Decomposing Change in Industry Concentration

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Abstract: In this paper we present an empirical application of the theoretical result found in Bajo and Salas (2002), namely, the decomposition of the change in industry concentration into the change in its two components (i.e., inequality and the number of firms), using a set of concentration indices previously computed for a number of sectors of the Spanish economy. This example would illustrate the usefulness of the approach, by helping to identify the sources of a change in industry concentration over a time period.

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1. Introduction

Concentration indices are traditional instruments in industrial economics, which provide a synthetic measure of market structure, and allow evaluating the degree of competition present in different industries [see, e.g., Waterson (1984) or Tirole (1988)]. Among the most outstanding concentration measures, we can quote the class of indices proposed by Hannah and Kay (1977), which incorporates as particular cases some of the most used indices in the literature.

A basic feature from the definition of concentration indices is that they incorporate the two relevant aspects of industry structure; namely, size inequalities and the number of firms [see Encaoua and Jacquemin (1980)]. On the one hand, concentration would unambiguously increase with inequality. However, on the other hand, although a higher number of firms would lead by itself to a fall in concentration, the degree of inequality within the industry would be also affected, so that concentration might actually increase if the new entrant into the industry would be large enough.

A consistent relationship between the whole set of Hannah-Kay industry concentration indices and the classical general entropy inequality measures from the income distribution literature, has been derived in Bajo and Salas (2002). An interesting feature of this relationship is that allows providing an explicit additive decomposition of the change in industry concentration into the change in its two components, i.e., inequality and the number of firms. In this paper we present an empirical application of this theoretical result, using a set of concentration indices computed for a number of sectors of the Spanish economy. This example would illustrate the usefulness of the approach, by helping to identify the sources of a change in industry concentration over a time period.

2. Decomposing Change in Industry Concentration

Our starting point will be the general entropy inequality indices, as defined by Cowell (1977, 1995):

$$I_{GE(c)} = \begin{cases} \dfrac{1}{n}\dfrac{1}{c(c-1)}\sum_{i=1}^{n}\left[\left(X_i / \overline{X}\right)^c - 1\right] & \forall\, c \neq 0,1 \\ \dfrac{1}{n}\sum_{i=1}^{n}\log\left(X_i / \overline{X}\right), & if\ c = 0 \\ \dfrac{1}{n}\sum_{i=1}^{n}\left[\left(X_i / \overline{X}\right)\log\left(X_i / \overline{X}\right)\right], & if\ c = 1 \end{cases} \qquad (1)$$

where, according to the income distribution literature, X_i denotes the *i*th household income, $\overline{X}$ is the mean income across households, and *n* is the number of households. Notice that, for our purposes, the concept of income will be extended to define the analogous concept for the firm, so that X_i would apply to any indicator of the firm's size.

Next, the Hannah and Kay concentration indices can be written as:

$$C_{HK(\alpha)} = \begin{cases} \left[\sum_{i=1}^{n} s_i^{\alpha} \right]^{\frac{1}{\alpha - 1}} & if\ \alpha > 0, \alpha \neq 1 \\ \exp\left[\sum_{i=1}^{n} s_i \log s_i \right] & if\ \alpha = 1 \end{cases} \qquad (2)$$

where $s_i = \frac{X_i}{\sum_{i=1}^{n} X_i}$ is the relative market share of the ith firm, X_i is an indicator of the size (usually measured in terms of sales or employment) of the ith firm, and n is the number of firms in the industry. Notice that $C_{HK(1)}$ is defined as the limit of $C_{HK(\alpha)}$ when $\alpha \to 1$, which coincides with the antilogarithm of (minus) the first-order entropy concentration index; see also Waterson (1984). Also, $C_{HK(2)}$ would coincide with the well-known Herfindahl's concentration index.

From the above definitions, Bajo and Salas (2002) show that equations (1) and (2) are related through:

$$C_{HK(\alpha)} = \begin{cases} \dfrac{\left[1 + \alpha(\alpha - 1) I_{GE(\alpha)}\right]^{\frac{1}{\alpha - 1}}}{n} & if\ \alpha = c > 0, \alpha = c \neq 1 \\ \dfrac{\exp\left[I_{GE(\alpha)}\right]}{n} & if\ \alpha = c = 1 \end{cases} \qquad (3)$$

Notice that equation (3) can be written in a more general form as:

$$C_{HK(\alpha)} = \frac{\varphi\left(I_{GE(\alpha)}\right)}{n} \qquad \forall\, \alpha > 0\,2 \tag{3'}$$

where $\varphi(I_{GE(\alpha)})$ is the component of inequality in $C_{HK(\alpha)}$, which is an increasing function of the general entropy inequality indices. Now, we can provide a decomposition of the change in concentration between the two sources identified above, i.e., the number of firms n and the degree of inequality I, by using the following additive expression that can be easily derived from (3'):

$$\frac{\Delta C_{HK(\alpha)}}{C_{HK(\alpha)}} \approx \frac{\Delta\varphi\left(I_{GE(\alpha)}\right)}{\varphi\left(I_{GE(\alpha)}\right)} - \frac{\Delta n}{n} \qquad \forall\, \alpha > 0 \tag{4}$$

In what follows, we will illustrate this decomposition by means of an empirical example. To that end, we will make use of the concentration indices computed in Bajo and Salas (1998) for 68 manufacturing and non-manufacturing sectors of the Spanish economy, from the Spanish Institute for Fiscal Studies' data set coming from VAT reports by more than 2,000,000 firms (i.e., providing an almost exhaustive coverage of both firms and sectors). In particular, our decomposition was applied to the change in concentration between 1992 and 1993, for the Hannah-Kay indices with α=0.5, 1, 1.5, 2, and 2.5.

Notice that, according to equation (4), and for any α, concentration would unambiguously increase when:

$$\frac{\Delta\varphi(I)}{\varphi(I)} > \frac{\Delta n}{n}$$

which, in turn, would occur in any of the following cases:

(i) $\Delta n < 0$ and $\Delta I > 0$

(ii) $\Delta n < 0$, $\Delta I < 0$ and $\dfrac{\Delta\varphi(I)}{\varphi(I)} > \dfrac{\Delta n}{n}$

(iii) $\Delta n > 0$, $\Delta I > 0$ and $\dfrac{\Delta\varphi(I)}{\varphi(I)} > \dfrac{\Delta n}{n}$

On the other hand, for any α, concentration would unambiguously decrease when:

$$\frac{\Delta\varphi(I)}{\varphi(I)} < \frac{\Delta n}{n}$$

which would occur in any of the following cases:

(iv) $\Delta n > 0$ and $\Delta I < 0$

(v) $\Delta n > 0$, $\Delta I > 0$ and $\dfrac{\Delta\varphi(I)}{\varphi(I)} < \dfrac{\Delta n}{n}$

(vi) $\Delta n < 0$, $\Delta I < 0$ and $\dfrac{\Delta\varphi(I)}{\varphi(I)} < \dfrac{\Delta n}{n}$

In Table 1 we present an example of the decomposition shown in equation (4). As the last column of the table shows, we are able to explain reasonably well the change in concentration during the period. From the 68 sectors for which concentration indices were computed, we have selected nine industries, which cover the six cases stated above.

For six of these nine industries, concentration increases. In three of them: Food Industry, Textiles, and Banking, concentration rises due both to a lower number of firms and a higher inequality -i.e., case (i) above-. In Basic Chemicals, concentration rises due to a lower number of firms and despite a lower inequality for α=0.5, 1 and 1.5 -i.e., case (ii) above-; however, for α=2 and 2.5, higher inequality would also lead to higher concentration -i.e., case (i) above-. Finally, in Chemicals, and in Precision Instruments, concentration rises due to a higher inequality and despite a higher number of firms -i.e., case (iii) above.

Table 1: Decomposition of the change in concentration, 1992-93

(A) Index HK(0.5)

SECTOR	Rate of change in the concentration index (1)	Rate of change in the inequality component (2)	Rate of change in the number of firms (3)	Explained rate of change (4)=(2)–(3)	% of explanation (5)=(4)/(1)* 100
Basic Chemicals	2.00	-0.06	-2.02	1.96	97.98
Chemicals	2.81	2.94	0.12	2.82	100.12
Precision Instruments	0.41	3.57	3.14	0.43	103.14
Food Industry	6.15	5.19	-0.91	6.09	99.09
Textiles	9.83	1.33	-7.74	9.07	92.26
Air and Sea Transportation	-15.69	-12.63	3.63	-16.25	103.63
Banking	4.61	2.13	-2.36	4.50	97.64
Computing Services	-11.73	-2.20	10.80	-13.00	110.80
House Renting	-7.10	-9.20	-2.26	-6.94	97.75

(B) Index HK(1)

SECTOR	(1)	(2)	(3)	(4)	(5)
Basic Chemicals	1.01	-1.02	-2.02	1.00	98.98
Chemicals	5.62	6.08	0.12	5.96	106.08
Precision Instruments	5.70	9.37	3.14	6.24	109.37
Food Industry	11.41	11.86	-0.91	12.76	111.86
Textiles	11.03	3.70	-7.74	11.44	103.70
Air and Sea Transportation	-52.50	-32.05	3.63	-35.67	67.95
Banking	5.14	2.93	-2.36	5.29	102.93
Computing Services	-10.63	0.15	10.80	-10.65	100.15
House Renting	-53.90	-36.49	-2.26	-34.23	63.51

Table 1 continued

(C) Index HK(1.5)					
Basic Chemicals	1.46	-0.50	-2.02	1.51	104.00
Chemicals	8.37	7.26	0.12	7.14	85.40
Precision Instruments	9.37	11.02	3.14	7.88	84.05
Food Industry	22.90	19.22	-0.91	20.13	87.89
Textiles	16.38	6.36	-7.74	14.10	86.06
Air and Sea Transportation	-31.73	-27.68	3.63	-31.31	98.66
Banking	4.52	1.72	-2.36	4.09	90.50
Computing Services	-6.83	2.88	10.80	-7.92	115.93
House Renting	-70.65	-69.46	-2.26	-67.21	95.12
(D) Index HK(2)					
Basic Chemicals	2.53	0.46	-2.02	2.48	97.98
Chemicals	10.62	10.75	0.12	10.63	100.12
Precision Instruments	9.15	12.58	3.14	9.44	103.14
Food Industry	34.34	33.12	-0.91	34.02	99.09
Textiles	19.83	10.55	-7.74	18.29	92.26
Air and Sea Transportation	-26.98	-24.33	3.63	-27.96	103.63
Banking	3.96	1.51	-2.36	3.87	97.64
Computing Services	-5.63	4.57	10.80	-6.23	110.80
House Renting	-78.34	-78.83	-2.26	-76.57	97.74
(E) Index HK(2.5)					
Basic Chemicals	3.57	1.48	-2.02	3.49	97.98
Chemicals	12.52	12.66	0.12	12.54	100.12
Precision Instruments	8.15	11.55	3.14	8.41	103.14
Food Industry	44.91	43.59	-0.91	44.50	99.09
Textiles	21.64	12.23	-7.74	19.97	92.26
Air and Sea Transportation	-23.84	-21.08	3.63	-24.70	103.63
Banking	3.75	1.29	-2.36	3.66	97.64
Computing Services	-4.50	5.81	10.80	-4.99	110.80
House Renting	-79.89	-80.35	-2.26	-78.09	97.74

For the three remaining industries, concentration decreases. In Air and Sea Transportation, concentration falls due both to a higher number of firms and a lower inequality -i.e., case (iv) above-. In Computing Services, concentration falls due to a higher number of firms and despite a higher inequality for α=1, 1.5, 2 and 2.5 -i.e., case (v) above-; however, for α=0.5 lower inequality would also lead to lower concentration -i.e., case (iv) above-. Finally, in House Renting, concentration falls due to a lower inequality and despite a lower number of firms -i.e., case (vi) above.

3. Conclusion

A consistent relationship between the whole set of Hannah-Kay industry concentration indices and the classical general entropy inequality measures from the income distribution literature, was derived in Bajo and Salas (2002). From there, we obtained an explicit additive decomposition of the change in concentration into the change in its two components, i.e., inequality and the number of firms. In this paper we have presented an empirical application of this theoretical result, using a set of concentration indices previously computed for a number of sectors of the Spanish economy. This example would illustrate the usefulness of the approach, by helping to identify the sources of a change in industry concentration over a time period.

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