Appendix

Table A.1. Spatial Bayesian Model Selection.

	Posterior Probabilities For W Matrices $P(W\|SM, X)$				Posterior Probabilities For Spatial Models $P(SM\|W, X)$			
Spatial Weight Matrix	SLM	SDM	SEM	SDEM	SLM	SDM	SEM	SDEM
$1/d^{\alpha}$. $\alpha = 2.00$ & Cut-off at 30 km	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
$1/d^{\alpha}$. $\alpha = 2.00$ & Cut-off at 50 km	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
$1/d^{\alpha}$. $\alpha = 2.00$ & Cut-off at 75 km	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
$(k = 5)$ & $1/k$.	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
$(k = 5)$ & $1/d^{\alpha}$. $\alpha = 2.00$.	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
$(k = 5)$ & $exp - (\theta d)$. $\theta = 0.01$	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
$(k = 5)$ & $exp - (\theta d)$. $\theta = 0.025$	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
$(k = 10)$ & $1/k$.	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
$(k = 10)$ & $1/d^{\alpha}$. $\alpha = 2.00$.	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
$(k = 10)$ & $exp - (\theta d)$. $\theta = 0.01$	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
$(k = 10)$ & $exp - (\theta d)$. $\theta = 0.025$	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
$(k = 15)$ & $1/k$.	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
$(k = 15)$ & $1/d^{\alpha}$. $\alpha = 2.00$.	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
$(k = 15)$ & $exp - (\theta d)$. $\theta = 0.01$	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
$(k = 15)$ & $exp - (\theta d)$. $\theta = 0.025$	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
$(k = 20)$ & $1/k$.	0.08	0.18	0.06	0.45	0.00	1.00	0.00	0.00
$(k = 20)$ & $1/d^{\alpha}$. $\alpha = 2.00$.	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
$(k = 20)$ & $exp - (\theta d)$. $\theta = 0.01$	0.50	0.52	0.75	0.21	0.00	1.00	0.00	0.00
$(k = 20)$ & $exp - (\theta d)$. $\theta = 0.025$	0.42	0.30	0.19	0.33	0.00	1.00	0.00	0.00

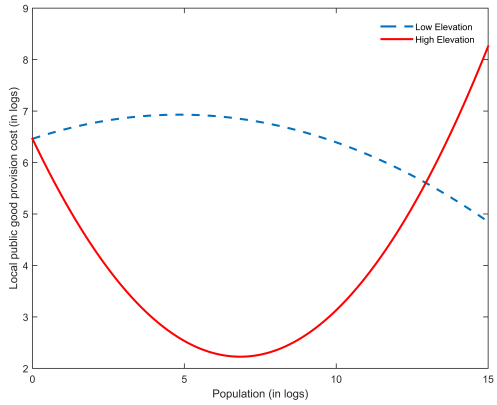
Notes: We employ the normal-gamma conjugate prior for β, θ and σ and a beta prior for ρ: $\pi(\beta) \sim N(c, T)$, $\pi\left(\frac{1}{\sigma^2}\right) \sim \Gamma(d, v)$, $\pi(\rho) \sim \frac{1}{Beta(a_0, a_0)} \frac{(1+\rho)^{a_0-1}(1-\rho)^{a_0-1}}{2^{2a_0-1}}$. Non-informative diffuse priors for the model parameters $(\tau, \eta, \beta, \theta, \sigma)$. Thus, parameter c are set to zero and T to a very large number $(1e + 12)$, which results in a diffuse prior for β, θ, τ, η while diffuse priors for σ are obtained by setting $d = 0$ and $v = 0$. Finally, $a_0 = 1.1$. Columns (1) to (4) report, for a given spatial specification, the Posterior Model Probabilities (PMP) across spatial weight matrices. Columns (5) to (8) report the PMP for the different spatial specifications including municipal fixed effects given alternative specifications of W, which allows the comparison of the different models for each W. As shown in Table (A.1.), for all the spatial weight matrices the SDM appears to be best specification and for the SDM specification the W matrix with higher PMP is that of 20-nearest neighbours with an exponential decay of the 1% as distance increases. Most importantly, this finding supports the empirical SDM specification including endogenous and exogenous interactions derived from our theoretical framework. The model comparison also reveals that the SEM/SDEM are unlikely to be the best candidates to describe local government spending interactions patterns, which is in line with the contributions of the benefit spillovers literature.

Table. A.2. Descriptive Statistics.

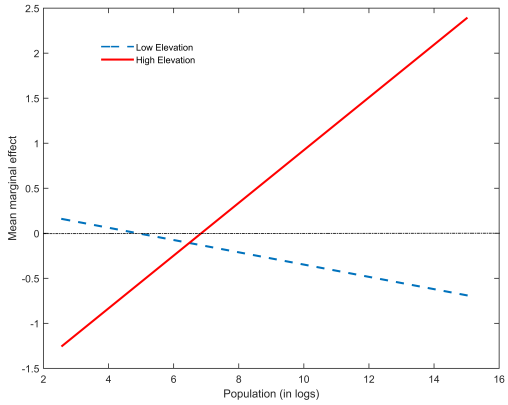
Variable	Mean	Standard Deviation	Min	Max	Source	Expected Effect
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable						
Current Spending pc	710.00	390.73	114.03	9,755.00	MPF	
Control Variables						
(i) Cost Factors						
Population	7,085.19	54,472.21	13	3,273,049	INE	?
Responsibility 1	0.80	0.40	0.00	1.00		+
Responsibility 2	0.14	0.35	0.00	1.00		+
Responsibility 3	0.04	0.19	0.00	1.00		+
Population clusters pc	0.01	0.01	0.00	0.62	INE	+
Migrants (%)	6.01	7.44	0.00	77.62	INE	+
Population> 65 (%)	27.28	11.79	0.00	79.17	INE	?
Elevation	646.00	380.75	0	2,439.5	NGI & GIS	+
Terrain ruggedness index	27.74	21.29	2.76	127.76	NGI & GIS	?
Provincial wages	23,177.40	3,404.27	14,765.86	34,901.86	INE	+
(ii) Demand Factors						
Income per capita	13,543.95	9,160.86	753.61	85,155.00	MPF	+
Current transfers per capita	474.26	257.75	0.00	11,303.00	MPF	+
Capital transfers per capita	459.09	531.66	0.00	24,681.00	MPF	+
Tax share	0.31	0.39	0.00	5.45	MPF	-
Ideology	5.85	1.93	2.22	8.08	MI & Deusto Polls	-
Government strength	0.62	0.17	0.18	1.00	MI	?

Notes: MPF denotes the Ministry of Public Finance, MI the Ministry of Internal Affairs, INE the National Statistics Institute, NGI the National Geographic Institute, GIS Geographical Information Systems.

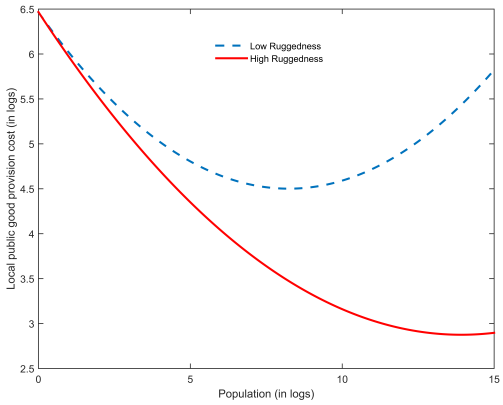
Figure A.1 The effect of Geography (summary)



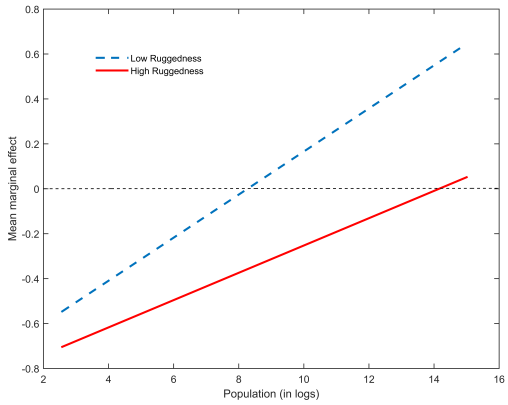
(a) Provision costs (elevation)



(b) Marginal effects (elevation)



(c) Provision costs (ruggedness)



(d) Marginal effects (ruggedness)

Table A.3. Per capita local spending and Terrain Elevation.

Variable	Own Coefficient (1)	Neighbour's Coefficient (2)	Direct Effects (3)	Indirect Effects (4)	Total Effects (5)
Ln Population & High Elevation	-0.812***	-0.211*	-0.832***	-1.196***	-2.028***
	(-16.91)	(-1.83)	(-17.35)	(-5.60)	(-9.43)
(Ln Population)^2 & High Elevation	0.019***	0.056***	0.021***	0.127***	0.148***
	(4.62)	(6.10)	(5.10)	(7.59)	(8.85)
Ln Population & Low Elevation	0.051	0.112	0.053	0.267	0.320
	(0.77)	(0.64)	(0.82)	(0.85)	(0.99)
(Ln Population)^2 & Low Elevation	-0.041***	0.025**	-0.041***	0.008	-0.033*
	(-9.30)	(2.22)	(-9.42)	(0.40)	(-1.67)
Responsibility 1	0.281***	0.187***	0.292***	0.634***	0.926***
	(19.77)	(3.41)	(20.35)	(6.39)	(9.07)
Responsibility 2	0.192***	0.086	0.198***	0.351***	0.549***
	(14.37)	(1.53)	(14.82)	(3.35)	(5.09)
Responsibility 3	0.119***	-0.008	0.122***	0.105	0.227*
	(8.64)	(-0.12)	(8.56)	(0.87)	(1.81)
Ln Population Clusters pc	-0.010***	0.028***	-0.009***	0.045***	0.036***
	(-4.35)	(4.19)	(-3.94)	(3.43)	(2.69)
Migration (%)	-0.001***	0.006***	-0.001***	0.011***	0.010***
	(-3.56)	(9.34)	(-2.72)	(9.46)	(8.74)
Population < 65	0.002***	0.002***	0.002***	0.005***	0.008***
	(10.89)	(3.11)	(11.23)	(5.54)	(7.95)
Ln Wages	0.041	0.129**	0.047	0.292***	0.339***
	(0.74)	(2.15)	(0.83)	(4.32)	(10.05)
Ln Income pc	0.016**	0.242***	0.024***	0.485***	0.509***
	(2.50)	(17.99)	(3.90)	(21.45)	(22.73)
Ln Current Transfers pc	0.099***	0.047***	0.102***	0.186***	0.288***
	(45.22)	(7.25)	(46.90)	(16.86)	(25.53)
Ln Capital Transfers pc	0.007***	0.000	0.007***	0.006*	0.013***
	(8.28)	(-0.16)	(8.51)	(1.69)	(3.60)
Tax-share	0.117***	0.206***	0.125***	0.511***	0.637***
	(20.01)	(11.14)	(20.64)	(14.57)	(17.65)
Ln Ideology	-0.001	-0.002	-0.001	-0.004	-0.005
	(-0.24)	(-0.40)	(-0.23)	(-0.43)	(-0.49)
Government strength	0.023***	-0.014	0.023***	-0.006	0.018
	(2.76)	(-0.45)	(2.74)	(-0.09)	(0.27)
Crisis	0.030***				
	(9.24)				
WY_t	0.494***				
	(58.17)				
R-squared	0.895				
Log-Likelihood	26036.744				
$\hat{\sigma}_\epsilon$	0.023				

Notes: * significant at 10% level, ** significant at 5% level, *** significant at 1% level. Inferences regarding the statistical significance of these effects are based on the variation of 1,000 simulated parameter combinations drawn from the variance-covariance matrix implied by the BCML estimates. The results are obtained using the 20 nearest neighbour's spatial weights matrix with exponential decay of the 1%.

Table A.4. Per capita local spending and Terrain Ruggedness.

Variable	Own Coefficient (1)	Neighbour's Coefficient (2)	Direct Effects (3)	Indirect Effects (4)	Total Effects (5)
Ln Population & High Ruggedness	-0.685***	0.253	-0.689***	-0.179	-0.867***
	(-12.53)	(1.58)	(-12.56)	(-0.59)	(-2.80)
(Ln Population)^2 & High Ruggedness	0.002	0.013	0.003	0.028	0.031
	(0.48)	(1.16)	(0.61)	(1.30)	(1.40)
Ln Population & Low Ruggedness	-0.363***	-0.031	-0.370***	-0.431**	-0.801***
	(-7.97)	(-0.29)	(-8.23)	(-2.19)	(-4.03)
(Ln Population)^2 & Low Ruggedness	-0.014***	0.038***	-0.013***	0.061***	0.049***
	(-4.02)	(5.09)	(-3.76)	(4.53)	(3.59)
Responsibility 1	0.284***	0.209***	0.296***	0.687***	0.983***
	(19.98)	(3.80)	(20.53)	(6.58)	(9.08)
Responsibility 2	0.197***	0.110**	0.204***	0.407***	0.610***
	(14.69)	(1.97)	(14.76)	(3.81)	(5.51)
Responsibility 3	0.121***	0.007	0.124***	0.129	0.253*
	(8.77)	(0.11)	(8.75)	(1.03)	(1.94)
Ln Population Clusters pc	-0.010***	0.026***	-0.010***	0.041***	0.031**
	(-4.51)	(3.83)	(-4.23)	(3.09)	(2.32)
Migration (%)	-0.001***	0.006***	-0.001***	0.011***	0.010***
	(-3.98)	(9.05)	(-3.26)	(8.77)	(7.97)
Population < 65	0.002***	0.001**	0.002***	0.005***	0.007***
	(10.90)	(2.56)	(11.22)	(5.06)	(7.44)
Ln Wages	0.044	0.112*	0.046	0.266***	0.312***
	(0.79)	(1.87)	(0.82)	(3.88)	(8.79)
Ln Income pc	0.015**	0.239***	0.023***	0.486***	0.510***
	(2.41)	(17.75)	(3.79)	(20.91)	(22.02)
Ln Current Transfers pc	0.100***	0.050***	0.103***	0.197***	0.300***
	(45.73)	(7.63)	(46.97)	(16.79)	(24.91)
Ln Capital Transfers pc	0.007***	0.000	0.007***	0.007**	0.015***
	(8.37)	(0.07)	(8.58)	(1.97)	(3.88)
Tax-share	0.117***	0.223***	0.127***	0.554***	0.681***
	(20.08)	(12.05)	(21.44)	(15.81)	(18.81)
Ln Ideology	-0.001	-0.007	-0.002	-0.015	-0.016
	(-0.49)	(-1.27)	(-0.61)	(-1.46)	(-1.59)
Government strength	0.023***	-0.013	0.023***	-0.001	0.021
	(2.66)	(-0.43)	(2.62)	(-0.02)	(0.34)
Crisis	0.031***				
	(9.65)				
WY_t	0.501***				
	(59.05)				
R-squared	0.895				
Log likelihood	25977.096				
$\hat{\sigma}_\epsilon$	0.023				

Notes: * significant at 10% level, ** significant at 5% level, *** significant at 1% level. Inferences regarding the statistical significance of these effects are based on the variation of 1,000 simulated parameter combinations drawn from the variance-covariance matrix implied by the BCML estimates. The results are obtained using the 20 nearest neighbour's spatial weights matrix with exponential decay of the 1%.

Table A.5 Pooled spatial panel data model specifications: Total effects.

	(1)	(2)	(3)	(4)
Ln population	-0.842***	-0.884***	-0.825***	-0.915***
	(-17.15)	(-17.09)	(-16.23)	(-18.44)
Ln population^2	0.062***	0.064***	0.059***	0.064***
	(16.91)	(16.70)	(15.63)	(17.64)
Ln population density	-0.062***	-0.063***	-0.062***	-0.085***
	(-8.84)	(-4.05)	(-8.99)	(-12.32)
Elevation		-0.070***		-0.158***
		(-9.70)		(-9.47)
Ruggedness			0.003***	0.004***
			(9.83)	(13.20)
Implied ln N^*	6.828	6.880	6.968	7.138
Implied N^*	923.59	972.15	1061.61	1258.85
Controls	Yes	Yes	Yes	Yes
Crisis Dummy	Yes	Yes	Yes	Yes

Dependent variable: Log of per capita current spending. Notes: t-stats in parenthesis, * significant at 10% level, ** significant at 5% level, *** significant at 1% level. Inferences regarding the statistical significance of the total effects reported here are based on the variation of 1,000 simulated parameter combinations drawn from the variance-covariance matrix implied by the BCML estimates. The results are obtained using the 20 nearest neighbour's spatial weights matrix with exponential decay of the 1%.

Table A.6 Interaction and Non-linearities: Population size and elevation (Total effects).

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Ln Population	-0.794***	-0.864***	-0.730***	-0.842***	-0.804***	-0.881***
	(-12.77)	(-9.62)	(-12.27)	(-9.75)	(-8.65)	(-8.19)
Ln Population^2	0.059***	0.064***	0.056***	0.062***	0.061***	0.065***
	(14.01)	(10.50)	(13.73)	(11.51)	(9.52)	(9.34)
Elevation $\times$ Ln Population	-0.048***	0.043	-0.094***	-0.016	0.000	0.056
	(-4.27)	(0.54)	(-7.98)	(-0.38)	(-0.01)	(0.63)
Elevation^2 $\times$ Ln Population	0.036***	0.036***		0.060*		-0.006
	(6.94)	(6.75)			(1.89)	(-1.06)
Elevation $\times$ Ln Population^2		-0.006			-0.006	0.047
		(-1.14)			(-1.16)	(1.43)
Elevation$^2\times$ Ln Population^2			0.005***	-0.003	0.005***	-0.002
			(7.13)	(-0.75)	(6.28)	-0.35)
Elevation	-0.083	-0.387	0.242***	-0.307	-0.073	-0.484
	(-0.81)	(-1.36)	(3.01)	(-1.02)	(-0.25)	(-1.23)
Ln Population density	-0.081***	-0.081***	-0.082***	-0.081***	-0.082***	-0.081***
	(-11.48)	(-10.61)	(-11.59)	(-10.69)	(-11.68)	(-10.69)
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: * significant at 10% level, ** significant at 5% level, *** significant at 1% level. Inferences regarding the statistical significance of the total effects are based on the variation of 1,000 simulated parameter combinations drawn from the variance-covariance matrix implied by the BCML estimates of a SDM pooled panel data specification including a constant and the regressors in X capturing cost and demand factors. The results are obtained using the 20 nearest neighbour's spatial weights matrix with exponential decay of the 1%.

Table A.7 Interaction and Non-linearities: Population size and ruggedness (Total effects).

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Ln Population	-0.7764***	-0.6575***	-0.7896***	-0.7728***	-0.6622***-	0.6737***
	(-15.44)	(-8.91)	(-16.10)	(-12.87)	(-9.80)	-9.61
Ln Population^2	0.057***	0.049***	0.057***	0.056	0.049***	0.049***
	(15.28)	(9.311)	(5.94)	(13.69)	(10.19)	(10.03)
Ruggedness × Ln Population	-0.000	-0.005***	0.000	-0.0003	-0.005***	-0.006***
	(-1.39)	(-2.81)	(-0.12)	(-0.60)	(-2.92)	(-3.01)
Ruggedness ^{2} × Ln Population (a)	-0.003**	-0.002**		-0.003		0.434***
	(-2.37)	(-1.97)		(-0.47)		(2.93)
Ruggedness × Ln Population^2 (a)		0.329***			0.355***	0.009
		(2.66)			(2.93)	1.09
Ruggedness ^{2}× Ln Population^2 (a)			-0.0005**	0.000	-0.0004**	-0.001
			(-2.39)	(0.05)	(-2.26)	(-1.40)
Ruggedness	0.006***	0.022***	0.004***	0.006*	0.022***	0.021***
	(4.79)	(3.64)	(3.46)	(1.74)	(3.61)	(3.42)
Ln Population density	-0.063***	-0.063***	-0.063***	-0.063***	-0.0631***	-0.062***
	(-9.35)	(-9.35)	(-9.09)	(-9.20)	(-9.43)	(-8.72)
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: * significant at 10% level, ** significant at 5% level, *** significant at 1% level. Inferences regarding the statistical significance of the total effects are based on the variation of 1,000 simulated parameter combinations drawn from the variance-covariance matrix implied by the BCML estimates of a SDM pooled panel data specification including a constant and the regressors in X capturing cost and demand factors. The results are obtained using the 20 nearest neighbour's spatial weights matrix with exponential decay of the 1%. Reported effects in this table correspond to the total effects × 1,000.

Figure A.2: Optimal Size and Elevation

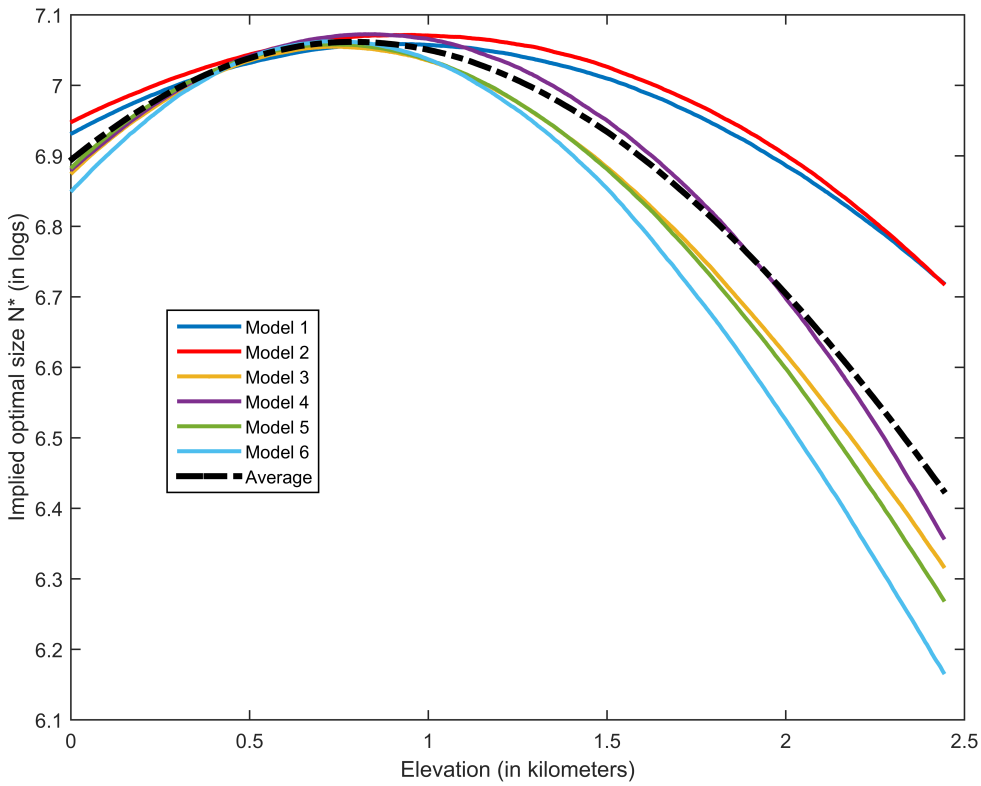
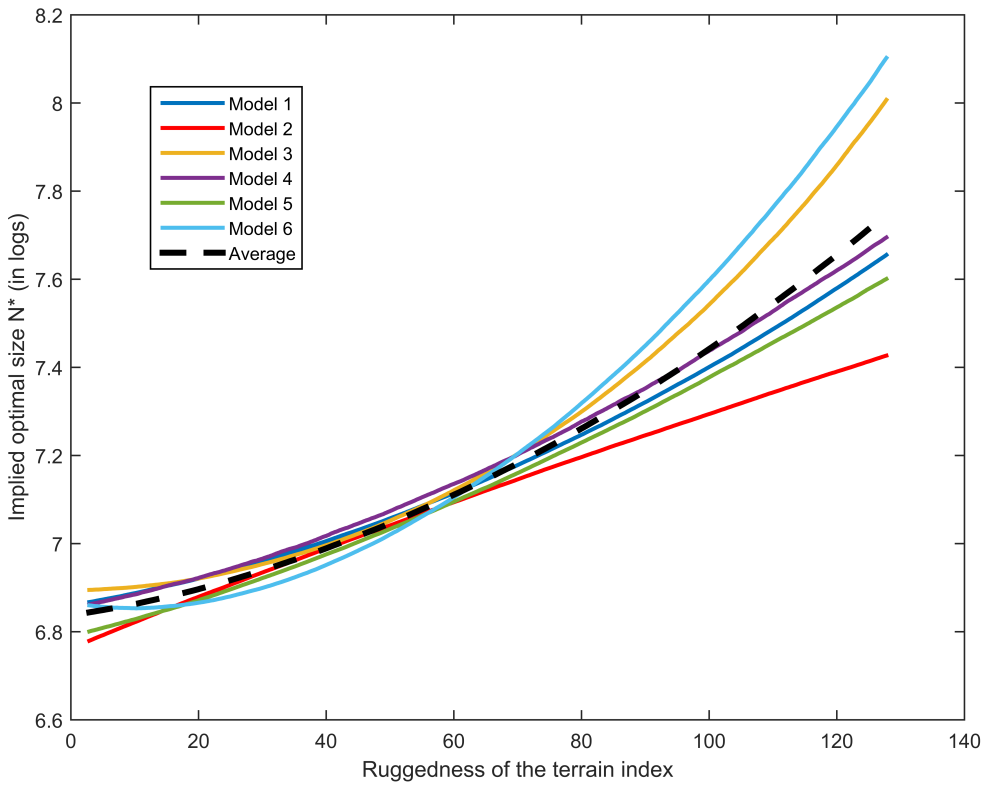



Figure A.3: Optimal Size and Ruggedness