Regional input-output tables and the FLQ formula: A case study of Finland

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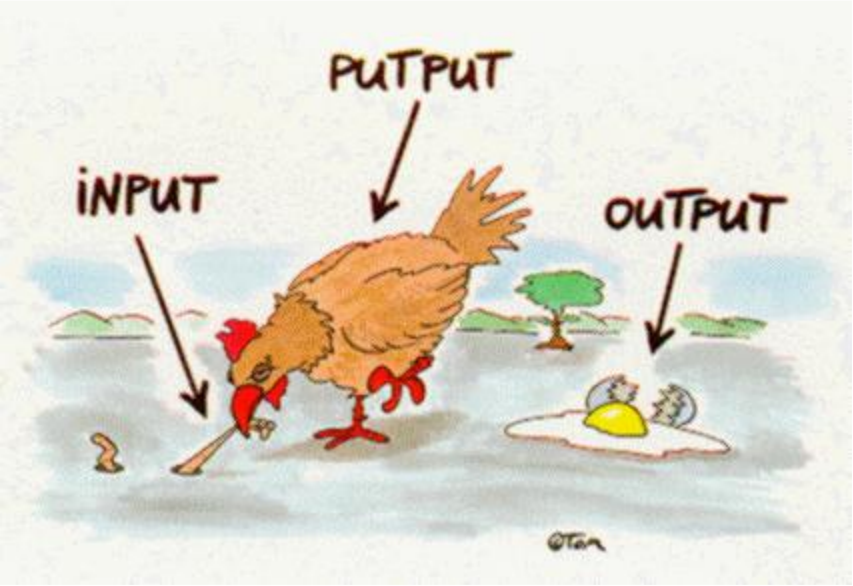
Background



Background

- Regional economies differ from national economies in several respects
- How to estimate interregional trade flows?
- Amount of regional data available?
- Obtaining the data required to construct a regional input-output table
  1) Well-designed survey (best)
  2) Indirect methods

National input coefficients in Finland

Industry	Industry						
	17	18	20	21	34	45	80
17 Manufacture of textiles	0,0511	0,0252	0,0002	0,0010	0,0002	0,0008	0,0000
20 Manufacture of wood and of products of wood and cork, except furniture	0,0012	0,0006	0,1262	0,0173	0,0025	0,0836	0,0006
21 Manufacture of pulp, paper and paper products	0,0053	0,0040	0,0062	0,1678	0,0016	0,0023	0,0046
34 Manufacture of motor vehicles, trailers and semi-trailers	0,0003	0,0002	0,0002	0,0001	0,0633	0,0003	0,0000
45 Construction	0,0000	0,0000	0,0005	0,0022	0,0000	0,0596	0,0056
80 Education	0,0001	0,0001	0,0000	0,0000	0,0000	0,0002	0,0104
Total use of domestic products at basic prices	0,3315	0,3047	0,6657	0,5609	0,3750	0,5319	0,2313
Total use of imported products	0,2692	0,2947	0,0821	0,1227	0,3684	0,0817	0,0236
Taxes less subsidies on products	0,0053	0,0047	0,0024	0,0059	0,0039	0,0149	0,0366
Total intermediate consumption/final use at purchasers' prices	0,6061	0,6042	0,7503	0,6896	0,7473	0,6285	0,2915
Compensation of employees	0,2727	0,3074	0,1570	0,1414	0,1947	0,2325	0,6403
Other taxes on production, net	0,0000	-0,0042	-0,0017	-0,0002	-0,0016	0,0002	-0,0025
Consumption of fixed capital	0,0667	0,0358	0,0406	0,0716	0,0275	0,0218	0,0630
Operating surplus, net	0,0545	0,0568	0,0540	0,0977	0,0322	0,1169	0,0077
Value added at basic prices	0,3939	0,3958	0,2497	0,3104	0,2527	0,3715	0,7085
Output at basic prices	1	1	1	1	1	1	1

Objectives

- To explore the best way of using LQs in constructing regional input-output tables
- Try to find the best possible initial set of regional input-output coefficients
- To examine how the FLQ can be used by analyst and private consultants as part of the hybrid approach or the RAS procedure

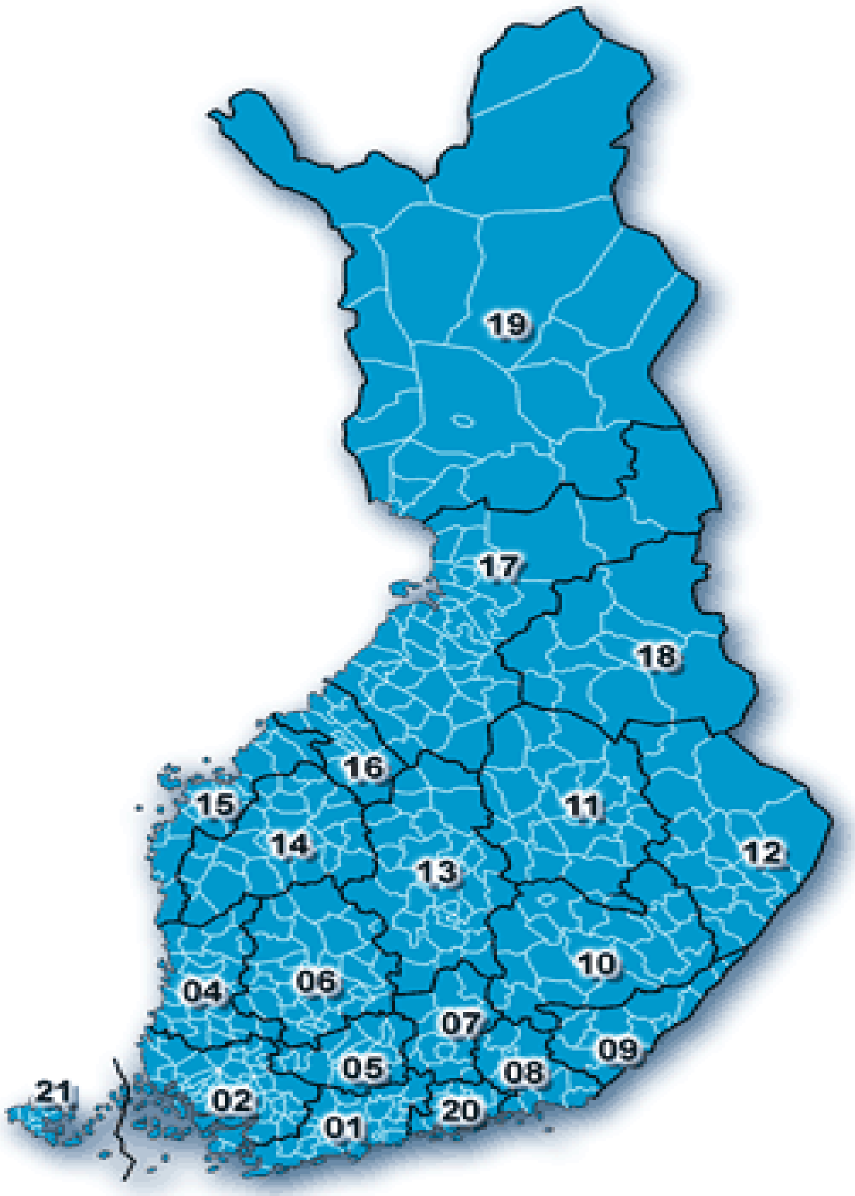
Data

- Data for 20 Finnish regions

Region	Value added (%)	Output (%)	Population (%)	Employees (%)	Herfindahl's index (1995) (All industries)	SLQ > 1 (number of sectors)	$r_{ij} > a_{ij}$ (number of sectors)
Ahvenanmaa	0.6	0.5	0.5	0.7	0.276	14	207
Keski-Pohjanmaa	1.1	1.2	1.4	1.3	0.088	15	208
Kainuu	1.5	1.3	1.9	1.6	0.080	20	231
Etelä-Savo	2.5	2.3	3.4	2.9	0.080	19	216
Itä-Uusimaa	1.7	2.5	1.7	1.6	0.067	4	155
Pohjois-Karjala	2.6	2.5	3.5	3.0	0.077	18	210
Etelä-Pohjanmaa	2.8	2.9	3.9	3.5	0.082	20	149
Kanta-Häme	2.8	3.0	3.2	3.1	0.072	18	220
Etelä-Karjala	2.9	3.2	2.7	2.5	0.091	7	154
Päijät-Häme	3.4	3.2	3.9	3.7	0.075	13	203
Pohjanmaa	3.4	3.5	3.4	3.4	0.071	12	156
Lappi	3.7	3.7	4.0	3.4	0.085	15	181
Pohjois-Savo	4.3	3.9	5.1	4.5	0.085	20	196
Kymenlaakso	3.9	4.4	3.8	3.7	0.096	7	150
Keski-Suomi	4.6	4.5	5.1	4.7	0.079	12	208
Satakunta	4.2	5.2	4.8	4.6	0.069	12	172
Pohjois-Pohjanmaa	6.0	6.0	7.0	6.1	0.083	13	249
Pirkanmaa	8.1	7.7	8.5	8.2	0.071	14	167
Varsinais-Suomi	8.4	8.9	8.5	8.9	0.075	11	204
Uusimaa	31.6	29.7	23.8	28.6	0.118	15	312
Mean					0.091	14	197

Finnish regions. Source: Statistics Finland

01= Uusimaa
02= Varsinais-Suomi
04= Satakunta
05= Kanta-Häme
06= Pirkanmaa
07= Päijät-Häme
08= Kymenlaakso
09= Etelä-Karjala
10= Etelä-Savo
11= Pohjois-Savo
12= Pohjois-Karjala
13= Keski-Suomi
14= Etelä-Pohjanmaa
15= Pohjanmaa
16= Keski-Pohjanmaa
17= Pohjois-Pohjanmaa
18= Kainuu
19= Lappi
20= Itä-Uusimaa
21= Ahvenanmaa



Model

- Our focus is on the modified FLQ formula
- The simplest version of the input–output model is:

$$\mathbf{x} = \mathbf{A}\mathbf{x} + \mathbf{f} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f}$$

$(\mathbf{I} - \mathbf{A})^{-1} = [b_{ij}]$ is the Leontief inverse matrix

A to be an n n matrix of interindustry technical coefficients,

f is an n 1 vector of final demands,

x is an n 1 vector of gross outputs,

I is an n n identity matrix,

Model

- How national coefficient matrix A is transformed into regional coefficient matrix R
- Considering formula:

$$\mathbf{r_{ij} = t_{ij} \times a_{ij}}$$

r_{ij} is the regional input coefficient,
t_{ij} is the regional *trading coefficient*
a_{ij} is the national input coefficient.

r_{ij} measures the amount of regional input *i* needed to produce one unit of regional gross output *j*
t_{ij} measures the proportion of regional requirements of input *i* that can be satisfied by firms located within the region

Model

- Using LQs, we can estimate the regional input coefficients via the formula:

$$\mathbf{r_{ij} = LQ_{ij} \times a_{ij}}$$

How to choose an LQ?

Model

- SLQ_i $$\equiv \frac{RE_i/TRE}{NE_i/TNE} \equiv \frac{RE_i}{NE_i} \times \frac{TNE}{TRE}$$

- $CILQ_{ij}$ $$\equiv \frac{SLQ_i}{SLQ_j} \equiv \frac{RE_i/NE_i}{RE_j/NE_j}$$

REi denotes regional employment (output) in supplying sector *i*
NEi denotes the corresponding national figure
REj and NEj are defined analogously for purchasing sector *j*
TRE and TNE are the respective regional and national totals

Model

$FLQ_{ij} \equiv CILQ_{ij} \times \lambda^*$ for $i \neq j$

$FLQ_{ij} \equiv SLQ_i \times \lambda^*$ for $i = j$

$\lambda^* = [\log_2(1 + TRE/TNE)]\delta$

$0 \leq \delta < 1$

$\delta = 0$ represents a special case where $FLQ_{ij} = CILQ_{ij}$

Model

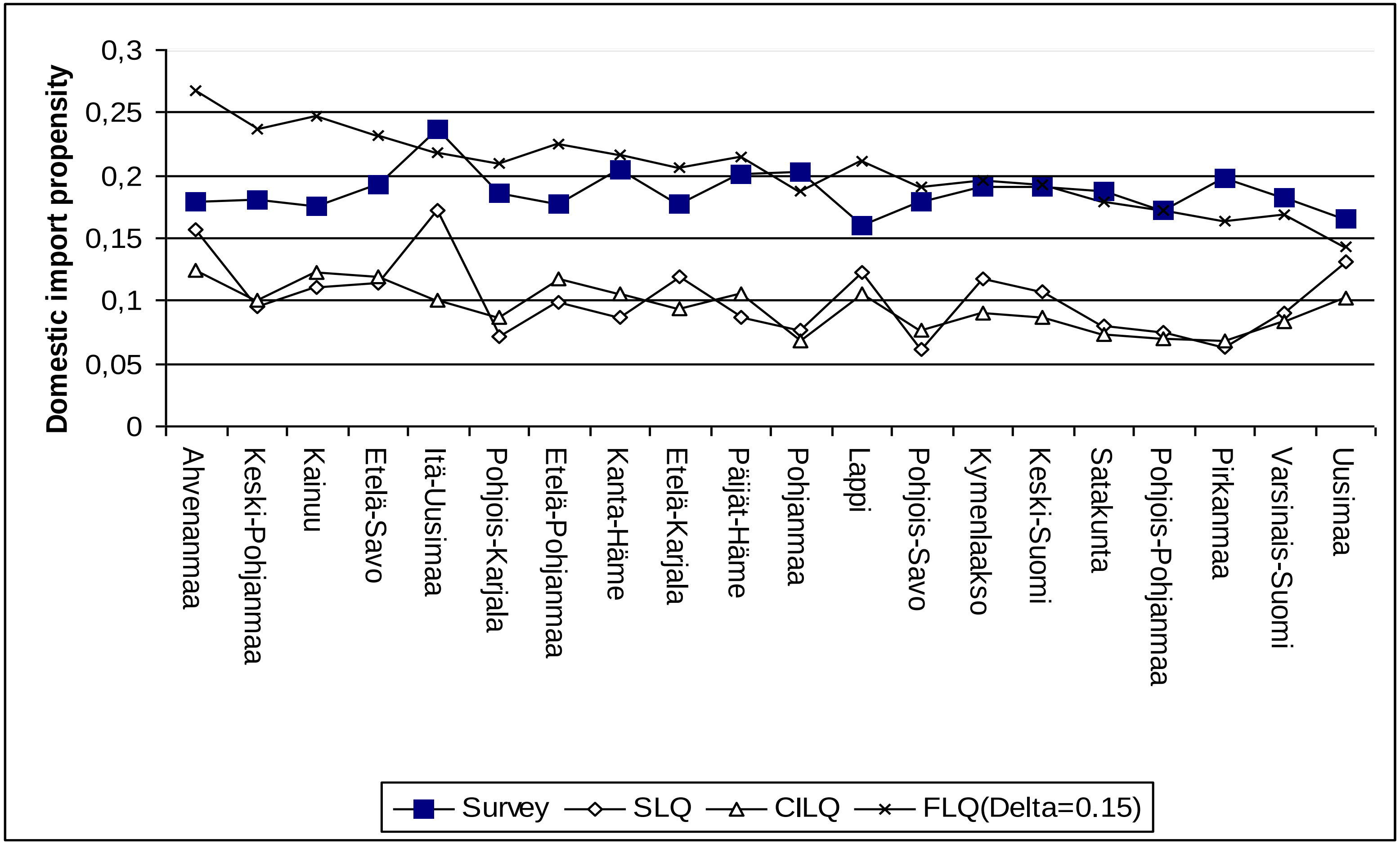
Features of FLQ:

- Use of SLQ_i along the principal diagonal
- As δ increases, so too does the allowance for interregional imports

The behaviour of the function λ for 20 Finnish regions in 1995*

		Value of δ				
	TRE/TNE	0.1	0.15	0.2	0.25	0.3
Ahvenanmaa	0.005	0.614	0.481	0.377	0.296	0.232
Keski-Pohjanmaa	0.012	0.663	0.540	0.440	0.359	0.292
Kainuu	0.013	0.671	0.550	0.451	0.369	0.302
Etelä-Savo	0.023	0.709	0.597	0.503	0.423	0.357
Itä-Uusimaa	0.025	0.716	0.606	0.513	0.434	0.367
Pohjois-Karjala	0.025	0.717	0.607	0.514	0.435	0.368
Etelä-Pohjanmaa	0.029	0.726	0.619	0.527	0.449	0.383
Kanta-Häme	0.030	0.730	0.624	0.533	0.455	0.389
Etelä-Karjala	0.032	0.735	0.630	0.540	0.463	0.397
Päijät-Häme	0.032	0.735	0.630	0.540	0.463	0.397
Pohjanmaa	0.035	0.741	0.638	0.549	0.472	0.406
Lappi	0.037	0.745	0.643	0.555	0.479	0.413
Pohjois-Savo	0.039	0.749	0.648	0.561	0.485	0.420
Kymenlaakso	0.044	0.758	0.659	0.574	0.500	0.435
Keski-Suomi	0.045	0.759	0.661	0.576	0.501	0.437
Satakunta	0.052	0.769	0.675	0.592	0.519	0.456
Pohjois-Pohjanmaa	0.060	0.781	0.690	0.609	0.538	0.476
Pirkanmaa	0.077	0.800	0.715	0.640	0.572	0.512
Varsinais-Suomi	0.089	0.811	0.730	0.657	0.592	0.533
Uusimaa	0.297	0.907	0.863	0.822	0.782	0.745
Mean		0.742	0.640	0.554	0.479	0.416

Figure 2.Estimates of domestic import propensities produced by the survey and by LQ-based methods



- Figure 2
  - Reveals that delta=0.15 overstates the propensity to import in the three smallest regions
    - Smaller delta is needed

  - Reveals that delta=0.15 understates the propensity to import in the larger regions
    - Higher delta is needed

Regression results

- $\ln \delta = 0.16673 + 0.29724 \ln R + 2.0110 \ln I - 0.35709 \ln H + e$

Where:

- R is regional size measured in terms of output and expressed as a percentage;
- I is the survey-based estimate of the regional propensity to import from other regions;
- H is Herfindahl's index of concentration (all industries);
- e is a residual.
- $R^2 = 0.893$; *t* ratios: 7.22, 5.03 & –3.01; expected signs;

  all χ^2 diagnostic tests passed:

  autocorrelation ($p = 0.837$),

  heteroscedasticity ($p = 0.340$),

  functional form ($p = 0.683$)

  normality ($p = 0.654$).

Measures of accuracy of coefficients

$\gamma_1 = \Sigma_j \Sigma_i \ (\hat{r}_{ij} - r_{ij}) \ / \ (n^2 - z)$

$$mse = \sum_j \sum_i (\hat{r}_{ij} - r_{ij})^2 / (n^2 - z)$$

$\gamma_2 = \Sigma_j \Sigma_i \ | \ \hat{r}_{ij} - r_{ij} \ | \ / \ (n^2 - z)$

$\gamma_3 = \Sigma_j \Sigma_i \ r_{ij} \ |\hat{r}_{ij} - r_{ij} \ | \ / \ (n \ \Sigma_i \ r_{ij})$

$\gamma_4 = 100 \ \Sigma_j \Sigma_i \ |\hat{r}_{ij} - r_{ij}| \ / \ \Sigma_j \Sigma_i \ r_{ij}$

$$\gamma_5 = 100 \sqrt{\frac{\sum_j \sum_i (\hat{r}_{ij} - r_{ij})^2}{\sum_j \sum_i r_{ij}^2}}$$

Rationale of measures of accuracy of estimated regional input coefficients

γ_1 is a measure of the extent to which a method tends to overestimate or underestimate the input coefficients (bias)

mse= the mean square error (measures bias and dispersion)

γ_2 Assures that positive and negative errors would not offset each others

γ_3 takes into account that errors in the largest coefficients tend to have the highest impact on the estimated multipliers

Rationale of measures of accuracy of estimated regional input coefficients

γ_4 expresses the mean absolute deviation as a percentage of the mean value of r_{ij} (comparisons are available)

γ_5 is Theil's index of inequality. The mse component can be decomposed into proportions due to bias, variance and covariance. (extreme values can distort statistic)

Assessment of accuracy using different criteria: input coefficients for 20 Finnish regions in 1995 (unweighted)

Method	Criterion					
	$\gamma_1 \times 10^3$	mse × 10^3	$\gamma_2 \times 100$	$\gamma_3 \times 100$	γ_4	γ_5
SLQ	2.905	0.331	0.474	2.986	78.9	75.3
CILQ	3.119	0.318	0.510	2.886	85.2	75.2
FLQ (δ = 0.05)	1.803	0.246	0.436	2.594	72.7	65.4
FLQ (δ = 0.1)	0.739	0.218	0.395	**2.580**	65.6	60.4
FLQ (δ = 0.15)	**–0.194**	**0.215**	0.372	2.710	61.6	**58.8**
FLQ (δ = 0.2)	–0.994	0.229	**0.365**	2.912	**60.3**	59.5

Decomposition of mean squared error (mse): input coefficients for 20 Finnish regions in 1995 (unweighted)

Method		Source of error		
	mse × 10^3	Bias	Variance	Covariance
SLQ	0.3296	0.0100	0.0699	0.2498
CILQ	0.3179	0.0109	0.0651	0.2419
FLQ (δ = 0.05)	0.2458	0.0042	**0.0311**	0.2105
FLQ (δ = 0.1)	0.2177	0.0014	0.0364	0.1799
FLQ (δ = 0.15)	**0.2152**	**0.0009**	0.0634	0.1509
FLQ (δ = 0.2)	0.2291	0.0019	0.1012	**0.1260**

Assessment of accuracy using different criteria: sectoral output multipliers for 20 Finnish regions in 1995 (unweighted)

Method	Criterion					
	μ_1	μ_2*	μ_3	μ_4	$\mu_5 \times 100$	sd
SLQ	14.7	59.8	14.2	20.4	15.745	0.1167
CILQ	15.0	63.3	12.3	19.9	16.395	0.1061
FLQ ($\delta = 0.1$)	3.4	17.8	2.1	11.0	7.968	0.0621
FLQ ($\delta = 0.15$)	**–0.5**	**1.7**	**–1.3**	**10.4**	**6.707**	**0.0580**
FLQ ($\delta = 0.2$)	–3.6	–11.5	–4.0	11.1	6.734	0.0610

Measures of accuracy of multipliers

$$\mu_1 = (100/n)\, \Sigma_j (\hat{m}_j - m_j) / m_j$$

$$\mu_2 = (100/n)\, \Sigma_j \, (\hat{m}_j - m_j)/(m_j - 1)$$

$$\mu_2^* = 100\, (\overline{\hat{m}} - \overline{m})/(\overline{m} - 1)$$

$$\mu_3 = 100\, \Sigma_j\, e_j (\hat{m}_j - m_j) / m_j$$

$$\mu_4 = 100 \sqrt{\frac{\sum_j (\hat{m}_j - m_j)^2}{\sum_j m_j^{\,2}}}$$

$$\mu_5 = (1/n)\, \Sigma_j \,|\, \hat{m}_j - m_j \,|\, / m_j$$

$$sd = [(1/n)\, \Sigma_j \{(\,|\, \hat{m}_j - m_j | / m_j) - \mu_5\}^2]^{0.5}$$

Measures of accuracy of multipliers

$\hat{m}_j$ is the estimated type I output multiplier for sector *j* in a given region

* column sum of the LQ-based Leontief inverse matrix,

m_j is the corresponding survey-based multiplier,

e_j is the proportion of regional employment in sector *j*

n is the number of sectors (=37).

Measures of accuracy of multipliers

μ_1 Mean percentage difference

* Has been used in many studies (comparisons)
* Measures bias
* Our preferred measure

μ_2 was not possible to compute (m_j=0 for some regions)

μ_2* is an effort to circumvent this problem

Measures of accuracy of multipliers

μ_3 is a measure with proportion of regional employment in sector j

μ_4 is Theil's index of inequality

μ_5 Mean absolute proportional deviation

sd Standard deviation (to measure dispersion in the absolute proportional error)

Conclusions

- The FLQ outperformed the conventional LQs
- Delta= 0.15 appears to be the best value for estimating coefficients and multipliers
- The optimal value of delta seems to vary systematically across regions
- Our regression equation can be used to obtain an approximate value of delta

Conclusions

- A regression equation was developed to ”fine tune” the best single value
- Taking account of regional specialization did not yield improved results
- The FLQ can generate a useful initial set of regional input coefficients $\rightarrow$ should be checked on the basis of informed judgement, surveys of selected industries etc.
- FLQ coefficients can be used as initial values in RAS procedure