Direct State funding of Chilean universities

Régis Lachaume

November 9, 2021

1 Calculation

1.1 Yearly evaluation

1.1.1 Determination

Art. 2 of Decree with Force of Law 4 of 1980, with modifications from Art. 1 of Ministry of Education Decree 116 of 2002, indicates that 5% part of the total funding of year $n+1$ is distributed to University i according to its metrics measured in year n. They involve

- $U_{i,n}$, the number of undergraduate students ("estudiantes de pregrado");
- $M_{i,n}$, the number of majors ("carreras");
- $S_{i,n}$, the number of equivalent full-time scholars ("académicos"), i.e. professors and researchers;
- $P_{i,n}$, the number of equivalent full-time scholars with a post-graduate title such as master or a PhD;
- $G_{i,n}$, the number of research grants ("proyectos");
- $P^{\mathrm{I}}_{i,n}$, the number of Web of Science publications (WoS)[1];
- and $P^{\mathrm{S}}_{i,n}$, the number of non-WoS publications indexed by the Scientific Electronic Library Online (Scielo) Chile.

The metrics, defined in the aformentioned decrees, are ratios meant to measure an output v. staff efficiency[2]

$$x_{i,n,1} = U_{i,n}/M_{i,n}, \tag{1a}$$
$$x_{i,n,2} = U_{i,n}/S_{i,n}, \tag{1b}$$
$$x_{i,n,3} = P_{i,n}/S_{i,n}, \tag{1c}$$
$$x_{i,n,4} = G_{i,n}/S_{i,n}, \tag{1d}$$
$$x_{i,n,5} = (P^{\mathrm{I}}_{i,n} + \frac{33}{100}P^{\mathrm{S}}_{i,n})/S_{i,n} \tag{1e}$$

According to Art. 3 of Ministry of Education Decree 128 of 1991, the evaluation formula renormalises the aforementioned ratios in this way[3]:

$$\mu_{n,k} = \frac{1}{N}\sum_j x_{j,n,k} \qquad \text{(mean)} \tag{2a}$$
$$\sigma_{n,k} = \sqrt{\frac{1}{N}\Big(\sum_j x^2_{j,n,k}\Big) - N\mu^2_{n,k}} \qquad \text{(std. dev.)} \tag{2b}$$
$$\xi_{i,n,k} = \frac{x_{i,n,k} - \mu_{n,k}}{\sigma_{n,k}} \qquad \text{(reduced coeff.)} \tag{2c}$$
$$y_{i,n,k} = \exp\left[-\frac{7}{5} + \frac{\xi_{i,n,k}}{4}\right]^3 \tag{2d}$$

where N is the total number of universities. The transform in Eq. (2c) ensures that Universities are compared by how much they deviate from the mean. The exponential in Eq. (2d) is supposed to simulate a biological growth. Figure 2 displays the exponential nature of the rating.

Table 1: Coefficients used for university evaluation since 1998.

	ratio	value
c_1	students-to-majors	0.01
c_2	students-to-staff	0.14
c_3	postgrad staff-to-staff	0.24
c_4	grants-to-staff	0.25
c_5	papers-to-staff	0.35

Art. 2 of Decree with Force of Law 4 of 1980 indicates that 5% of the funding is indexed on a weighted average of the metrics $y_{i,n,k}$ (k in $1\cdots5$) (see Sect. 1.1.1). The weights c_k may vary from year to year, but have been constant since 1998 (see Table 1). University i is thus assigned a score

$$y_{i,n} = \sum_k c_k y_{i,n,k}. \tag{3a}$$

and, using the total score

$$y_n = \sum_i y_{i,n}, \tag{3b}$$

a funding share

$$f_{i,n} = \frac{y_{i,n}}{y_n} \tag{3c}$$

[1] At the time of the Decree 116 it was known as ISI

[2] While the number of publications is defined by the number of WoS plublications plus one third of Scielo one by Ministry of Education Decree 116 of 2002, the Ministry has consistently used factor 0.33 instead of 1/3 for the calculation.

[3] Although not specified by the decree, the Ministry has consistently used the population variance, not the sample variance, for the calculation.

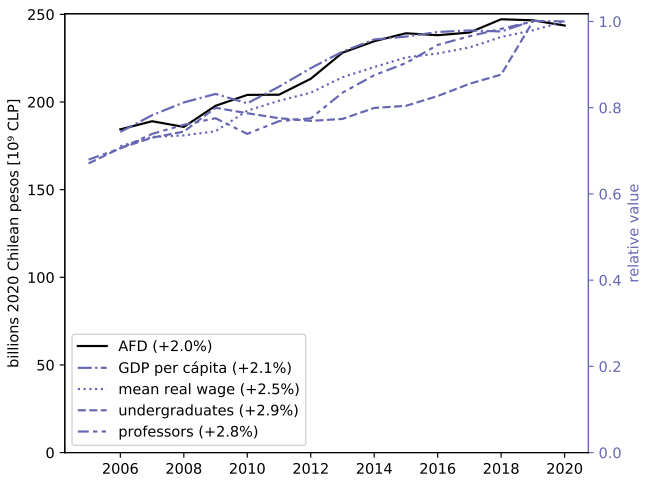

Figure 1: Evolution of total direct State funding to traditional Chilean Universities, in 2020 pesos (inflation-corrected) compared to the evolution of the GDP per capita (World Bank data), the mean real wage (Instituto Nacional de Estadísticas data) the number of undergraduate students and the number of professors.

1.1.2 Marginal earnings

In this section, I focus on a yearly snapshot and drop the n index in the formulae. I examine the case where university i decides to increase one of its ratios number k by a small number of standard deviations $\Delta\xi_{i,k}$, so that the ratio $x_{i,k}$ improves by $\Delta x_{i,k} = \sigma_k \Delta\xi_{i,k}$.

For any university j, the new value of the score $y_{j,k}$ is usually modified because the mean and standard deviation are changed via $x_{i,k}$. The difference $\Delta y_{j,k}$ is given by differentiating Eq. (2d), and in turn Eqs. (2a–2c) on which it depends. The calculation, detailed in in Appendix A.1, yields

$$\frac{\Delta y_{j,k}}{y_{j,k}} = \frac{3}{4}\left(\frac{\xi_{j,k}}{4} - \frac{7}{5}\right)^2 \left(\delta_{ij} - \frac{1}{N} - \frac{\xi_{i,k}\xi_{j,k}}{N}\right) \Delta\xi_{i,k}, \quad (4)$$

where $\delta_{ij} = 1$ if universities i and j are the same and zero otherwise.

The meaning of Eq. (4) is the following:

1. $(\xi_{j,k}/4 - 7/5)^2$ *factor*: The relative improvement depends on the relative standing of the University in the ranking. A university lagging behind by 2 standards deviations gets a relative improvement 4,5 times higher than a university standing out by 2 standard deviations.

2. δ_{ij} *term:* University i generally benefits from an increase of its own ratio $\Delta x_{i,k}$: the δ_{ij} $(= 1$ for $i = j)$ term in the equation is the only one that is not in $1/N$. However, if $|\xi_{i,k}| > \sqrt{N-1} \approx 5$ standard deviations, University could lose from improving. Nevertheless, the data of the Ministery from 2006 to 2020 can be used to show that the highest deviation any of the ratio has ever reached is 3.7.

3. University j may benefit from, or be harmed by, the improvement of University i. There are two effects at play.

   (a) $1/N$ *term*: The increase of the mean, would on its own hurt all other universities as their position relative to the mean $\xi_{j,k}$ would drop (see the $1/N$ term in the equation).

   (b) $\xi_{i,j}\xi_{j,k}/N$ *term*: However, the modification of the standard deviation works both ways. Intuitively, if a university with a high $\xi_{i,k} > 0$ $(x_{i,k} > \mu_k)$ improves, it will increase the standard deviation, so that all universities deviate less from the mean: other universities with $\xi_{j,k} > 0$ will lose some of their good standing and lower tier ones with $\xi_{j,k} < 0$ will decrease their lag . Conversely, on can see that the improvement of a University with a lower rank $\xi_{j,k} < 0$, by decreasing the standard deviation of the sample when it goes closer to the mean, will help those with good standing to stand out more and harm other lower tier ones.

   For both effects combined, University j benefits if $\xi_{i,k}\xi_{j,k} < -1$ and is harmed otherwise.

To determine the additional funding fraction Δf_j, let's propagate Eq. (4) into Eqs. (3a–3c):

$$\frac{\Delta f_j}{f_j} = c_k \left[\left(1 - \frac{y_j}{y}\right)\frac{\Delta y_{j,k}}{y_j} - \sum_{l\neq j}\frac{y_l}{y}\frac{\Delta y_{l,k}}{y_l}\right]. \quad (5)$$

The first term in the square brackets has the same sign as $\Delta y_{j,k}$ because, by definition, $y_j < y$. In most cases, the second term is smaller than the first one because the $\Delta y_{l,k}$ partially cancel out (some positives and some negatives) and $y_l < y$. It means that the funding received by a university that has an improved rating normally receives additional funding. It is possible, though, that a university with a very small $\Delta y_{j,k}$ (e.g. $\xi_{j,k} < -2$) will be harmed by increasing its score, because the other, larger, $\Delta y_{l,k}$ coould lead to a second term larger than the first term under these circumstances. In years 2006–2019 it has ocurred once, very marginally, in 2015, for Universidad de Talca. It would have received 1,000 CLP less had it substituted four regular professors with ones owning a postgraduate degree (improvement of $y_{\text{U. Talca},2015,3}$). It happened on that year that Universidad de Talca had the highest negative standard deviation observed for any metrics in the period 2006–2019 ($\xi \approx -2.8$).

1.2 Time evolution

Total funding The total funding in year n, F_n, is a slowly increasing series (see Fig. 1). In half of the years it approximately follows the consumer price index, but it has received a modest boost in other years. The average

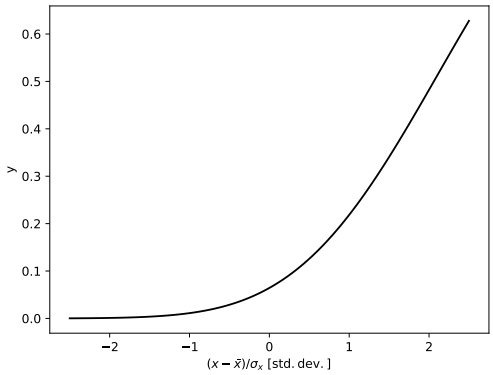

Figure 2: Transformation of the metric $x_{i,n,k}$ into $y_{i,n,k}$, before a weighted sum $\sum_k c_{i,n,k} y_{i,n,k}$ is performed to determine the rating of university i in year n.

inflation-corrected increase has been 2.0% per year in period 2006–2020. This increases matches the increase in undergraduate students (+2.9% in 2005–2019), professors (+2.8% in 2005-2019), real wages (+2,5% in 2006-2019), and GDP per capita (+2.1% in 2006-2019). Table 3 in Appendix A.2 gives an overview of the main macroeconomic quantities in this period.

Increase in standard of living and student population are long-term trends that I would expect to hold for at least the next decade, so I assume that University funding by the State will still follow this trend. For predictions, beyond 2020, I will therefore take

$$F_{n+1} = F_n(1+q), \tag{6}$$

where $q = 2\%$.

University funding Let $F_{i,n}$ be the funding received by university i at year n. Art. 2 of Decree with Force of Law 4 of 1980 indicates that 5% of the funding is indexed on metrics $y_{i,n,k}$ and 95% of the funding is related to the previous year's share of the total funding. So,

$$F_{i,n+1} = \left(\frac{19}{20} \frac{F_{i,n}}{F_n} + \frac{1}{20} \frac{y_{i,n}}{\sum_j y_{j,n}} \right) F_{n+1}. \tag{7}$$

1.3 Checks

Yearly evaluation I have checked the calculations of the 5% using open data from the Eduction Ministry for years 2006 to 2020. For each year since 2011 and 2007–2009, the percentages I derived (see Table 4 for 2018) match within numerical rounding errors (8 digits) with those of the Ministry. The subsidies I predict for each university differ by at most CLP 1,000 (USD 1.50) with the official ones due to rounding errors, as the accounting unit used in the official documents is 1,000 Chilean pesos. In 2010, the Ministry used the 2009 calculation with 2008 metrics, instead of 2009 ones, leading to large differences if the 2009 metrics given in the Ministry's spreadsheet is used. Difference are zero within rounding errors using 2008 data instead. In 2006, there is an unexplained 0.01% discrepancy between my determination and the Ministry's. The official spreadsheet file from the ministry, with additional sheets showing my calculations, are available from github project `https://github.com/loqueelvientoajuarez/afd`.[4]. The detail of calculations for year 2018 is given in Appendix. A.3. For that year, my calculations match exactly the Ministery's to the peso.

Time-evolution I have checked the recurrence formula Eq. (7) using the total amount given for each year F_n. The 95% funding is well predicted from year to year, except again for 2010, where I had to substitute 2008 funding percentages to the expected 2009 ones. Because of rounding errors cumulating from year to year, the amounts I predict differ by up to 4,000 pesos (approx USD 10) with those of the Ministry.

Marginal earnings Marginal earnings have been determined by two methods. The first one, using differential calculus in Sect. 1.1.2, and the second one, by doing the full calculation with Eq. (7) using the new values of the coefficients. I have checked that both method agree within a few significant digits as long as the variations remain small.

2 Incentives & desincentives

2.1 Marginal earnings

If an additional paper is published by a researcher of University i in year n, it will reflect in the 5% funding of year $n+1$. Let us call $\Delta F_{i,n+1}$ the additional earnings of the university in that year. In the subsequent years, it will reflect via the 95% (first term of the right handside of Eq. (7)) in this way:

$$\Delta F_{i,n+k} = \frac{19}{20} \Delta F_{n+k-1} F_{n+k} / F_{n+k-1},$$

so, using Eq. (6),

$$\Delta F_{i,n+k} = \Delta F_{n+k-1} \frac{19(1+q)}{20} \tag{8}$$

The additional funding obtained by the university in all

[4]The original ministry file can be obtained from `http://dfi.mineduc.cl/usuarios/MECESUP/File/2018/instrumentos/AFD/AFD_2006_al_2018_MontosVariables5xc(1).xlsx` and my calculations from `https://github.com/loqueelvientoajuarez/afd/blob/master/src/tabla-afd.xlsx`

Table 2: Additional earnings in 2020 Chilean pesos for thes marginal improvement of 2019 metrics: an additional full-time contract of a postgraduate professor, an additional research grant, and an additional Web of Science (ex-ISI) publication. 2020 funding is accurate to 1,000 pesos. The total funding assumed that the State funding continues growing by 2% a year real terms. A research grant typically lasts 3 years and will carry the same level of funding for each year it is active. An additional tenure-track/tenured professor will bring as many times more funding as the years they stay hired.

university	postgraduate staff		research grant		WoS publication	
	2020	all years [CLP]	2020	all years [CLP]	2020	all years [CLP]
U. de Chile	314,000	10,129,032	943,000	30,419,355	492,000	15,870,968
P. U. Católica de Chile	310,000	10,000,000	972,000	31,354,839	495,000	15,967,742
U. de Concepción	1,177,000	37,967,742	1,278,000	41,225,806	523,000	16,870,968
U. Católica de Valparaíso	3,048,000	98,322,581	3,150,000	101,612,903	1,634,000	52,709,677
U. Téc. Federico Sta. María	884,000	28,516,129	1,834,000	59,161,290	866,000	27,935,484
U. de Santiago	323,000	10,419,355	1,113,000	35,903,226	379,000	12,225,806
U. Austral	1,482,000	47,806,452	1,362,000	43,935,484	846,000	27,290,323
U. Católica del Norte	176,000	5,677,419	742,000	23,935,484	681,000	21,967,742
U. de Valparaíso	782,000	25,225,806	739,000	23,838,710	287,000	9,258,065
U. de Antofagasta	1,057,000	34,096,774	1,022,000	32,967,742	1,588,000	51,225,806
U. de la Serena	186,000	6,000,000	876,000	28,258,065	910,000	29,354,839
U. de Bío-bío	4,319,000	139,322,581	1,464,000	47,225,806	599,000	19,322,581
U. de la Frontera	2,971,000	95,838,710	5,195,000	167,580,645	2,315,000	74,677,419
U. de Magallanes	2,841,000	91,645,161	1,593,000	51,387,097	1,860,000	60,000,000
U. de Talca	3,791,000	122,290,323	2,305,000	74,354,839	1,056,000	34,064,516
U. de Atacama	82,000	2,645,161	477,000	15,387,097	541,000	17,451,613
U. de Tarapacá	5,650,000	182,258,065	1,218,000	39,290,323	1,972,000	63,612,903
U. Arturo Prat	158,000	5,096,774	307,000	9,903,226	81,000	2,612,903
U. Metropolitana	1,833,000	59,129,032	220,000	7,096,774	66,000	2,129,032
U. de Playa Ancha	4,645,000	149,838,710	853,000	27,516,129	168,000	5,419,355
U. Tecnológica Metropolitana	937,000	30,225,806	619,000	19,967,742	230,000	7,419,355
U. de Los Lagos	816,000	26,322,581	619,000	19,967,742	204,000	6,580,645
U. Católica de Maule	1,326,000	42,774,194	539,000	17,387,097	517,000	16,677,419
U. Católica de Temuco	986,000	31,806,452	639,000	20,612,903	193,000	6,225,806
U. C. de la Sant. Concepción	527,000	17,000,000	600,000	19,354,839	341,000	11,000,000
U. de O'Higgins	27,762,000	895,548,387	28,235,000	910,806,452	11,357,000	366,354,839
U. de Aysén	55,246,000	1,782,129,032	60,558,000	1,953,483,871	18,833,000	607,516,129

years is therefore

$$\begin{aligned}\Delta F_i &= \sum_{k=1}^{+\infty} \Delta F_{i,n+k} \\ &= \sum_{k=1}^{+\infty} \frac{19(1+q)}{20} \Delta F_{i,n+1} \\ &= \frac{20}{1-19q} \Delta F_{i,n+1} \\ &\approx 32 \Delta F_{i,n+1}.\end{aligned} \tag{9}$$

The determination of $\Delta F_{i,n+1}$ is straightforward. The calculations in Eqs. (1a–7) are done with the metrics provided by the Ministry (see Sect. 1.1.1) and for the same ones with an additional publication. The difference in funding is $\Delta F_{i,n+1}$.

Table 2.1 gives the 2019 funding a University would have received, had an additional 2019 paper been published, an additional one-year science staff (professor) been contracted, or an additional grant been obtained (postdoct staff or other project). I have made the hypothesis that no other Traditional University has co-authored the paper, in which case the amount may vary.

My figures are much larger than those derived by Ramírez and Alfaro [2012]. The reasons are that they

1. only consider the first five years after the paper is published while the half-life of the 95% dampening is 14 years, meaning that they underestimate the total revenue obtained with a paper by a factor of ≈ 4

2. include an additional dampening of 8% per year that they do not justify and is not based on any kind of calculation by the Ministry, meaning that they underestimate the additional funding by a factor of ≈ 2.5 to 4;[5]

[5] Quite the contrary, the constant increase of the total funding (consumer price index +2%) calls for an amplification of 2%

Table 3: Macroeconomic data for Chile 2006 to 2020: UF, a price-indexed fiscal currency unit, the growth of the GDP per capita, and the growth of the mean wage.

year	UF[1] [CLP]	GDP per capita[2] [growth in %]	Mean wage[3] [growth in %][4]
2006	18,152.61	5.20	3.0
2007	18,627.89	3.79	0.5
2008	20,260.76	2.42	1.3
2009	20,930.92	−2.60	6.4
2010	21,204.99	4.75	2.9
2011	21,892.81	5.05	2.3
2012	22,627.36	4.30	4.3
2013	22,852.67	3.03	2.7
2014	24,026.01	0.69	2.5
2015	24,984.62	1.10	1.0
2016	26,053.81	0.37	1.5
2017	26,665.98	−0.24	2.6
2018	27,161.48	2.51	1.6
2019	27,908.86	−0.13	2.1[5]
2020	28,695.46	—	—

[1] Source: SII. UF (price indexed) on July 1st
[2] Sourec: World Bank
[3] Source: Instituto Nacional de Estadísticas
[4] From January to January
[5] Up to September

3. use 2010 data, meaning that the monetary incentive is larger than the 2018 one by a factor of ≈ 2; and

4. seem to use different values for the coefficients than those retroactively published in 2012. Their Fig. 4 doesn't match the corrected coefficients I derive for 2009, 2010, or 2011. Actually, both our data and Ministry's figures for years 2006 to 2017 show a systematic discrepancy between U. de Chile and P. U. Católica de Chile of the order of 25-35% in weighted sum of corrected coefficients and share of the 5%, while their Figure gives about 10%.

2.2 Value of collaborations

A Appendix

A.1 Derivation of equation

The variation in $\Delta y_{j,k}$ is linked to $\Delta\xi_{i,k}$ via the derivative:

$$\Delta y_{j,k} \approx \frac{\partial\, y_{j,k}}{\partial x_{i,k}}\,\Delta x_{i,k}, \tag{10}$$

$$\approx \frac{\mathrm{d}\, y_{j,k}}{\mathrm{d}\xi_{i,k}}\,\frac{\partial\,\xi_{i,k}}{\partial x_{i,k}}\,\sigma_k \Delta\xi_{i,k}, \tag{11}$$

so, substituting Eq. (2c), for the second factor

$$\approx \frac{\mathrm{d}\, y_{j,k}}{\mathrm{d}\xi_{i,k}}\left[\frac{\partial\, x_{j,k}}{\partial x_{i,k}} - \frac{\partial\,\mu_k}{\partial x_{i,k}} - \frac{x_{j,k}-\mu_k}{\sigma_k}\frac{\partial\,\sigma_k}{\partial x_{i,k}}\right]\Delta\xi_{i,k} \tag{12}$$

and, backsubstituting Eq. (2c),

$$\approx \frac{\mathrm{d}\, y_{j,k}}{\mathrm{d}\xi_{i,k}}\left[\frac{\partial\, x_{j,k}}{\partial x_{i,k}} - \frac{\partial\,\mu_k}{\partial x_{i,k}} - \xi_{j,k}\frac{\partial\,\sigma_k}{\partial x_{i,k}}\right]\Delta\xi_{i,k}. \tag{13}$$

The first factor is the derivative of the function in the right handside of Eq. (2d). It is:

$$\frac{\mathrm{d}\, y_{i,k}}{\mathrm{d}\xi_{i,k}} = \frac{3}{4}\left[-\frac{7}{5} + \frac{\xi_{i,k}}{4}\right] y_{i,k}. \tag{14}$$

In the second factor, the first term is one if $i = j$, $x_{j,k}$ and $x_{i,k}$ being then the same variable, and zero otherwise. The second term is the variation of the mean when one of the term varies, it is therefore $1/N$ the variation of the individual term. So,

$$\frac{\partial\, x_{j,k}}{\partial x_{i,k}} = \delta_{ij}, \tag{15}$$

$$\frac{\partial\,\mu_k}{\partial x_{i,k}} = \frac{1}{N}\sum_j \frac{\partial\, x_{j,k}}{\partial x_{i,k}} = \frac{1}{N}\sum_j \delta_{ij} = \frac{1}{N}. \tag{16}$$

The last term requires some more calculation. Let's use Eq. (2b):

$$\frac{\partial\,\sigma_k}{\partial x_{i,k}} = \frac{\partial}{\partial x_{i,k}}\sqrt{\frac{1}{N}\Big(\sum_j x_{j,n,k}^2\Big) - \mu_{n,k}^2}, \tag{17}$$

$$= \frac{1}{2\sigma_k}\frac{\partial}{\partial x_{i,k}}\left[\frac{1}{N}\Big(\sum_j x_{j,k}^2\Big) - \mu_k^2\right], \tag{18}$$

$$= \frac{1}{2\sigma_k}\left[\frac{2}{N}\sum_k x_{j,k}\frac{\partial\, x_{j,k}}{\partial x_{i,k}} - 2\mu_k\frac{\partial\,\mu_k}{\partial x_{i,k}}\right], \tag{19}$$

so, using Eq. (15) and Eq. (16),

$$= \frac{1}{2\sigma_k}\left[\frac{2\xi_{i,k}}{N} - \frac{2\mu_k}{N}\right] \tag{20}$$

and, finally, with Eq. (2c),

$$= \frac{\xi_{i,k}}{N}. \tag{21}$$

A.2 Macroeconomic quantities

The Chilean consumer price index narrowly followed by the unidad de fomento (UF), a fiscal currency unit with daily conversions published by the inland revenue service known as Servicio de Impuestos Internos (SII). The GDP growth per capita has been taken from the World Bank online database and the growth of the mean wage from the Chilean institute for Statistics (Instituto Nacional de Estadística). They are summed up in Table 3.

A.3 Direct state funding in 2018

Table 4 show the metrics used by the Ministry in 2018 and the calculation details for x_k and y_k.

Table 4: Metrics used for the calculations of the Direct State funding (aporte fiscal directo) of traditional Chilean Universities in 2018: U, the number of undergrad students; M, the number of majors; S, the number of (equivalent) full-time professors and researchers ("académico"); P, the number of (equivalent) full-time staff with post-graduate title; G, the number of research grants; P^{I}, the number of ISI publications; and P^{S}, the number of non-ISI publications indexed by the Scientific Electronic Library Online Chile. Calculation details for the 5% direct State funding (aporte fiscal directo) include intermediate variables x_i and y_i for each metric, the percent share of the 5% and the total amount.

University	U	M	S	P	G	P^{I}	P^{S}	x_1	y_1	x_2	y_2	x_3	y_3	x_4	y_4	x_5	y_5	(%)	kCLP
U. de Chile	30480	77	2236.64	1499.84	855.5	2305	279	396	0.561	13.6	0.033	0.671	0.062	0.382	0.512	1.072	0.475	10.43	1,220,349
P. U. Católica de Chile	26767	76	2232.60	1508.94	763.0	2171	237	352	0.421	12.0	0.021	0.676	0.066	0.342	0.406	1.007	0.411	8.76	1,025,067
U. de Concepción	24666	90	1432.16	1129.67	388.0	1050	121	274	0.204	17.2	0.081	0.789	0.217	0.271	0.241	0.761	0.198	6.39	748,010
U. Católica de Valparaíso	14121	52	633.04	518.95	209.0	545	69	272	0.199	22.3	0.215	0.820	0.278	0.330	0.377	0.897	0.307	9.88	1,155,812
U. Téc. Fedérico Sta. María	15105	77	677.03	405.92	169.0	522	6	196	0.072	22.3	0.216	0.600	0.023	0.250	0.200	0.774	0.207	5.25	614,754
U. de Santiago	18645	68	1122.57	695.14	210.0	565	58	274	0.205	16.6	0.071	0.619	0.030	0.187	0.105	0.520	0.072	2.32	271,561
U. Austral	13218	60	911.62	628.02	184.0	534	66	220	0.103	14.5	0.042	0.689	0.078	0.202	0.124	0.610	0.109	3.09	362,052
U. Católica del Norte	10407	52	590.90	362.66	63.0	328	34	200	0.077	17.6	0.088	0.614	0.028	0.107	0.036	0.574	0.092	2.03	237,356
U. de Valparaíso	14737	60	873.13	557.72	120.0	409	42	246	0.145	16.9	0.075	0.639	0.040	0.137	0.056	0.484	0.060	1.87	218,799
U. de Antofagasta	6369	56	399.75	256.79	39.0	207	11	114	0.016	15.9	0.060	0.642	0.042	0.098	0.032	0.527	0.074	1.73	202,772
U. de la Serena	7084	41	370.42	209.56	28.0	165	14	173	0.049	19.1	0.121	0.566	0.013	0.076	0.022	0.458	0.052	1.49	173,877
U. de Bio Bio	11028	62	498.67	426.73	66.0	198	26	178	0.054	22.1	0.209	0.856	0.359	0.132	0.052	0.414	0.041	4.75	555,201
U. de la Frontera	9346	48	423.96	300.01	160.0	450	40	195	0.071	22.0	0.206	0.708	0.097	0.377	0.499	1.093	0.496	11.52	1,348,115
U. de Magallanes	2962	27	268.08	129.13	27.0	106	15	110	0.015	11.0	0.016	0.482	0.003	0.101	0.033	0.414	0.041	0.84	97,927
U. de Talca	9342	41	465.00	427.80	124.0	312	43	228	0.115	20.1	0.146	0.920	0.518	0.267	0.233	0.701	0.159	8.52	997,062
U. de Atacama	6359	71	317.73	138.05	5.0	78	3	90	0.009	20.0	0.144	0.434	0.001	0.016	0.008	0.249	0.015	0.95	110,755
U. de Tarapacá	8525	63	358.23	305.34	36.0	248	32	135	0.025	23.8	0.271	0.852	0.351	0.100	0.033	0.722	0.172	6.31	738,384
U. Arturo Prat	4326	39	441.08	227.30	16.0	52	18	111	0.015	9.8	0.010	0.515	0.005	0.036	0.011	0.131	0.006	0.26	30,451
U. Metropolitana	4548	24	325.96	212.83	3.0	33	8	190	0.065	14.0	0.036	0.653	0.049	0.009	0.007	0.109	0.005	0.70	81,804
U. de Playa Ancha	7747	52	421.98	309.35	30.0	65	18	149	0.032	18.4	0.104	0.733	0.128	0.071	0.021	0.168	0.008	1.78	208,595
U. Tecnológica Metropolitana	7970	36	297.30	175.73	13.0	61	5	221	0.105	26.8	0.400	0.591	0.020	0.044	0.013	0.211	0.011	2.38	278,301
U. de Los Lagos	4150	43	430.32	254.29	36.0	97	11	97	0.011	9.6	0.010	0.591	0.020	0.084	0.025	0.234	0.013	0.56	66,056
U. Católica de Maule	6955	28	405.88	281.93	22.0	95	24	248	0.151	17.1	0.080	0.695	0.083	0.054	0.016	0.254	0.015	1.39	162,712
U. Católica de Temuco	8404	57	492.29	340.62	42.0	125	26	147	0.031	17.1	0.078	0.692	0.081	0.085	0.026	0.271	0.017	1.43	167,667
U. C.de la Sant.Concepción	8844	31	497.69	285.65	24.0	107	11	285	0.231	17.8	0.092	0.574	0.015	0.048	0.014	0.222	0.012	0.89	104,634
U. de O'Higgins	0	0	34.86	29.03	4.0	14	0	0	0.001	0.0	0.000	0.833	0.307	0.115	0.041	0.402	0.038	3.17	370,823
U. de Aysén	0	0	15.35	11.28	1.0	3	0	0	0.001	0.0	0.000	0.735	0.130	0.065	0.019	0.195	0.010	1.29	150,972

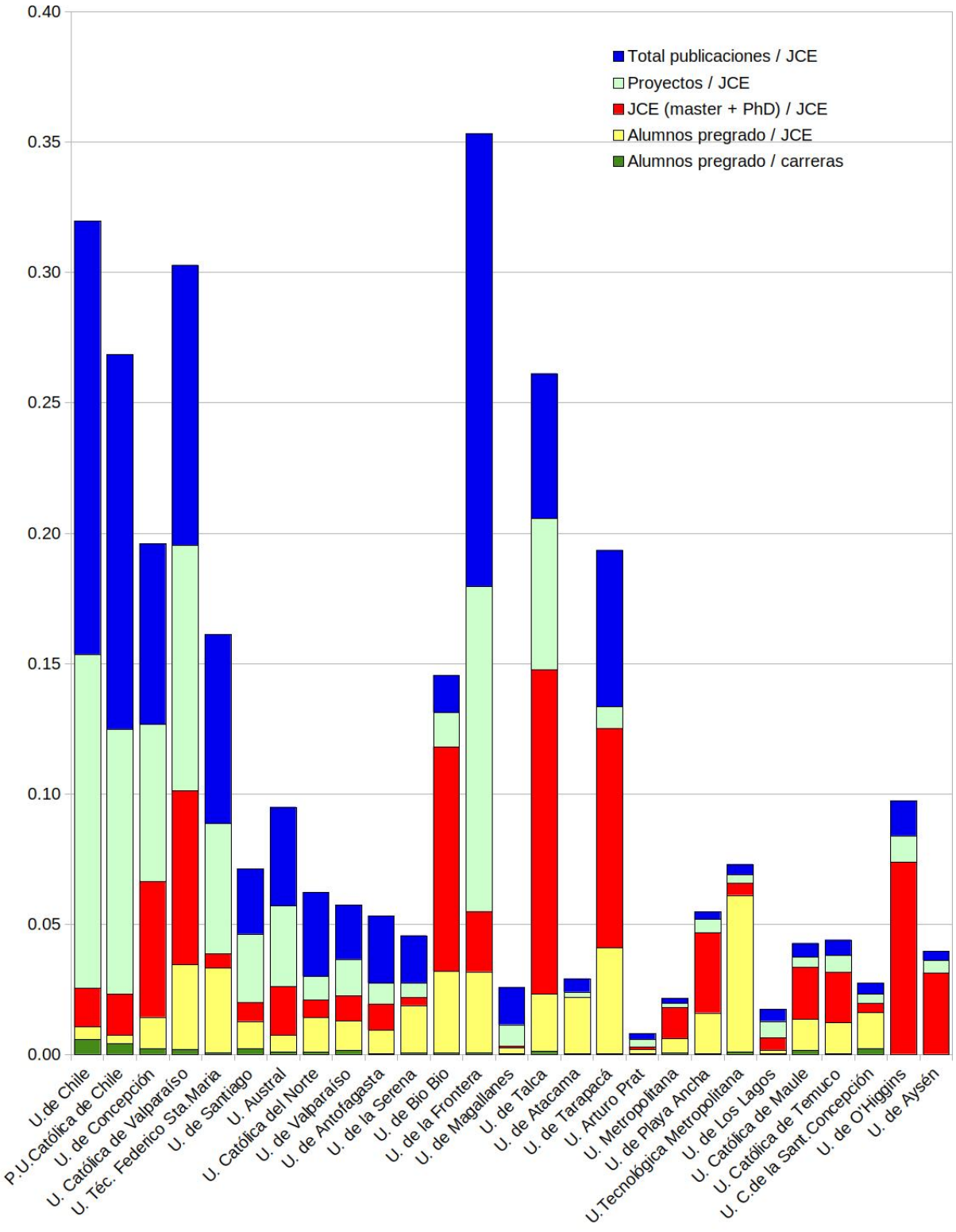

Figure 3: Graphical representation of the contributions of each AFD coefficient ($c_k y_k$) to each University's score.

Bibliography

References

Patricio E Ramírez and Jorge L Alfaro. Desincentivo a la Investigación: Resultado del Comportamiento Inequitativo del Modelo de Aporte Fiscal Directo (AFD) a las Universidades Chilenas. *Formación universitaria*, 5:27 – 36, 00 2012. ISSN 0718-5006. doi: 10.4067/S0718-50062012000400004.