Efficiency and productivty in education systems, a Canadian perspective

Tzvi Aviv
500671456

Final Assignment in Business Analytics

Submitted to Prof. Ojelanki Ngwenyam
MT8312, Ryerson MBA
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Background:

In 2015 Canada is on the verge of a new economic and political era. The collapse in commodities and oil price starting at the end of 2014 is derailing the resource dependent Canadian economy into a tailspin. Contracting productivity, decreasing interest rates, and sharp devaluation of the Canadian dollar likely contributed to sweeping former PM Steven Harper and his conservative government out of office. The new liberal government, headed by PM Justin Trudeau, elected based on an ambitious platform of 'borrow and spend' is under dire pressure to stimulate the economy and increase productivity as soon as possible. According to modern governance theory, education systems should supply high quality labor force to move the wheels of the economy, and as such should synchronize to reflect major events and shifts in the economy. In Canada, there is no federal minister of education, and each one of the provinces is funding and regulating its network of schools and universities. The Honorable Nadvdeep Bains, the minister of Innovation, Science and Economic Development was commissioned to review efficiency and productivity in the higher education system in Canada in comparison to other education systems worldwide.

Problem Statement:

How to measure efficiency in higher education systems?

How efficient are education systems in Canada in comparison to other countries?

Which polices could increase education efficiencies in Canada?

How compatible is the education system with the economy in Canada? Should it be reformed?

Methodology and Data

Education systems are complex, heterogeneous systems with multiple inputs and outputs and many inter-connections to their economic environment. To illustrate some of the challenges in assessment of efficiency and productivity in education systems, the average PISA math scores, reflecting academic quality of high school students were correlated with national economic and demographic indicators across a database of 33 nations retrieved from the OECD. This dataset was also used to identify cohorts of peer countries for international comparisons.

Performance analysis of tertiary education systems was conducted using a dataset of input factors including government and private funding, and output factors including number of graduating students in several levels. These data was developed for selected eight peer countries (Australia, Austria, Belgium, Canada, Denmark, Finland, Ireland and the USA) using data retrieved from OECD, UNESCO and CANSIM. Efficiency in education systems was inspected using non-parametric method in EMS. Macro level university operations over four years (2010-2013) of data availability were examined to determine technical and scale efficiencies. Non-parametric DEA models with constant return to scale (CRS), variable return to scale (VRS), and non-increasing returns to scale (NIRS) models were computed in EMS. These efficiency scores were than used to determine scale efficiency of education systems on the production frontier as increasing returns to scale (IRTS), most productive scale size (MPSS) or decreasing return to scale (DRTS). Finally, data retrieved from a sample of five Canadian universities, 10 Australian universities, and two Finnish universities are used to populate a university level production model.

Results:

Predictors of academic success in secondary education systems

Learning is a life journey from cradle to deathbed, often delivered by education systems that have evolved to supply the diverse learning needs of many types of students at all ages. Modern education systems are typically organized as three systems: primary, secondary, and tertiary educations systems, according to student ages. Most children and youth, from elementary school to high school levels, are taught in the primary and secondary school systems, two relatively integrated systems. University students are taught in the post-secondary or tertiary system, and many graduates continue to find employment in the job market. In analogy to production theory, education systems utilize capital and labour to process incoming students into graduates. One possible measurement of efficiency in education system could be computed from student's grades, reflecting academic achievements, since at all levels of the education system, exams and assignments are typically scored by teachers and their educational institutions. However, comparing outputs of educational systems at the national and global level requires comprehensive standardized tests, taken equally across nations to establish common reference for evaluating the quality students. Naturally, comparing schools across large spectrum of languages and cultures requires large effort in constructing and delivering appropriate measuring tools. Unfortunately, comprehensive standard tests for university students are not available for comparison. In lieu of standardized academic performance for tertiary students, correlation of economic and technological indicators to education achievements can be developed in the secondary education system, where standardized tests are the norm. PISA, is a collaborative effort among OECD member countries to assesses learning of youth through common international tests. PISA tests examine math and language skills of 15 year old students, as they transition through the secondary education system. To examine factors that may influence educational performance, a small dataset of ten economic and demographic factors were collected for 33 countries (**Table 1**). Recent PISA math scores, ranging from 413 (Mexico) to 553 (Korea), approximate the quality of the students as products of the educational system at the national level. GDP, an overall measure of national economic performance is normalized to population size per capita. Mean salaries of teachers, at the entrance level and top level expressed in USD are used to gauge labor compensation in primary and secondary education systems. Demographic indicators such as rural population and internet connectivity are expressed as parentage (**Table 1** for descriptive statistics).

Table 1: Descriptive statistics of demographic and economic variables

	Year	N	Minimum	Maximum	Mean	Std. Deviation
Employment (%)	2013	33	49	82	66	8
GDP ($ per capita)	2013	33	16,891	65,685	36,548	11,168
Internet access (%)	2010	33	22	97	70	17
Math score	2012	33	413	554	494	30
Private tertiary education (%)		28	4	78	32	23
Rural area (%)		30	9	99	61	28
Rural population (%)		30	2	72	29	18
Teacher salary ($)	2011	31	10,241	47,488	27,442	10,277
Tertiary education (%, age 25-64)		33	14	51	31	10
Top teacher salary ($)	2011	31	13,864	76,528	42,789	16,636
Valid N		23				

Table 2: Correlations of economic, demographic and educational indicators

	GDP	Employment	Math score	Rural area	Rural population	Private tertiary education	Internet access	Teacher salary	Top teacher salary	Tertiary education 25-64 population
GDP	1	.684**	.462**	.197	.098	-.236	.738**	.750**	.603**	.531**
Employment	.684**	1	.467**	.164	-.037	-.101	.700**	.456**	.352	.536**
Math score	.462**	.467**	1	-.248	-.215	-.060	.759**	.374*	.476**	.438*
Rural area	.197	.164	-.248	1	.791**	-.096	.053	.188	.134	.221
Rural population	.098	-.037	-.215	.791**	1	-.378	.013	-.014	-.097	.013
Private tertiary education	-.236	-.101	-.060	-.096	-.378	1	-.217	-.133	.247	.304
Internet access	.738**	.700**	.759**	.053	.013	-.217	1	.508**	.438*	.553**
Teacher salary	.750**	.456**	.374*	.188	-.014	-.133	.508**	1	.817**	.355*
Top teacher salary	.603**	.352	.476**	.134	-.097	.247	.438*	.817**	1	.428*
Tertiary education 25-64 population	.531**	.536**	.438*	.221	.013	.304	.553**	.355*	.428*	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

High correlations (>0.7) are highlighted in red.

Inspecting Pearson correlations within this dataset reveals no redundant variables (**Table 2**). In addition, detection of expected correlations, such as the positive correlation of GDP with employment ratio, and the correlation of entry level salary and top level teacher salaries raise confidence in the dataset. To identify potential influencer of math scores in the secondary education system, regression analysis was performed. Surprisingly, the compensation of teachers at the entry level had a negative impact on math scores with low significance (β=-0.15, sig= 0.62, **Table 3**). It is possible that mathematics, especially at the higher grades, is taught by more experienced and better paid teachers. Yet, compensation of top level teachers had only a minor positive impact on math achievements (β=0.36, sig= 0.17, **Table 3**). Interestingly, the strongest predictor of math achievements is internet connectivity, expressed as percentage of households (β=0.85, sig= 0.002, **Table 3**). Multivariate adaptive regression splines (MARS) model can be constructed to describe average math scores as a function of only two variables, internet access with a positive contribution and rural area with a negative contribution:

```
Math_pisa_2012 = 4.54746571973635e+002 + 1.31276159208241e+000*max(0, Internet access
2010-2.21900000000000e+001) - 3.74742726872793e-001*max(0, Rural area (pc)-
8.65000000000000e+000)
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Table 3: Regression analysis of math achievements in secondary education systems

	(R^2 = 0.78)	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	425.477	56.649		7.511	0
	GDP ($ per capita)	-0.001	0.001	-0.383	-1.454	0.17
	Employment (%)	-0.135	0.998	-0.03	-0.135	0.895
	Rural area (%)	-0.497	0.291	-0.453	-1.707	0.112
	Rural population (%)	0.304	0.44	0.181	0.691	0.502
	Private tertiary education (%)	-0.012	0.302	-0.009	-0.04	0.969
	Internet access (%)	1.449	0.379	0.846	3.824	0.002
	Teacher salary	-0.001	0.001	-0.151	-0.504	0.623
	Top teacher salary	0.001	0	0.356	1.456	0.169
	Tertiary education (%)	0.796	0.621	0.268	1.283	0.222
a Dependent Variable: Math scores (Pisa, 2012)						

The small negative impact of rural population on math scores likely reflects administrative challenges in distributing effective learning over vast geographies or among a large spectrum of sub-populations. While the percentage of rural area in Canada is among the highest at 99%, vast areas in Canada are actually unpopulated, making little impact on the quality of education. More influential indicator is rural population, indicating the relative size of non-urban dwellers. In

Canada, rural population mounts to 28%, very similar to the mean rural population in this cohort of nations at 29%.

The most significant relation uncovered in this secondary education data is the correlation of internet access, expressed as percentage of households connected to the internet in 2010, to PISA math scores in 2012. Can internet connectivity predict academic success? Caution need to be exercised to separate causative relations from co-factual relations. Online learning tools may be so effectively assimilated in secondary education systems to raise academic achievements of students. On the other hand, household internet access might affect education achievements indirectly. Indeed, internet connectivity is highly correlated with household access to personal computers (Pearson correlation coefficient = 0.965), therefore, access of students to personal computers at home may be the driving force of academic success and not internet connectivity. Lastly, both of these indicators, internet connectivity and personal computers, may be indirectly related to student achievements and may reflect more general societal trends of technology acceptance. If so, education systems are not only providing labor to the greater economy, they also may reap the benefits of technological innovation in the greater economy.

Performance analysis of tertiary education systems

Despite the complex relations of pure production factors in education and general socioeconomic and technological indicators illustrated above, a simplified production model for data envelop analysis (DEA) was further explored to measure efficiency in tertiary education systems. The advantage of using DEA in education systems is in its ability to handle multiple input and output factors to estimate a production frontier, or the most productive utilization of input factors for generating outputs. This framework can easily position the Canadian education system relative to its peers and identify suitable systems as benchmarks to objectively observe scale efficiency in tertiary education. Direct inputs in the education system include capital inputs, such as buildings, and labour inputs, mainly salaries of academic instructors and administrators. Incoming students may be viewed as ‘raw materials’ in accordance with production theory. Outputs of tertiary academic systems can be segregated to two types. Graduating students are one main output; these students provide qualified labour for industries in the greater economy. In addition, academic institutions produce research activity, expanding knowledge in the economy. Research activity can be measured directly by the number of publications and patents. However, unlike the PISA exam in the secondary education systems, there is little common reference for comparing the quality of graduates or publications produced by tertiary education systems.

Herein, a simplified production model was developed from publicly available data sources. First, a small dataset of socioeconomic indicators in 23 countries (**Table 1, Appendix 1**) was used to identify a cluster of eight peer countries including Canada (Australia, Austria, Belgium, Canada, Denmark, Finland, Ireland and the USA). Second, a dataset of input factors including government and private funding, and output factors including numbers of graduating students in several levels in the years 2010-2012 was constructed. Two input factors are used in this model, total annual government and private funding, these figures are derived from cross referencing data reported in OECD, UNESCO and CANSIM. Outputs are defined as the numbers of graduate students in each academic level (Level 5, Bachelor, Masters, and PHD). In this panel of 23 peer decision making units (DMU), efficiency of operations in input oriented and constant return to scale (CRS) model ranges from 90% to 100%, with an average of 97% (**Appendix 3**) suggesting a similar range of academic productivity in this cohort, despite cultural and geographical diversity. The tertiary education system in Canada is consistently at the bottom of this international cohort, with an input oriented efficiency average of 91.8% over the last four years, and a worrisome downward slopping trend (**Figure 1**). Interestingly, efficiency in the USA, Canada's biggest neighbor and trading partner is also slipping in recent years from 100% to 90% (**Figure 1**). Relevant benchmark education systems for the Canadian system identified by EMS are the Australian and Finnish tertiary education systems (**Figure 1**). Examining scale efficiency in the operations of education systems by comparing input oriented CRS and NIRS to output oriented VRS models, reveal nine cases of DRTS systems, wasteful systems in which additional budget inputs are likely to reduce outputs. Sadly, four of the nine DRTS cases identified in this cohort represent the operations of the Canadian tertiary system during the years 2010 to 2013 (**Appendix 3**).

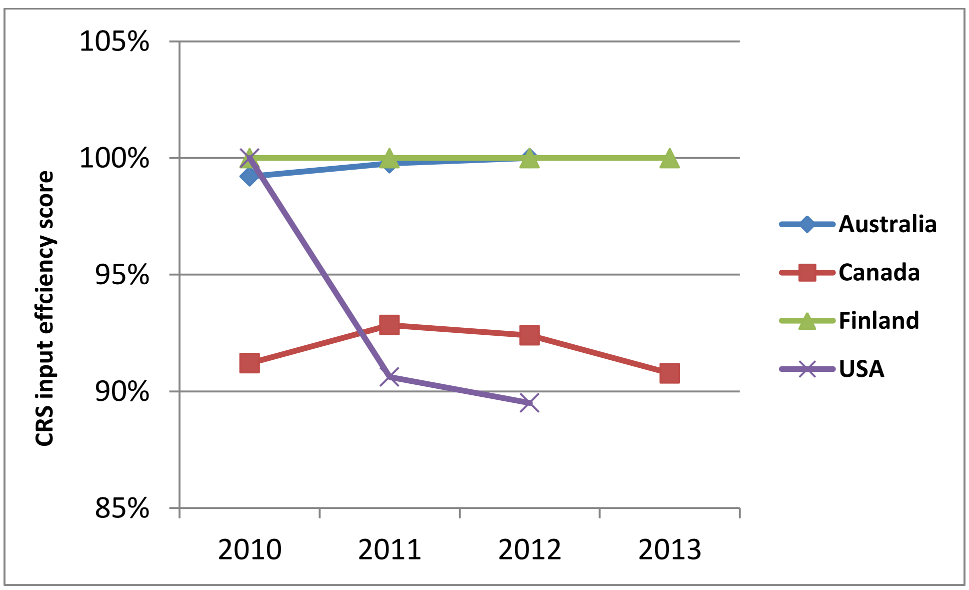


Figure 1: Input oriented efficiency scores (2010-2013) in selected tertiary education systems.

Inspecting changes in the number of Canadian graduates over the years as recorded in the OECD database revealed an unexplained jump from 1 million total graduates per year to 2.5 million graduation in 2013 (**Appendix 3**). Further inspection revealed large discrepancies in the total number of Canadian graduates reported in the OECD database and the total number of graduating and enrolled students reported by Statistics Canada (**Figure 2**). Performance analysis using DEA is sensitive to these large changes in input factors, however, since OECD estimates of the number of graduates in Canada are overestimated, correcting these numbers by a factor of

0.5 will decrease Canadian efficiency even further. Running DEA without the skewed 2013 Canadian data and with corrected total input factors retrieved directly from CANSIM (**Figure 3**) decreases Canadian efficiency scores to 85% in the years 2010-2012.

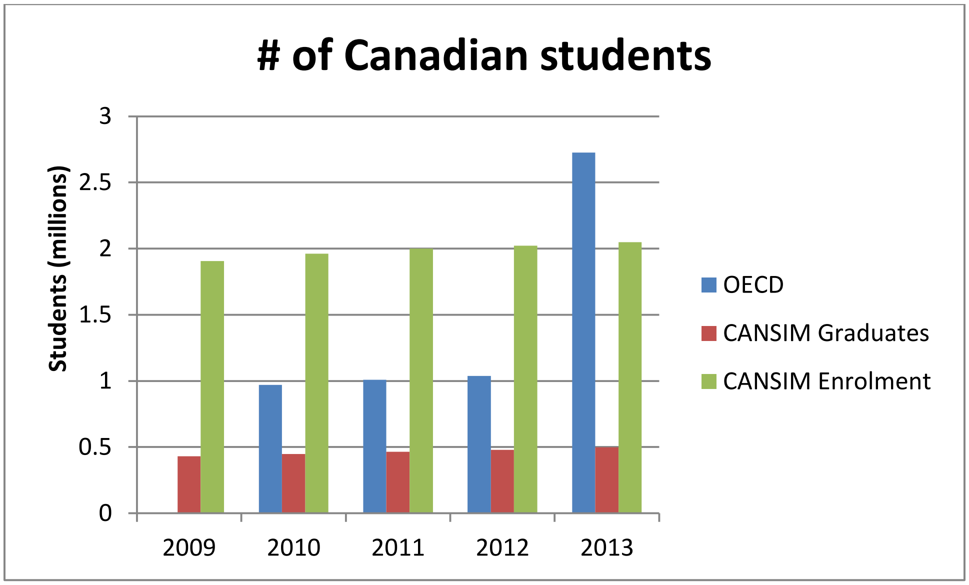


Figure 2: Discrepancies in the numbers of Canadian students reported by OECD and CANSIM.

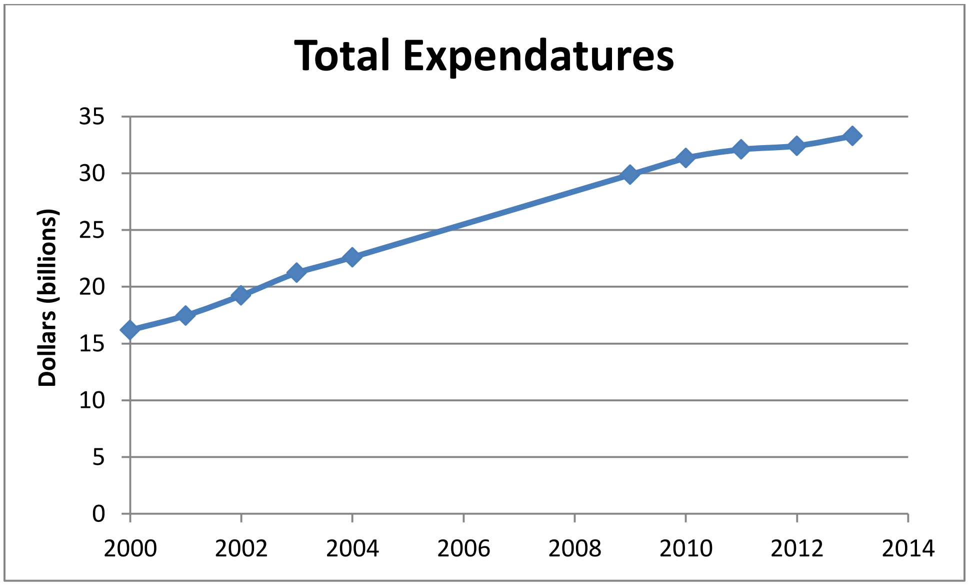


Figure 3: Total revenues of Canadian universities (2000-2013, CANSIM).

Complementing the results from national level DEA, annual growth rates of revenues and student enrolments in all Canadian university were calculated. From 2000 to 2004 university revenues in Canada increased by 8.7% a year (**Figure 3**). In the last four years of Canadian data, the rate of growth has slowed to 2.7% annual growth. However, from 2009 to 2013 total enrolment in Canadian universities increased by 7.4%, while revenues of Canadian universities increased by 11% (**Figure 4**). When these growth rates are compared to the real growth in Canadian GDP, it appears that revenue growth is similar to growth in GDP, yet enrolment growth is below GDP growth (**Figure 4**). The discrepancy in growth rates of revenues relative to outputs and in enrolment rates relative to GDP growth is another independent indication of poor efficiency in the Canadian tertiary education system.

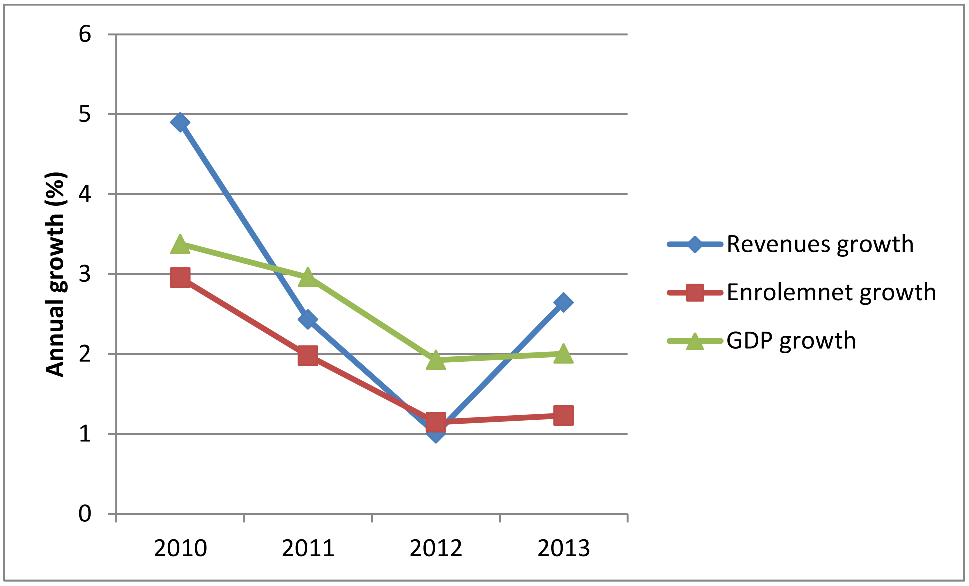


Figure 4: Annual growth rates in the Canadian tertiary education system and the Canadian economy (2010-2013, calculated from CANSIM and OECD data).

DEA analysis at the micro level

To inspect how these results translate from the national level to the university level, revenue and enrolment data in five prominent Canadian universities and in ten Australian universities in the province of New South Wales were collected from annual reports. One DEA model was constructed for these institutions using university revenues as a single input factor and enrolment data as a single output factor. Current parity of the Canadian and Australian dollar, similar scales of operations and similar split of public and private funding supports comparing these DMUs under the same model. The results of this DEA indicates that Australians universities are operating at a high level of efficiency (84%±10), while Canadian institutions achieved a lower level of efficiency (77%±8). However, due to the large range of efficiencies found in both countries (**Table 4**), the efficiency advantage of Australian universities do not reach high significance (p=0.052, t-test). Charles Sturt University was selected as a benchmark DMU, with the lowest revenue per student (12,639 CAD). Aggregated revenue per student in New South Wales universities is 22,069 CAD, nearly identical to the aggregated Australian revenue per student in 2012 (16,111 USD, OECD data), raising confidence in this analysis performed both at the macro and micro levels. The aggregated revenue per student in this sample of Canadian universities is 26,761 CAD, significantly different from revenue per student calculated from aggregated CANSIM data (16,245 dollars). Importantly, decreasing return to scales dominate this sample of Canadian universities (except Ryerson and Waterloo Universities, **Appendix 5**), indicating that increasing funding is not likely to contribute to additional outputs in Canada. In Australian universities on the other hand, most inefficiencies are computed as increasing return to scales (**Appendix 5**), indicating that extra funding to Australian universities is likely to increase outputs.

Table 4: Efficiency of representative universities

	University	Annual revenue (CAD, Millions)	Enrolment	CRS Score	Average	SD
Canada					0.7681	0.0780
	Ryerson	579.27	33,340	0.8637		
	York	1,016.00	53,000	0.8297		
	UofT	2,563.00	84,556	0.7085		
	Waterloo	877.54	35,900	0.7585		
	UBC	2,095.00	59,659	0.68		
Australia					0.8431	0.1021
	CSTU	494.10	39,093	1		
	MU	764.67	38,793	0.8206		
	SCU	211.02	14,369	0.9303		
	UNE	291.45	20,912	0.9534		
	NSW	1,658.93	52,326	0.6993		
	NC	764.67	36,448	0.8012		
	Woll	553.59	30,554	0.8488		
	Sydney	1,897.85	54,306	0.6808		
	ST	700.00	37,638	0.8398		
	SW	741.21	41,864	0.8569		

Conclusions:

The presence of internationally standardized exams in the secondary education system provides quality measures of outputs. Regression analysis of math scores and national indicators demonstrated weak influence of teacher compensation on student achievements. Conversely, internet connectivity of households is positively correlated with academic achievements. These surprizing observations illustrate some of the challenges in predicting educational outcome using labor compensation (the main input in all education systems) and technology and socio-economic indicators.

Comparative analysis of efficiencies in tertiary education systems is even more challenging due to differences in reporting and lack of standardized tests across nations. Using university revenues as common financial and the number of graduates as outputs provide a simplified production model for crudely measuring efficiencies in higher education systems. Three independent lines of evidence suggest that Canadian universities are operating inefficiently. First, analysis of nationally aggregated university data to populate a simplistic production model as suggested above indicates poor performance in the Canadian tertiary education system. Canadian higher education is about 10% more expansive relative to peer countries. In four out of four years examined, the Canadian higher education system was operating at decreasing returns to scales, indicating wasteful operations. Second, these results obtained at the macro, national, levels were mostly corroborated using a representative sample of Canadian and Australian universities. It was found that Canadian universities operate at average 76% efficiency, while Australian universities operate at 86% efficiency. Even worse, most Canadian universities sampled were operating at decreasing returns to scale. Third, examining the growth rates in revenues and enrolments in the Canadian education system reveals higher growth rate in revenues relative to enrolment rates.

In summary, this study reveals that up to 10% of the 30 billion dollar annual spending on tertiary education system in Canada could be trimmed with little effects on output levels. This could lead to $3 billion in total saving, and may be split evenly between private and public sources of university funding to create about $1.5 billion in direct government saving, eliminating some of the debt that will be required to balance future budgets proposed by the liberal government. However, it is likely that the response of most Canadian universities to these steps will be hiking up student fees to compensate for reduced government funding instead of enhancing efficiencies, as they did over the last decade. The lack of federal Education minister in Canada speaks volumes about the priority given to the needs of the education system by federal policy makers, leaving provincial governments and universities to fend for themselves. Increasing transparency and consolidation of university reports will assist in monitoring efficiency in the Canadian system in almost real time. The federal government should explore reforming the high education system in Canada to synchronize shifts in the economy and labor market with educational changes. The rise of online learning technology may disrupt current universities in Canada or may be harnessed to lower education costs and increase efficiencies.

Limitation:

High education systems are engaged in two major activities, teaching and research. The simplified production model analysed here is completely ignoring research activities. It is likely that some of the 'slacks' exposed in this model are actually supporting research activities. Yet, research activities are performed by universities in all peer countries. A modified model including standardized measures of research activity will give a better picture of inefficiencies, especially at the micro level. Administrative separation of research and teaching activity may be further explored.

This study also ignores the contribution of international students to efficiency and productivity.

Data sources:

CANSIM (2015). Statistics Canada, Table 477-0058 - Financial information of universities and degree-granting colleges, revenues by type of funds, annual (dollars).

OECD (2015). Organization for Economic Co-operation and Development. Retrieved online on December 2015 from https://data.oecd.org/

UNESCO (2015). The United Nations Educational, Scientific and Cultural Organization. Retrieved online on December, 2015 from http://data.uis.unesco.org/

Australian Universities (2015). Retrieved on December, 2015 from https://www.universitiesaustralia.edu.au

Appendix 1: Clustering of peer countries

	GDP	Employment	Math	Rural area	Rural population (pc)	Private tertiary education (pc)	Internet access 2010	Teacher_salary_2011	Top teacher salary 2011	Tertiary education 25-64 population	Final classification (Calculated cluster number)
Australia	44,706	72	504	95	22	54	79	34,610	48,522	38	3
Austria	45,133	71	506	78	45	12	73	31,501	62,129	19	3
Canada	43,038	72	518	96	28	43	78	35,534	56,349	51	3
Denmark	44,195	73	500	72	42	5	86	43,461	50,332	34	3
Finland	40,017	69	519	92	59	4	81	30,587	40,160	39	3
Iceland	41,987	82	493	99	36	9	92	23,988	28,145	34	3
Ireland	46,858	60	501	99	72	19	72	33,484	62,166	38	3
Norway	65,685	75	489	84	47	4	90	33,350	42,055	38	3
Sweden	44,586	74	478	90	48	9	88	30,059	39,865	35	3
United States	52,592	67	481	78	38	64	71	37,595	53,180	42	3
Czech Republic	28,963	68	499	9	5	21	61	16,680	22,236	18	2
Estonia	26,160	68	521	21	10	25	68	11,621	16,985	37	2
France	37,617	64	495	41	17	18	74	25,646	48,916	30	2
Italy	34,781	56	485	27	9	32	59	27,288	40,119	15	2
Mexico	16,891	61	413	83	38	30	22	15,081	32,136	17	2
Poland	23,616	60	518	72	47	29	63	10,362	17,200	24	2
Portugal	27,651	61	487	70	20	31	54	30,946	52,447	17	2
Slovak Republic	26,586	60	482	32	25	30	67	10,241	13,864	19	2
Slovenia	28,675	63	501	70	56	15	68	26,486	33,817	25	2
Spain	32,546	56	484	45	13	22	59	35,881	50,770	32	2
Chile	21,888	62	423	92	36	78	30	17,385	31,201	29	1
Japan	36,225	72	536	31	12	66	67	26,031	57,621	46	1
Korea	33,089	64	554	58	17	73	97	27,581	76,528	40	1

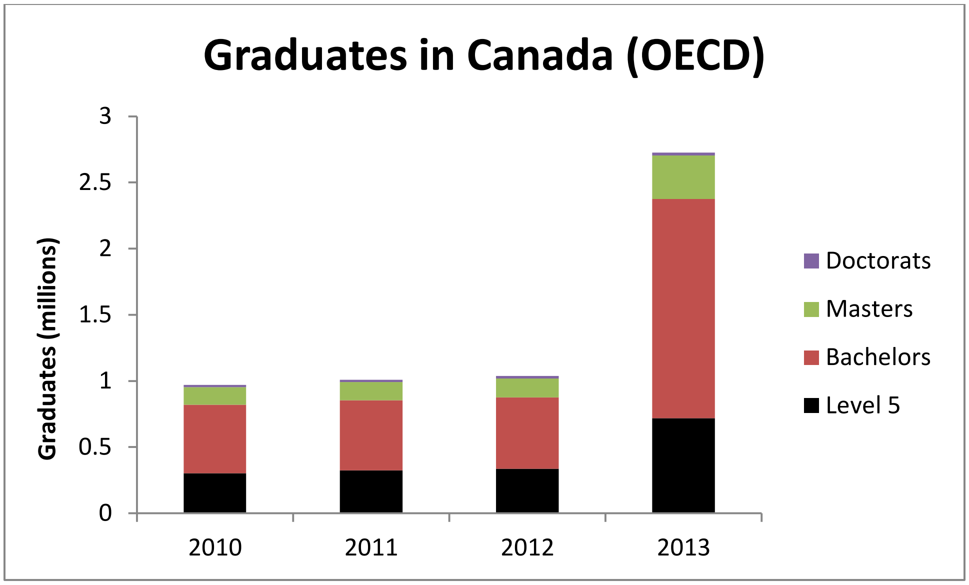
Appendix 2: Inputs and outputs of national tertiary education systems

DMU	Level_5 {O}	Bachelors {O}	Masters {O}	Doctorates {O}	Private funding {I}	Government funding {I}
AUS10	232416	561902	197712	18208	7.5E+09	9.1E+09
AUS11	280113	600891	201062	19482	8.57E+09	9.35E+09
AUS12	287276	609021	189789	20371	9.04E+09	8.79E+09
AUT10	80105	47980	71156	7228	4.9E+08	3.28E+09
AUT11	79213	60820	73349	6834	5.07E+08	3.39E+09
AUT12	81693	72371	76721	6948	6.5E+08	4.35E+09
BEL10	2554	164252	87923	5916	5.95E+08	3.56E+09
BEL11	3100	167453	93772	6260	4.51E+08	3.72E+09
BEL12	4058	175183	96446	6604	6.54E+08	3.91E+09
CAN10	303715	517087	133629	16609	1.05E+10	1.33E+10
CAN11	323898	529730	137647	17321	1.03E+10	1.31E+10
CAN12	335674	539646	143649	18754	1.08E+10	1.37E+10
CAN13	718922	1656747	328777	21753	2.93E+10	3.73E+10
DNK10	18567	90907	42437	3838	1.51E+08	2.88E+09
DNK11	21438	92404	45222	4262	1.74E+08	3.3E+09
DNK12	22872	93255	47937	4503	1.94E+08	3.69E+09
FIN10	261	84532	46293	4895	4.66E+08	1.92E+09
FIN11	183	88845	41839	5157	4.63E+08	1.99E+09
FIN12	75	90418	45780	5103	86619235	2.05E+09
IRL13	84300	83835	44911	4347	8.22E+08	3.56E+09
USA10	2423188	4811993	2256629	167939	1.64E+11	8.81E+10
USA11	2679593	4992711	2369930	175131	1.6E+11	1.06E+11
USA12	2835904	5198944	2443435	181573	1.93E+11	1.1E+11

Appendix 3: Scale efficiency in national tertiary education systems

DMU	Year	Country	CRS_IN	VRS_OUT	NIR_IN	CRS/VRS	NRS/CRS	SE
AUS10	2010	AUS	0.9921	1	1	0.9921	1.007963	IRTS
AUS11	2011	AUS	0.9977	1	1	0.9977	1.002305	IRTS
AUS12	2012	AUS	1	1	1	1	1	MPSS
AUT10	2010	AUT	1	1	1	1	1	MPSS
AUT11	2011	AUT	1	1	1	1	1	MPSS
AUT12	2012	AUT	0.9458	1	1	0.9458	1.057306	DRTS
BEL10	2010	BEL	0.9914	1.4896	0.9923	0.999093	1.000908	IRTS
BEL11	2011	BEL	1	1	1	1	1	MPSS
BEL12	2012	BEL	0.9449	1.2844	0.9964	0.948314	1.054503	DRTS
CAN10	2010	CAN	0.9121	1.2145	0.9455	0.964675	1.036619	DRTS
CAN11	2011	CAN	0.9284	1	1	0.9284	1.077122	DRTS
CAN12	2012	CAN	0.924	1	1	0.924	1.082251	DRTS
CAN13	2013	CAN	0.9078	1	1	0.9078	1.101564	DRTS
DNK10	2010	DNK	1	1	1	1	1	MPSS
DNK11	2011	DNK	0.9814	1	1	0.9814	1.018953	IRTS
DNK12	2012	DNK	0.9588	1	1	0.9588	1.04297	DRTS
FIN10	2010	FIN	1	1	1	1	1	MPSS
FIN11	2011	FIN	1	1	1	1	1	MPSS
FIN12	2012	FIN	1	1	1	1	1	MPSS
IRL13	2013	IRL	1	1	1	1	1	MPSS
USA10	2010	USA	1	1	1	1	1	MPSS
USA11	2011	USA	0.9062	1	1	0.9062	1.103509	DRTS
USA12	2012	USA	0.8951	1	1	0.8951	1.117194	DRTS

Appendix 4: Canadian graduates by level of education in the OECD database



Appendix 5: Scale efficiency in university operations

	DMU	CRS	VRS	NRS	CRS/VRS	NRS/VRS	SE
Canada							
	Ryerson	0.86	1.12	0.86	0.77	1.00	IRTS
	York	0.83	1.00	1.00	0.83	1.21	DRTS
	UofT	0.71	1.00	1.00	0.71	1.41	DRTS
	Waterloo	0.76	1.19	0.76	0.64	1.00	IRTS
	UBC	0.68	1.13	0.82	0.60	1.21	DRTS
Australia							
	CSTU	1.00	1.00	1.00	1.00	1.00	MPSS
	MU	0.82	1.10	0.82	0.75	1.00	IRTS
	SCU	0.93	1.00	0.93	0.93	1.00	IRTS
	UNE	0.95	1.01	0.95	0.94	1.00	IRTS
	NSW	0.70	1.13	0.80	0.62	1.14	DRTS
	NC	0.80	1.14	0.80	0.71	1.00	IRTS
	Woll	0.85	1.17	0.85	0.73	1.00	IRTS
	Sydney	0.68	1.15	0.78	0.59	1.15	DRTS
	ST	0.84	1.09	0.84	0.77	1.00	IRTS
	SW	0.86	1.05	0.90	0.82	1.05	DRTS