Distribution	(log LH) \blacktriangle	KS \blacktriangleright	(log step) \blacktriangle	geo/arith \blacktriangle	$ \theta $	BIC \blacktriangleright	AIC \blacktriangleright	\hat{r}	$\hat{\delta}$
Belgium	Lognormal (Eeckhout)	-11.69	0.1986	-5.266	0.005166/0.01449	2	1621	1617		
Belgium	GEV (Berliant & Watanabe)	-11.40	0.1122	-4.981	0.006870 /0.01449	5	1594	1583		
Belgium	Complete Graph (de facto)	$-\infty$	0.6812	$-\infty$	0/0.01449	1	∞	∞		
Belgium	ER/BA (Jackson & Rogers)	-11.47	0.1348	-5.072	0.006268 /0.01449	5	1604	1593	0.002745	2.536
Belgium	ER (Jackson & Rogers)	-11.49	0.1766	-5.086	0.006185/0.01449	4	1603	1594	∞	
MA	Lognormal (Eeckhout)	-14.28	0.1036	-6.232	0.001996/0.003623	2	7891	7884		
MA	GEV (Berliant & Watanabe)	-14.13	0.04334	-6.089	0.002267 /0.003623	5	7828	7810		
MA	Complete Graph (de facto)	$-\infty$	0.7935	$-\infty$	0/0.003623	1	∞	∞		
MA	ER/BA (Jackson & Rogers)	-14.17	0.06102	-6.134	0.002168 /0.003623	5	7852	7834	0.001154	1.275
MA	ER (Jackson & Rogers)	-14.21	0.1057	-6.173	0.002084/0.003623	4	7860	7851	∞	
CBSA	Lognormal (Eeckhout)	-13.05	0.09402	-7.548	0.0005270/0.001085	2	2.407e+04	2.406e+04		
CBSA	GEV (Berliant & Watanabe)	-12.91	0.02606	-7.409	0.0006056 /0.001085	5	2.384e+04	2.382e+04		
CBSA	Complete Graph (de facto)	$-\infty$	0.8362	$-\infty$	0/0.001085	1	∞	∞		
CBSA	ER/BA (Jackson & Rogers)	-12.95	0.05922	-7.449	0.0005819 /0.001085	5	2.391e+04	2.389e+04	0.0004526	1.278
CBSA	ER (Jackson & Rogers)	-13.29	0.1762	-7.794	0.0004121/0.001085	4	2.450e+04	2.450e+04	∞	
Places	Lognormal (Eeckhout)	-9.258	0.01895	-8.840	0/3.944e-05	2	4.696e+05	4.696e+05		
Places	GEV (Berliant & Watanabe)	-9.254	0.008847	-8.836	0/3.944e-05	5	4.694e+05	4.693e+05		
Places	Complete Graph (de facto)	$-\infty$	0.8342	$-\infty$	0/3.944e-05	1	∞	∞		
Places	ER/BA (Jackson & Rogers)	-9.268	0.02198	-8.849	0/3.944e-05	5	4.701e+05	4.700e+05	0.0003171	0.9911
Places	ER (Jackson & Rogers)	-9.392	0.1134	-8.974	0/3.944e-05	4	4.764e+05	4.763e+05	∞	
Places	Lognormal as Degree Dist.	-9.258	0.01896	-8.840	0/3.944e-05	4	4.696e+05	4.696e+05		
Places	GEV as Degree Dist.	-9.255	0.01159	-8.836	0/3.944e-05	5	4.694e+05	4.694e+05		

Note: Row color corresponds to the line colors in Figures 10 to 13. \blacktriangle denotes a statistic the higher value of which indicates a better fit and \blacktriangleright the other way around. In the first row, (log LH) denotes the average of the log of likelihood values, KS denotes the Kolmogorov-Smirnov statistic, (log step) measures the geometric mean of the step $F(s_j; \theta) - F(s_{j-1}; \theta)$ in the logarithmic scale. Geo/arith measures the ratio between geometric mean and arithmetic mean of the step. The closer the geometric mean is to the arithmetic mean, the better the fit is. It is zero for Places due to multiple cities having the same size. $|\theta|$ counts the number of parameters. BIC and AIC stand for Bayesian and Akaike Information Criteria for detecting overfitting. **Blackface with white foreground** marks the winner and **black foreground** denotes the runner-up among the five distributions tested. See the last paragraph in Section 4.2 for an explanation of the last two rows.

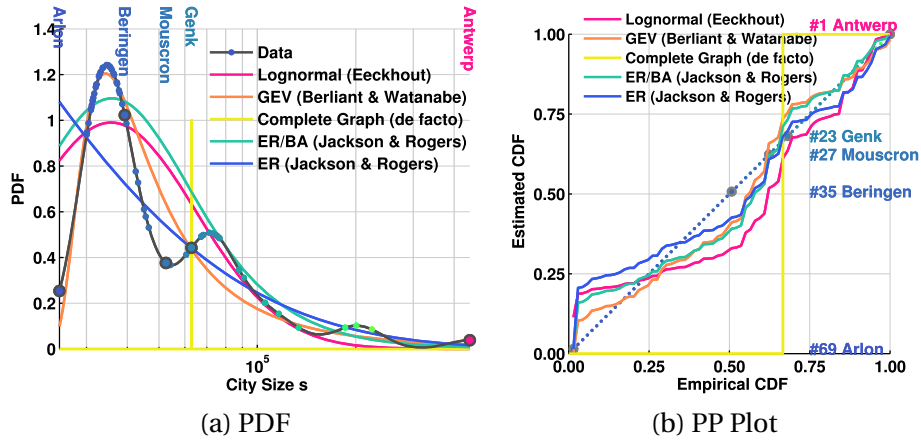


FIGURE 10. Model comparison (Belgium).

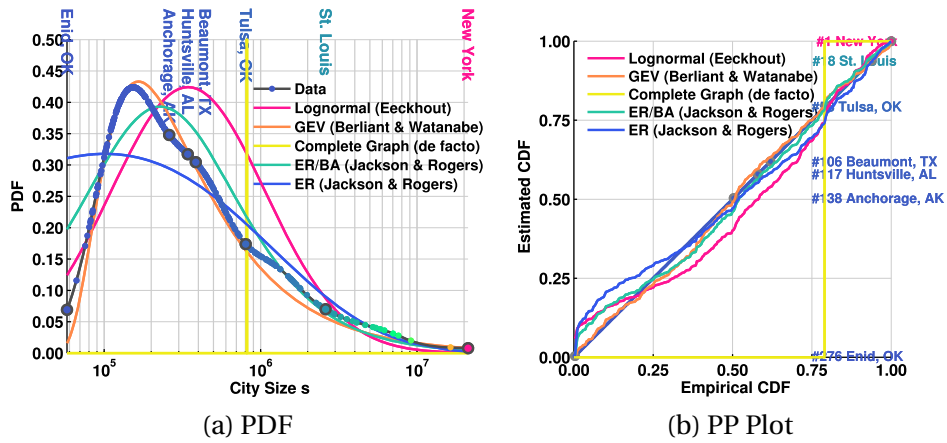


FIGURE 11. Model comparison (MA).

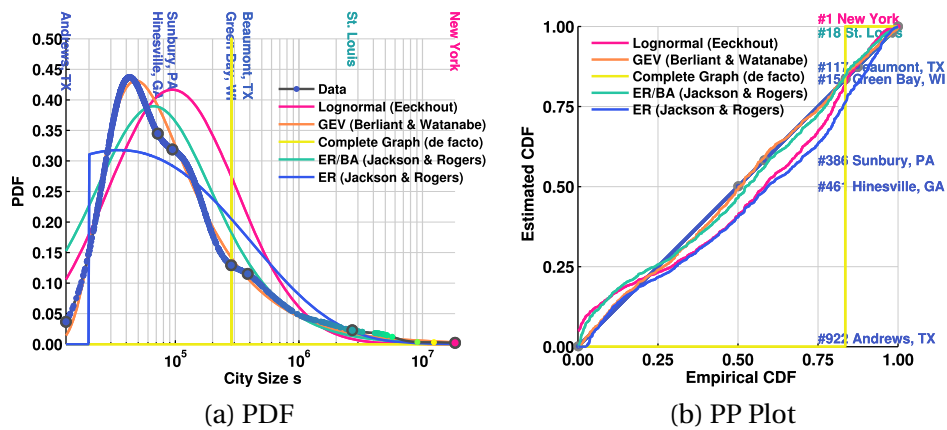


FIGURE 12. Model comparison (CBSA).

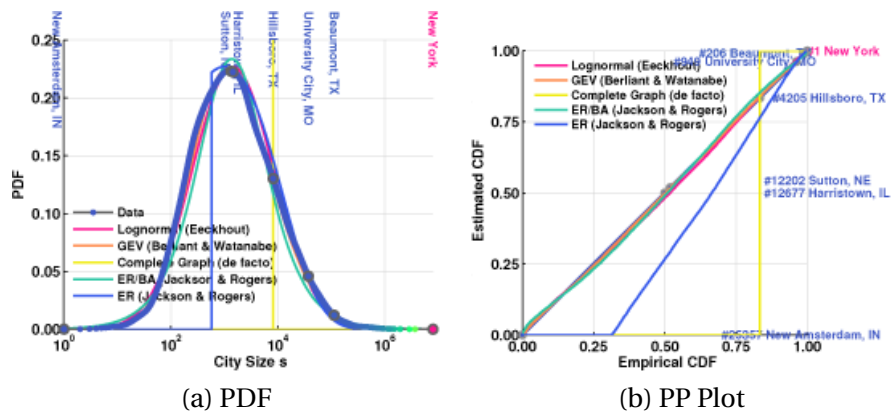


FIGURE 13. Model comparison (Places).

Co-editor Karl Schmedders handled this manuscript.

Manuscript received 21 September, 2015; final version accepted 28 September, 2017; available online 23 October, 2017.