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An international journal that promotes research into effective learning and teaching practice in economics higher education

The International Review of Economics Education is dedicated to enhancing learning and teaching in the higher education economics community. It provides a forum for high quality research in the areas of curriculum design, pedagogy, assessment, innovation and evaluation. The journal seeks to promote critical dialogue on educational theory and practice in economics and to demonstrate the relevance of research to good professional practice.

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Editorial Issue 11.2

Peter Davies, Ross Guest and David McCausland

Moving to a new publisher

We are pleased to announce that from 2013 the International Review of Economics Education will be published by Elsevier. We will also be increasing our issues to three per calendar year. These changes reflect the growing success of the journal. We are very grateful to the referees who have provided immensely valuable comments on the increasing volume of submissions we have been receiving. We are also very pleased with the rising number of high quality submissions we have been receiving.

Although we are moving publishers we will be maintaining our close connection with the Economics Network. The birth and growth of the journal would not have been possible without the Network which has been our home for ten years. It is through the generous funding from the Network that it has been possible to maintain the journal as open access with no author fees. Changing higher education policy in England has seen the withdrawal of government funding for the Network. The excellent work of the Network will, however, continue with the support of the Royal Economic Society, the Scottish Economic Society and many economics departments across the UK. Readers of the journal will be able to follow links to IREE through the Network web site and followers of the Network will be able to follow a link from the new Elsevier page for past IREE editions.

We owe a special debt to John Sloman who, as Director of the Economics Network, has been enormously supportive of the journal. He has also helped a great deal in the negotiations for our move to a new publisher. We wish him well in his 'retirement'.

Improving grades and upgrading the curriculum

Which factors are more important for students' grades? This issue includes papers which consider three plausible causes that have each attracted substantial interest from economics lecturers: prior achievement, students' critical reasoning and study time. These studies prompt reflection on the extent to which the effects of these three factors reflect the methods of teaching and assessment which dominate current practice in the profession.

Chang Da Wan and Roland Cheo contribute to the literature on the effect of pre-university academic achievement on university economics achievement, following the paper on this topic in IREE by Fallan and Opstad (2010, Vol. 9). Wan and Cheo find that although overall pre-university achievement is important, there is no separate effect of performance on particular pre-university subjects including economics or mathematics, contrary to some other studies. Nor did they find any gender effects. The data were drawn from two large south-east Asian universities.

Alexei Orlov and John Roufagalas examine the relationship between students' critical reasoning and performance in undergraduate economics. Using a short test of critical reasoning (Frederick, 2005), they find no association for Principles courses but find a fairly strong association for upper level courses. Given evidence (e.g. Siriopoulos and Pomonis, 2009) of the effect of different teaching methods on the development and exercise of students' thinking skills, Orlov and Roufagalas may be interpreted as a cautionary tale about the level of intellectual demand provided by first year courses. This story suggests that the nature of teaching has important effects on outcomes for students.

Economists (e.g. Stinebrickner and Stinebrickner, 2004) have been very interested in the relationship between student effort and grades. The question has largely been addressed in terms of the amount of time which students have chosen to devote to their academic studies. Hans Bonesrønning and Leiv Opstad contribute to this literature with a study which addresses endogeneity problems by comparing effort and grades for the same student over time. Their evidence supports the conclusions from previous studies in finding a strong positive relationship between effort and grades. They also find that students increase their efforts after they find that they have performed less well than they expected.

The global financial crisis and ensuing Great Recession have led to much soul-searching in macroeconomics education and of course policy. Ideas that have been around for some time but have not hitherto penetrated mainstream macro teaching are beginning to do so. These include the role of leverage in balance sheets of households, firms and banks, the role of bounded rationality in decision making and other concepts from behavioural economics such as present bias and herding. In this vein, the paper here by David Kauper introduces further realism into the neoclassical model of economic growth. Kauper argues against a pedagogy that starts from a theoretical Solow world of diminishing returns to capital leading to convergence of growth rates. Rather we should start with the way students see firms prospering over time. We need to explain the process of creative destruction leading to popular new products, such as the BMW M3, Apple iPhone, Avatar in 3-D, Nintendo Wii, which in turn generates economic growth. It is the desire for profit that drives this process. Kauper's contribution is to show ways of linking profit seeking and creative destruction to the neoclassical model of growth in order that students can connect growth theory more readily with their observations of the world.

Injecting more realism into our models is one way of improving student engagement. Another is to introduce more variety into our classroom delivery methods. Wayne Geerling provides us with a number of excellent examples of multimedia exercises along with some excellent advice on how to get the most out of them. Geerling reminds us that we must be discerning in using multimedia. Youtube clips and the like that are not well chosen are not only a waste of time but can turn students off multimedia in economics teaching.

We are pleased to include two papers in the IT in economics education (formerly CHEER) section of the journal. William and Kevin Hamlen show us an interactive computer model of two-country trade that allows students to investigate the consequences of changing economic parameters. The model is self-contained and makes no assumption concerning the existence of social welfare functions or social indifference curves. The factors of production earn incomes that lead to the demand for two goods. Students can see who are the winners and losers when going from a closed economy to an open economy. The students are able to predict the consequences and then obtain immediate feedback.

Tim Kochanski introduces us to a simulation model, programmed in Netlogo, that demonstrates changes in market structure that occur as marginal costs, demand, and barriers to entry change. Students predict and observe market structure changes in terms of number of firms, market

concentration, market price and quantity, and average marginal costs, profits, and mark-ups across the market as firms innovate. By adjusting the demand growth and barriers to entry, students can explore market changes in terms of these output variables. This facilitates students' understanding of different market structures and exposes them to computational methods, simulation, and a dynamic perspective on the static models provided by standard texts.

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Determinants of Malaysian and Singaporean Economics Undergraduates' Academic Performance

Chang Da Wan and Roland Cheo

Abstract

This study examines the determinants of economics undergraduates' academic performance in the top national universities of Singapore and Malaysia: the National University of Singapore (NUS) and the University of Malaya (UM). Using three basic components of economics as the dependent variable, i.e. basic microeconomics, basic macroeconomics and statistics/econometrics, it was found that students' pre-university grade is the most important determinant in undergraduates' performance. However, unlike in some previous studies which suggest that taking economics and mathematics before university does have a major impact on students' higher economics grades at undergraduate level, in this study, it was found that the type of subjects taken before university, including both economics and mathematics, has no significant impact on students' academic performance. The type of pre-university programme taken prior to admission, and ethnicity were found to be important determinants among UM students, but not NUS. This is a significant finding since Malaysia does practice a modified quota system based on ethnicity in one of the pre-university programmes. The study also found no significant distinction between male and female performance in economics controlling for other socioeconomic and attitudinal effects.

JEL classification: A21, A22, I21, I23

1. Historical Motivation

This study examines the performance of students from two sister institutions with a shared history but subsequently independent paths in the development of their economics' programmes. The University of Malaya (UM) was established in April 1949 in Singapore. The population of the university grew and hence the need for a larger campus resulted in the establishment of an additional campus in Kuala Lumpur. In 1962, the government of Malaya[1] and Singapore[2] agreed that these two campuses should be autonomous universities and thus the campuses in Kuala Lumpur and Singapore were renamed the University of Malaya and the University of Singapore respectively. This was followed by the formation of the Federation of Malaysia in September 1963, comprising of Malaya, Singapore, Sabah and Sarawak. Singapore left the federation in

[1] Malaya had already gained its independence from Britain in August 1957.

[2] From 1959 to 1963, Singapore was a self-governing state under the colonial rule of the British Empire.

August 1965 to become the Republic of Singapore. However the political evolution of both countries did not bring about great changes to the structure of the two universities. Only in 1980, the University of Singapore merged with Nanyang University in Singapore and the National University of Singapore (NUS) was formed (UM, 2007; NUS, 2007).

Economics was initially taught under the Faculty of Arts and Social Sciences in both universities. The economics department at NUS remains relatively unchanged. However, the economics department at UM branched out of the Faculty of Arts and Social Sciences and developed into a separate faculty, the Faculty of Economics and Administration (FEA).[3] UM students in this faculty pursue a Bachelor of Economics with specialisation and focus in various aspects of economics, while those at NUS pursue a Bachelor of Social Science with specialisation in economics. Therefore the structural change from a department into a faculty has also brought about changes to the approach and focus of the teaching of economics at UM (UM, 2006).

Both Singapore and Malaysia inherited the Cambridge A-Levels education system from the British as the mode of pre-university education. However, since the independence of both countries, their pre-university education paths have taken quite different routes. On the one hand, the A-level programme continues to be dominant in Singapore's pre-university system. A-level programmes are taught in Junior Colleges and administrated under the Ministry of Education of Singapore. In addition, there are also a small number of students who study the International Baccalaureate (IB) Programme or the Integrated Programme.

By contrast, the development of the Malaysian pre-university system has been more diverse. For admission into a public university, such as UM, there are generally three routes of admission. The first route is the *Sijil Tinggi Persekolahan Malaysia*[4] (STPM), taught in secondary schools and administrated by the Malaysian Examinations Council. The STPM is relatively similar to the Cambridge A-levels system but is modified and adapted to the local context. Second, there is the Matriculation Programme,[5] taught in full-time Matriculation colleges with compulsory boarding arrangements operated under the Malaysian Ministry of Education. It is important to note that the Matriculation Programme admits a significant proportion of *Bumiputera*[6] or Malay students. Third, there is the admission route for those with a diploma in a relevant field such as accounting, business or commerce from a polytechnic. Besides the STPM, Matriculation Programme and diploma routes, other types of pre-university education, such as IB, Cambridge A-levels or South Australian Matriculation (SAM), are taught in private colleges but these qualifications are not considered for local admission into Malaysian public universities, and therefore, remain beyond the discussion of this paper.

It is this historical background of the two universities, as well as the pre-university programmes, which provide an interesting backdrop to comparing the two campuses and the determinants of economics undergraduates' performance. Of particular note, is the fact that this study looks specifically at both the basic microeconomics and macroeconomics courses. Whereas other studies have to contend with agglomeration effects of having to consider both the study of microeconomics and macroeconomics in an introductory course in the first year, we are specifically looking at how pre-university performance may have persistent effects further on as students progress towards a Bachelors degree in economics.

[3] FEA consists of the Department of Economics, the Department of Development Studies, the Department of Administrative Studies and Politics, and the Department of Applied Statistics. Initially the departments in the faculty also included the Department of Business Studies and the Department of Accounting (which later branched into a separate faculty), while the Department of Economics was merged in 2006 from the Department of Analytical Economics and the Department of Applied Economics.

[4] Malaysia Higher School Certificate.

[5] Will be known as Malaysian Matriculation from this point onwards.

[6] Literally means "Sons of the soil"; this also refers to the indigenous Malay ethnicity.

1. Previous literature

The determinants of academic performance have been widely researched. Many studies have been conducted to examine the factors that influence students' academic performance. Some of these studies have concentrated on specific subjects while others focus on more general topics across the disciplines. With regards to methodology, economists usually apply an educational production function to explore these relationships, where academic achievement is a function of student ability, time devoted to learning, various attributes on an individual level (see for example, Schmidt, 1983; Park and Kerr, 1990; Durden and Ellis, 1995; Parker, 2006; and Opstad and Fallan, 2010) and on an aggregate level the relationship between school resource variables, student background characteristics and school outcomes (see for example, Hanushek, 1996; Hedges *et al.*, 1996; and Hãkkinen *et al.,* 2003).

In most of these studies, students' academic performance has been measured by a variety of methods. The principal variables used to capture academic performance are grade point average (GPA), percentage grades, cumulative average points (CAP), degree classification or the grade in the targeted subject (Pseiridis *et al*., 2005; and Swope and Schmitt, 2006). However, it is important to point out that this approach only highlights the post-test or output performance of the students, and the theoretical assumption is based upon an economic production function. As Parker (2006) illustrates, this method of assessing educational effectiveness is essentially a "black box" approach where determinants are applied to the students in the box to yield some type of output.

Alternatively, students' academic performance could also be measured by a pre-test and post-test comparison based upon educational evaluation principles. For example, Ballard and Johnson (2004) incorporated an elementary mathematics skills test at the beginning of the course, reflecting a measurement of the pre-test abilities of the students. Other similar analysis could focus on pre-university economics grades or prior performances, as the pre-test indicators to compare with the post-test performance.

As for the determinants, a large number of studies have been conducted to study the effect of various factors. The frequently examined factors can be categorised into individual characteristics, academic background, institutional characteristics and environment (see Anderson *et al*., 1994; Birch and Miller, 2007; Crowley and Wilton, 1974; Harbury and Szreter, 1968; Krohn and O'Connor, 2005; Pseiridis *et al*., 2005; Reid, 1983; and Swope and Schmitt, 2006). However, the determinants of economics students' performance are said to be few and their effect is not unanimously supported (Pseiridis *et al*., 2005). For example, Anderson *et al*. (1994) and Krohn and O'Connor (2005) found that gender was a determinant favouring the male students, while Borg and Stranahan (2002) and Lawson (1994) found no such difference in their studies. Moreover, although there has been substantial research to support the argument that more exposure to and proficiency in mathematics improves student performance in economics courses at university (Anderson *et al*., 1994; and Ballard and Johnson, 2004), the study by Cohn *et al*. (1998) revealed no significant effect. Similarly, while other determinants such as ethnicity, family background and personality, continue to have varying effects on the academic performance of students, it is fair to conclude, as Opstad and Fallan (2010) point out, that such results and findings are not universal.

However, there has been little cross-country or cross-university comparison of students' performance in economics in the literature. Therefore, it is the intention of this paper to examine more closely what determines undergraduate performance in economics of these two sister institutions, which have branched out onto different paths from common roots, and to see how different pre-university subjects and results as well as students' characteristics affect undergraduates' performance in economics in both microeconomics and macroeconomics courses.

2. The data

For the purpose of this study, a two-page survey questionnaire[7] was distributed at NUS and UM between September 12 and October 5, 2007. A total of 269 second and third-year economics students from the two universities participated in the survey. The survey was done after a pilot survey of 24 students was conducted at NUS on August 29, 2007, after which the survey was revised in order to be more cognisant. The variables surveyed in the questionnaire are categorised in Table 1. Table 2 summarises the subjects taken by UM and NUS undergraduate economics students prior to university admission and their average grades.

Table 1: Categorisation of Variables in Questionnaire

Categories	Specific Variables
Individual Characteristics	Age, Gender, Ethnicity, Nationality, Birth order, National service, Working experiences, Level of interest in Economics
Academic Background	Pre-university qualification and the grades
Institutional Characteristics	Accommodation in university
Environment	Place of study and its environment, Effort devoted to study, Source of financial allowances, Participation in extra-curricular activities

Table 2: Subjects Taken at Pre-University Level and its Average Grade

Subject	Percentage (No. of Students)	Average Grade
Economics	88% (197)	3.542
Mathematics	70% (156)	3.295
Business Studies	33% (75)	3.649
Accounting	24% (53)	3.675
Languages (Malay, English, Chinese or Tamil)	24% (54)	3.537
Chemistry	24% (53)	2.819
Physics	20% (44)	2.720
History	15% (33)	3.427
Geography	13% (29)	3.224

Note: some subjects were excluded due to small sample.
Grade calculated as follows: *A(4.0); A–(3.7); B+(3.3); B(3.0); B–(2.7); C+(2.3); C(2.0); C–(1.7); D+(1.3); D(1.0);* and *F(0.0)*

[7] See Appendix 2.

A general overview of the data revealed that out of the 269 respondents, 55 percent were from UM, compared to 45 percent from NUS, while females outnumbered males by a ratio of three-to-one. Sixty-five percent of respondents were Chinese[8] students, followed by 25 percent Malay, while the remaining 10 percent were categorised as other ethnic groups (see Appendix 1).

At this point of the study, it is important to note that Singapore and Malaysia have differences in their grading systems and their type -university admissions requirements. Malaysian universities commonly accept three major pre-university entry qualifications, namely STPM, Diploma and Malaysian Matriculation while the respondents from NUS predominantly have A-level qualifications, with a small percentage entering with STPM, Diploma or other pre-university qualifications from neighbouring countries. For the purpose of standardisation, the grading system of each pre-university programme has been restructured to enable comparison of students' pre-university academic performance (see footnote of Table 2).

Table 3: Wilcoxon-Mann-Whitney Test on Pre-university Grade

		N	Mean Rank	Sum of Ranks
Pre_U Grade	UM	138	155.08	21400.50
	NUS	106	80.09	8489.50
	Total	244		

	Test Statistics	Pre_U Grade
	Mann-Whitney U	2818.500
	Wilcoxon W	8489.500
	Z	–8.241
	Asymp. Sig. (2-tailed)	0.000

Subsequently, the Wilcoxon-Mann-Whitney[9] non-parametric test was conducted to identify whether the pre-university grades of students from the two universities were comparable. The Wilcoxon-Mann-Whitney test ranks the pre-university grades and then counts the rank according to the university. If there are no differences between the universities, the average ranks in each of the two groups are expected to be about equal (Siegel and Castellan, 1988). However, Table 3 reveals that the pre-university scores of UM were significantly higher than NUS, with the mean rank of UM almost doubling that of NUS. The test also indicates that when the Wilcoxon (W) statistics are asymptotically normally distributed, the probability of accepting the notion that the pre-university scores of both universities are similar is 0.0001 percent (as shown by Asymp. Sig. column). Therefore the differences are significant.

[8] "Chinese" is strictly referring to Malaysians and/or Singaporeans of Chinese descent. Nationalities of the PRC are included in other ethnic groups.

[9] The Wilcoxon-Mann-Whitney Test is an independent proposed nonparametric test to examine whether two independent groups of samples have been drawn from the same population.

To overcome the differences, the pre-university grade index was formulated based on the average value of both samples, as illustrated in Equation (1).

$$Index = \frac{score}{mean} \times 100 \quad (1)$$

The dependent variable, students' performance at university, was based on self-reporting of students in the questionnaire. Six essential modules were listed specifically for students to indicate their grades, with the remaining eight slots allocated to other modules taken during their first year. The six essential modules were basic microeconomics, basic macroeconomics, statistics and econometrics, quantitative methods and mathematics, sociology, and principles of accounting (refer to Appendix 2).

The students' performance indicator is tabulated based on results in basic microeconomics, basic macroeconomics, and statistics/econometrics. The consistency in microeconomics and macroeconomics was expected because both modules were compulsory for economics majors at both universities. Statistics is also compulsory at UM while basic econometrics is essential for those who major in the NUS economics programme. Although quantitative methods, sociology and principles of accounting are also compulsory at UM, the responding percentage were drastically reduced because these modules are not compulsory at NUS. Therefore the academic performance indicator (known as CAP3) only tabulates three modules - microeconomics, macroeconomics, and statistics/econometrics at each respective institution.

Table 4: Wilcoxon-Mann-Whitney Test on CAP3

		N	Mean Rank	Sum of Ranks
CAP3	UM	143	146.16	20900.50
	NUS	118	112.63	13290.50
	Total	261		

Test Statistics	CAP3
Mann-Whitney U	6269.500
Wilcoxon W	13290.500
Z	–3.577
Asymp. Sig. (2-tailed)	0.000

Similar to the pre-university score, the Wilcoxon-Mann-Whitney Test was conducted on CAP3 to identify differences between the samples. The result in Table 4 indicates that the CAP3 for UM is again significantly higher than NUS (asymptotic significance is smaller than 0.0001 percent) and therefore the performance indicator is also formulated into an index score (as Equation 1), known as grade index, to enable comparison between the universities.

National Service, a mandatory two-year military attachment for all Singaporean males prior to entering university, was included as a variable in the survey. This was motivated by the 2005/2006 and 2006/2007 cohorts from UM, who were the first two batches of Malaysians to undergo a three-month National Service,

drawn randomly, after their 11th year of education. Therefore, the variable was included with the objective of exploring whether National Service has an effect on students' academic performance. However, the sample that completed National Service in Singapore and Malaysia were merely 15 percent and 4 percent respectively.

Information on students' involvement in extra-curricular activities during their first year at university was also collected. However, due to the complexity of the types of extra-curricular activities that students participated in and the incomparable differences within and across both institutions that could not be captured within a Likert scale, as well as the subsequent insignificant results gathered from the primary analysis, this variable was excluded from the model.

The hometown variable, studying the differences in students' background was only surveyed among UM students. This was due to the fact that NUS is located in the city-state of Singapore and therefore the suburban and rural categories become irrelevant.

3. The model

The full specification multiple regression model comprising of all the variables collected was regressed with the grade index as the dependent variable. The independent variables in the full model explained 59 percent of the variations in the dependent variable (R^2 = 0.592). Although the *R*-squared was acceptable, the significance of individual independent variables was below the expected level[10]. As Greene (2003) highlighted, the downward reduction from a full model to the preferred specification poses two advantages, which the general-to-simple approach enables, the elimination of "by accident" significant variables that might exist in a big model and the reduction of the possibility of mis-specifying the model.

Therefore, using the downward reduction method, the model is specified as in column 1 of Table 5, while columns 2 and 3 are specific models for UM and NUS respectively. Column 4 is the model with the inclusion of the university-specified dummy. Similarly, column 1 of Table 6 illustrates the logarithm model and columns 2, 3 and 4 are the university-specified logarithm models and the addition of the university-specified dummy.

Although the results in column 4 of both Table 5 and Table 6 reflected higher *R*-squared and *F*-values, the problem of multicollinearity is suspected to be due to the high correlation between the university-specified dummy variable and the type of pre-university programme (r = 0.812), as mentioned in Greene (2003). Therefore, the models in column 1 are assumed to be the better specified model.

In deciding between the level model and logarithm model, the regression specification error test, Ramsey's RESET test was employed. The *R*-squared of both the level model (Table 5) and logarithm model (Table 6) were used for the tabulation of the *F* value. The results indicated that both models were adequately specified, where the *F* value (0.0737) was statistically insignificant. Therefore, the analysis of the determinants of the students' academic performance will be based on the logarithm model in Table 6, due to the higher *F* value that explains the variability of the independent variables in the model.

[10] In the situation whereby the coefficients have low significance levels and the R^2 is high, the problem of multicollinearity might exist (see Greene, 2003, p. 57).

Table 5: Determinants of Grade Index

Grade Index-Dependent Variable	Level Model			Level Model (UM)			Level Model (NUS)			Level Model with University Dummy		
(Constant)	111.035		(23.150)	127.517		(45.577)	76.925		(30.153)	101.272		(21.874)
PreU_indexscore	0.473	**	(0.058)	0.599	**	(0.149)	0.356	**	(0.067)	0.436	**	(0.055)
Male	1.919		(2.564)	4.043		(2.874)	–3.942		(5.200)	2.561		(2.416)
Malay	–10.473	**	(2.786)	–11.047	**	(2.968)	–4.076		(12.528)	–13.194	**	(2.679)
Other Ethnic	–0.051		(3.423)	–7.823		(5.299)	5.488		(4.544)	0.887		(3.226)
Age	–2.541	**	(1.007)	–3.351	*	(1.713)	–1.650		(1.295)	–2.669	**	(0.948)
Alevels	–6.587	**	(3.295)				15.480		(9.919)	11.033	**	(4.733)
OtherPreU	–10.827	**	(4.581)	–12.517	**	(5.219)	10.120		(12.814)	–6.472		(4.400)
National Service	3.715		(2.735)	–0.257		(3.633)	7.210		(5.376)	2.625		(2.583)
JobExperience	–2.543		(1.981)	–3.109		(2.583)	–4.344		(2.910)	–3.666	*	(1.878)
PhoneBill	–0.045		(0.030)	–0.023		(0.029)	–0.070		(0.070)	–0.048	*	(0.028)
Econ_yn	3.674		(3.056)	4.567		(6.004)	4.007		(3.569)	3.724		(2.876)
Math_yn	–0.946		(2.978)	–1.511		(3.090)	0.844		(6.345)	–0.556		(2.803)
Phy_yn	0.147		(2.681)	–7.297		(14.922)	4.138		(3.234)	2.190		(2.557)
Chem_yn	1.583		(2.771)	15.103		(12.668)	6.199	*	(3.303)	3.253		(2.629)
Geo_yn	–5.689	*	(3.304)	–7.205	**	(3.558)	1.266		(6.094)	–5.841	*	(3.109)
Bus_yn	–2.285		(2.755)	–3.690		(2.912)	–9.117		(10.976)	–5.590	**	(2.678)
Hist_yn	–7.007	**	(3.169)	–11.227	**	(3.531)	5.946		(6.469)	–8.286	**	(2.993)
AC_yn	–0.285		(3.157)	–1.615		(3.233)	3.257		(13.596)	–3.528		(3.043)
Interest_moderate	3.809		(4.753)	–5.923		(10.400)	1.572		(5.586)	1.111		(4.506)
Interest_good	7.173		(4.567)	–3.312		(10.295)	5.795		(5.185)	3.733		(4.354)
Interest_vgood	9.199	*	(5.360)	–1.190		(10.771)	9.658		(6.760)	6.400		(5.076)
UM										25.072	**	(5.088)
R-squared	0.522			0.656			0.557			0.579		
F value	9.357			8.110			4.428			11.190		

Note: Standard error in parentheses; ** Significance at 5% level; *Significance at 10% level

From the model in Table 6, it was clear that students' pre-university grades are the most important determinant in their university academic performance. A student, who scored 10 percent higher in their pre-university index score, will most likely also achieve a higher grade index by four percent at university, *ceteris paribus*. This finding is consistent for the entire sample from both UM and NUS, whereby UM and NUS students achieved six percent higher and three percent higher grades respectively. However, the particular type of pre-university education in contributing to the students' performance was only significant in the

combined model and the UM model. The significance of this variable in the combined model might explain specific institutional differences, other than students' related variables. Therefore, it is interesting to note that there are statistical differences between STPM and other pre-university qualifications in the UM model. Students with other qualifications scored about 12 percent lower in their grade point index compared to those with STPM pre-university qualifications.

Table 6: Determinants of Logarithm Grade Index

Logarithm Grade Index-Dependent Variable	Log Model			Log Model (UM)			Log Model (NUS)			Log Model with University Dummy		
(Constant)	4.808		(0.783)	4.155		(1.508)	4.454		(1.035)	4.897		(0.734)
LogPreUindexscore	0.390	**	(0.055)	0.622	**	(0.163)	0.287	**	(0.064)	0.359	**	(0.052)
Male	0.026		(0.028)	0.049		(0.030)	–0.029		(0.059)	0.034		(0.026)
Malay	–0.107	**	(0.031)	–0.111	**	(0.031)	–0.006		(0.142)	–0.137	**	(0.029)
Other Ethnic	–0.004		(0.038)	–0.080		(0.055)	0.060		(0.052)	0.008		(0.035)
LogAge	–0.619	**	(0.236)	–0.725	*	(0.372)	–0.435		(0.317)	–0.657	**	(0.221)
Alevels	–0.065	*	(0.036)				0.183		(0.112)	0.138	**	(0.052)
OtherPreU	–0.103	**	(0.051)	–0.119	**	(0.054)	0.112		(0.148)	–0.055		(0.048)
National Service	0.039		(0.030)	–0.002		(0.037)	0.069		(0.061)	0.026		(0.028)
JobExperience	–0.021		(0.022)	–0.031		(0.026)	–0.038		(0.033)	–0.034	*	(0.020)
LogPhoneBill	–0.029		(0.019)	–0.009		(0.020)	–0.038		(0.034)	–0.033	*	(0.018)
Econ_yn	0.043		(0.034)	0.041		(0.061)	0.042		(0.041)	0.043		(0.031)
Math_yn	–0.024		(0.033)	–0.026		(0.032)	–0.014		(0.072)	–0.020		(0.031)
Phy_yn	0.003		(0.029)	–0.066		(0.153)	0.043		(0.037)	0.026		(0.028)
Chem_yn	0.012		(0.030)	0.125		(0.130)	0.059		(0.037)	0.031		(0.029)
Geo_yn	–0.074	**	(0.036)	–0.086	**	(0.037)	–0.010		(0.070)	–0.075	**	(0.034)
Bus_yn	–0.020		(0.030)	–0.037		(0.030)	–0.131		(0.119)	–0.056	*	(0.029)
Hist_yn	–0.082	**	(0.035)	–0.124	**	(0.036)	0.048		(0.075)	–0.096	**	(0.033)
AC_yn	0.000		(0.035)	–0.018		(0.033)	0.048		(0.154)	–0.036		(0.033)
Interest_moderate	0.055		(0.052)	–0.070		(0.107)	0.031		(0.064)	0.024		(0.049)
Interest_good	0.090	*	(0.050)	–0.046		(0.106)	0.081		(0.059)	0.051		(0.047)
Interest_vgood	0.112	*	(0.059)	–0.028		(0.110)	0.128	*	(0.078)	0.080		(0.055)
UM										0.284	**	(0.055)
R-squared	0.477			0.648			0.521			0.544		
F value	7.812			7.822			3.840			9.694		

Note: Standard error in parentheses; ** Significance at 5% level; *Significance at 10% level

In addition to pre-university qualification and performance, the model also included dummy variables on the pre-university subjects taken by students for admission into university. The model showed that students who took geography and history performed worse compared to their peers who studied languages (the control variable in the model) prior to attending university. Similar results could be observed for the UM model but not the NUS model. The model also highlighted that a pre-university background in economics and mathematics had no implication on the grade index of economics undergraduates' academic performance, based on our sample. This can be explained by understanding that many of the economics examinations at undergraduate level include essay components, which may favour those with a higher proficiency in languages, as well as the economics programme in UM which is, in general, also less mathematically-oriented.

In addition to pre-university background, ethnicity and age also showed a high level of significance in the combined model and the UM model. Again, these variables were insignificant in the NUS model. In terms of the grade index, Chinese students performed 11 percent better than their Malay peers, while the differences between Chinese and other ethnic groups were statistically insignificant. The insignificance of the NUS model in terms of ethnicity could be largely due to the small sample of non-Chinese NUS students in the survey. On the other hand, younger students tend to score higher in the grade index compared to their more mature peers, with differences of six percent declination in grade index when age increased by 10 percent, *ceteris paribus*.

Regarding students' level of interest in economics and their performance, the combined model revealed that level of interest does have an effect in motivating students to perform better. Students who indicated "good" and "very good" in their level of interest in economics tended to score about nine percent and 11 percent higher compared to their peers whose level of interest were either "very bad" or "bad". This is not a causal inference though and likely reflects co-movement between these variables. However, the university-specified models for UM and NUS do not show significant levels of difference between interest and student performance, with the only exception being that those at NUS who indicated "very good" tended to score better grades than those with other levels of interest.

Subject-specified models

Progressing ahead, subject-specified models comprising of the same explanatory variables in the grade index model were examined. The subject-specified models sought to identify specific determinants in affecting the grade of microeconomics or macroeconomics, which might have been manifested differently under the grade index model (Krohn and O'Connor, 2005).

Table 7: Determinants of Logarithm Microeconomics Grade Index

Logarithm Microeconomics Grade Index	Log Model			Log Model (UM)			Log Model (NUS)		
(Constant)	5.574		(1.104)	5.291		(2.767)	4.966		(1.315)
LogPreUindexscore	0.421	**	(0.078)	0.818	**	(0.299)	0.304	**	(0.080)
Male	0.010		(0.040)	-0.001		(0.054)	0.037		(0.075)
Malay	–0.074	*	(0.043)	-0.075		(0.056)	-0.008		(0.179)
Other Ethnic	–0.033		(0.053)	-0.080		(0.100)	0.036		(0.065)
LogAge	–0.914	**	(0.333)	-1.475	**	(0.683)	-0.613		(0.403)
Alevels	–0.107	**	(0.050)				0.148		(0.141)
OtherPreU	–0.016		(0.071)	-0.032		(0.099)	0.076		(0.186)
National Service	0.082	*	(0.042)	0.054		(0.069)	0.018		(0.077)
JobExperience	0.017		(0.030)	0.023		(0.049)	-0.008		(0.041)
LogPhoneBill	–0.017	*	(0.026)	0.031		(0.037)	-0.056		(0.043)
Econ_yn	0.046		(0.047)	0.102		(0.113)	0.046		(0.051)
Math_yn	–0.078	*	(0.046)	-0.097	*	(0.058)	-0.017		(0.091)
Phy_yn	0.034		(0.042)	-0.029		(0.280)	0.075		(0.046)
Chem_yn	0.010		(0.043)	0.275		(0.238)	0.060		(0.047)
Geo_yn	–0.047		(0.051)	-0.061		(0.068)	0.038		(0.087)
Bus_yn	–0.043		(0.043)	-0.057		(0.055)	-0.157		(0.149)
Hist_yn	–0.054		(0.049)	-0.076		(0.067)	0.065		(0.094)
AC_yn	–0.050		(0.049)	-0.071		(0.061)	0.100		(0.193)
Interest_moderate	0.003		(0.073)	-0.073		(0.196)	0.011		(0.080)
Interest_good	0.079		(0.070)	0.027		(0.194)	0.072		(0.074)
Interest_vgood	0.051		(0.082)	-0.006		(0.203)	0.077		(0.097)
R-squared	0.360			0.357			0.427		
F value	4.787			2.363			2.591		

Note: Standard error in parentheses; ** Significance at 5% level; *Significance at 10% level

Table 7 and Table 8 illustrate the logarithm microeconomics grade index model and logarithm macroeconomics grade index model respectively. Column 1 is the combined model and columns 2 and 3 are the university-specified models. The combined model and the UM model generally reflect identical results. The most significant determinant in students' microeconomics and macroeconomics performance is their pre-university performance, consistent over all models. As explained previously, the significance of the A-level dummy variable in the combined model also reflects the differences between UM and NUS in terms of the nature of pre-university admissions qualifications. However, the A-levels effect is only observable in the microeconomics model.

Table 8: Determinants of Logarithm Macroeconomics Grade Index

Logarithm Macroeconomics Grade Index	Log Model			Log Model (UM)			Log Model (NUS)		
(Constant)	5.142		(1.253)	4.965		(3.193)	4.721		(1.467)
LogPreUindexscore	0.403	**	(0.088)	0.621	*	(0.347)	0.289	**	(0.090)
Male	0.038		(0.046)	0.087		(0.065)	-0.075		(0.083)
Malay	–0.256	**	(0.050)	-0.233	**	(0.067)	-0.089		(0.199)
Other Ethnic	0.027		(0.060)	-0.055		(0.116)	0.078		(0.073)
LogAge	–0.720	*	(0.378)	-0.912		(0.787)	-0.518		(0.450)
Alevels	0.036		(0.057)				0.220		(0.157)
OtherPreU	–0.213	**	(0.081)	-0.273	**	(0.114)	0.064		(0.208)
National Service	–0.004		(0.048)	-0.075		(0.079)	0.095		(0.086)
JobExperience	–0.022		(0.035)	-0.057		(0.056)	-0.021		(0.046)
LogPhoneBill	–0.057	*	(0.030)	-0.068		(0.043)	-0.025		(0.048)
Econ_yn	0.032		(0.053)	-0.066		(0.130)	0.063		(0.057)
Math_yn	–0.007		(0.052)	0.009		(0.068)	-0.086		(0.101)
Phy_yn	–0.010		(0.047)	-0.097		(0.324)	0.051		(0.052)
Chem_yn	–0.002		(0.049)	0.034		(0.277)	0.067		(0.053)
Geo_yn	–0.110	*	(0.058)	-0.132	*	(0.079)	-0.048		(0.097)
Bus_yn	–0.054		(0.049)	-0.060		(0.063)	-0.136		(0.167)
Hist_yn	–0.124	**	(0.055)	-0.188	**	(0.077)	0.104		(0.104)
AC_yn	0.044		(0.055)	0.030		(0.070)	0.138		(0.215)
Interest_moderate	0.088		(0.083)	0.047		(0.226)	0.046		(0.089)
Interest_good	0.104		(0.080)	0.018		(0.224)	0.087		(0.083)
Interest_vgood	0.197	**	(0.094)	0.107		(0.234)	0.210	*	(0.109)
R-squared	0.452			0.579			0.423		
F value	6.988			5.774			2.550		

Note: Standard error in parentheses; ** Significance at 5% level; *Significance at 10% level

Students' performance in macroeconomics is significantly worse for undergraduates who took geography and history in their pre-university studies. All other subjects taken previously, including economics and mathematics at pre-university level do not seem to have provided a head-start for students to perform better in macroeconomics. Concomitantly, students' performance in microeconomics also does not seem to be correlated with pre-university subject selection. Only mathematics in the combined model and the UM model shows a negative relationship, of significance levels of 10%, to the students' performance if he or she has taken the subject at pre-university level. The results of the NUS model do not show any significant relationship.

The age-factor, comparing between the dependent variable of microeconomics or macroeconomics, indicated that the effect is greater on microeconomics. With an increase in students' age by 10 percent, the microeconomics grade index will decrease by nine percent, at significance levels of 5%, while the macroeconomics grade index only decreases by seven percent at significance levels of 10%.

4. Discussion

General pre-university performance matters

It is important to note that this study represents further evidence that performance prior to university entrance significantly determines how students perform in economic courses in the early stages of their university career.

Using average grade index - comprising of basic microeconomics, basic macroeconomics and statistics/econometrics - as the indicator of students' academic performance, it was apparent that students' pre-university performance has the most significant impact on their undergraduate performance. This variable has been found consistent as a positive explanatory variable (Anderson *et al*., 1994; Krohn and O'Connor, 2005; Harbury and Szreter, 1968). Previous studies using the Scholastic Aptitude Test (SAT) and Grade 13 performance also yielded similar significant results. Indeed, pre-university performance is the best measurement of students' academic ability because it captures not only the intellectual ability to qualify for tertiary education but also other important characteristics of student's' background that enable them to succeed until pre-university level. Therefore this variable has been used as the most important criteria for admission into university and this study validates this practice.

Pre-university subjects matter less

Previous studies such as that by Anderson *et al*. (1994) have argued that economics and mathematics (specifically calculus) results in pre-university have a major impact on the results of basic economic modules at university. However, this study shows that the type of subjects taken at pre-university level were relatively unrelated to students' first-year performance, except for geography and history which are negatively related to the grade index. This finding again contradicts the discovery of Harbury and Szreter (1968) that these two subjects (geography and history) have no significant effect on economics performance in first year as an undergraduate. Generally, the finding of this study that subjects taken at pre-university level have no effect on economics undergraduates' performance was further reinforced through the subject-specified analysis for microeconomics and macroeconomics grades.

Ethnicity or types of pre-university qualifications?

Ethnicity, in the UM model, seems to be an important determinant. The Chinese ethnic students significantly outperformed the Malay ethnic students in the overall grade performance. However, the level of significance was reduced from 5% to 10% in the macroeconomics grade, and was non-significant in the microeconomics grade. Although many studies at Malaysian universities have concluded that Chinese students perform better than students from other ethnic groups (Alfan and Othman, 2005; and Ismail and Othman, 2006), there is an additional variable in this framework that allows a more detailed examination of this notion about ethnic differences.

There are three different routes of entry for students into the UM economics course, with the majority of the respondents from UM entering through the STPM and the Matriculation Programme. From the results, it is apparent that students who entered the economics programme with the STPM qualification performed significantly better than those who entered under the Malaysian Matriculation programme or Diploma. The difference between STPM and other pre-university qualifications also needs to take into account the ethnicity

factor. From the Malaysian Ministry of Education website (accessed August 2007), the Matriculation is a pre-university programme with a modified quota system, specifically to cater for the needs of the *Bumiputera*[11]. It is a two-semester pre-university programme, which arguably has a more intensive curriculum due to a shorter semester. Students in this programme are evaluated by two end-of-semester examinations, which are internal examinations between all the Matriculation colleges. STPM, on the other hand, is a one and half year pre-university programme accessible to all students, who are selected based on their SPM[12] examination results. STPM is commonly taught in public secondary schools and students sit a central examination at the end.

While it is clear from our results that both the different pre-university systems in Malaysia and ethnicity are important determinants on the academic performance of economics undergraduates in UM, it remains inconclusive as to whether the differences between students' performance in UM resulted from the ethnicity factor or the nature of each pre-university programme, which suggests potential for future research.

Pre-university performance and its effect on microeconomics and macroeconomics performance

Students' performance in macroeconomics is significantly worse for undergraduates who have taken geography and history in their pre-university studies. All other subjects taken previously, including economics and mathematics at pre-university level do not seem to have provided a head-start for students to better perform in macroeconomics. Concomitantly, students' performance in microeconomics also does not seem to be correlated with pre-university subject selection. Only mathematics in the combined model and the UM model shows a negative relationship, of significance levels of 10%, on the students' performance if they have taken the subject at pre-university level. The results of the NUS model do not show any significant relationship. This seems counterintuitive to how many departments are running their economics programmes with an increasing emphasis on mathematical rigour. The results shown here suggest that pre-university competence in mathematics does not lead to better performance in either basic micro or macro-economics. In fact there is weak evidence to show that it may even hinder (see Table 3). There may be a disconnect between the tools that students are required to know in these courses versus the intuition that economics itself conveys to solve everyday problems in the Asian context. We do not suggest generality in these results but offer more contrary evidence to the role mathematics plays in undergraduate performance in economics (see Cohn *et al.*, 1998).

5. Conclusion

In conclusion, the most important determinant of an economics undergraduate's academic performance is his or her pre-university results. The importance of this factor clearly outweighs other determinants, be it personal background, or environmental or other institutional characteristics of the university.

However, determinants such as ethnicity, the types and subjects taken at pre-university level, have a highly significant influence on the students' performance in the UM model but such influence did not exist in the NUS model. A plausible explanation is that NUS is less diverse compared to UM in terms of the students' ethnicity for this difference to be statistically significant.

[11] Literally means "Sons of the soil"; also refers to the indigenous Malay ethnicity.
[12] Malaysian Certificate of Education, taken at the end of High School. Equivalent of O-levels or Grade 10.

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Appendix 1: Descriptive statistics of variables in the model

Variable	Description	Mean	Std Dev	Minimum	Maximum
Gender	Dummy variable for Female	0.74	0.442	0	1
	Dummy variable for Male	0.26	0.442	0	1
School	Dummy variable for NUS	0.45	0.499	0	1
	Dummy variable for UM	0.55	0.499	0	1
Ethnicity	Dummy variable for Malay	0.25	0.433	0	1
	Dummy variable for Chinese	0.65	0.477	0	1
	Dummy variable for Other Ethnic	0.10	0.295	0	1
Age	Continuous variable for student's age	21.42	1.161	18	25
Nationalities	Dummy variable for Singaporean	0.35	0.479	0	1
	Dummy variable for Malaysian	0.59	0.493	0	1
	Dummy variable for Other Nationalities	0.06	0.240	0	1
Hometown[1]	Dummy variable for Urban	0.45	0.499	0	1
	Dummy variable for Sub-urban	0.32	0.469	0	1
	Dummy variable for Rural	0.20	0.398	0	1
Birth Order	Continuous variable for student's birth order in his/her family	2.15	1.534	1	12
Entry Qualification for University	Dummy variable for STPM	0.41	0.492	0	1
	Dummy variable for A-Levels	0.35	0.479	0	1
	Dummy variable for Diploma	0.11	0.310	0	1
	Dummy variable for Malaysian Matriculation and others	0.11	0.315	0	1
Subjects Taken at Pre-U	Dummy variable for Economics	0.88	0.331	0	1
	Dummy variable for Mathematics	0.70	0.458	0	1
	Dummy variable for Business Studies	0.33	0.472	0	1
	Dummy variable for Accounting	0.24	0.426	0	1
	Dummy variable for Languages	0.24	0.429	0	1
	Dummy variable for Chemistry	0.24	0.428	0	1
	Dummy variable for Physics	0.20	0.398	0	1
	Dummy variable for History	0.15	0.355	0	1
	Dummy variable for Geography	0.13	0.341	0	1
Pre-U Score	Continuous variable on the Pre-U entry score	3.34	0.600	1.67	4.00
	Index score on Pre-U entry score	100.0	17.976	49.92	119.80
National Service	Dummy variable for National Service (1=yes)	0.21	0.406	0	1
Working Experiences	Dummy variable for Working Experience	0.70	0.460	0	1
	Continuous variable on the working duration (months)	5.45	3.758	1	24
Accommodation	Dummy variable for staying in Hall/Residential College	0.66	0.476	0	1
	Dummy variable for staying at home	0.34	0.474	0	1
	Dummy variable for other arrangement	0.02	0.123	0	1
Roommate	Dummy variable for Roommate (1=No)	0.46	0.499	0	1
	Dummy variable for Bad or Moderate Roommate	0.08	0.273	0	1
	Dummy variable for Good Roommate	0.25	0.433	0	1
	Dummy variable for Excellent Roommate	0.21	0.409	0	1

[1] This question only applies to students in UM

Study Location	Dummy variable for Library	0.66	0.476	0	1
	Dummy variable for Own Room/House	0.34	0.474	0	1
	Dummy variable for Other Locations	0.02	0.123	0	1
Study Environment	Dummy variable for Very Bad and Bad	0.10	0.300	0	1
	Dummy variable for Moderate	0.48	0.501	0	1
	Dummy variable for Good and Excellent	0.42	0.495	0	1
Hours devoted to Study (per week)	Dummy variable for less than 5 hours	0.34	0.474	0	1
	Dummy variable for 5 to 10 hours	0.40	0.491	0	1
	Dummy variable for 11 to 20 hours	0.18	0.385	0	1
	Dummy variable for more than 20 hours	0.08	0.273	0	1
Hours devoted to Study before exam (per week)	Dummy variable for less than 5 hours	0.03	0.183	0	1
	Dummy variable for 5 to 10 hours	0.26	0.438	0	1
	Dummy variable for 11 to 20 hours	0.38	0.485	0	1
	Dummy variable for more than 20 hours	0.33	0.472	0	1
Source of Allowances	Dummy variable for Parents or Family	0.55	0.498	0	1
	Dummy variable for Scholarship	0.13	0.341	0	1
	Dummy variable for Study Loan	0.35	0.479	0	1
	Dummy variable for Part-time Job or Savings	0.20	0.397	0	1
Average Spending per month	Continuous variable on expenditure per month (excluding tuition fees and accommodation)	302.32	167.412	30	1500
Average Monthly Mobile Phone Bill	Continuous variable on average monthly phone bill	46.57	29.784	6	200
Reason in Choosing Economics	Dummy variable for Personal Interest	0.51	0.501	0	1
	Dummy variable for Useful Subject	0.26	0.438	0	1
	Dummy variable for Good Career Prospect	0.37	0.484	0	1
	Dummy variable for No Other Choices	0.03	0.173	0	1
Problems Faced	Dummy variable for Financial Problems	0.25	0.435	0	1
	Dummy variable for Health Problems	0.22	0.417	0	1
	Dummy variable for Environment	0.43	0.496	0	1
	Dummy variable for Family Problems	0.14	0.349	0	1
Extra-Curricular Participation	Dummy variable for No Involvement	0.23	0.419	0	1
	Dummy variable for Minimal Involvement	0.21	0.406	0	1
	Dummy variable for Moderate Involvement	0.26	0.440	0	1
	Dummy variable for Active Involvement	0.24	0.426	0	1
	Dummy variable for Very Active Involvement	0.06	0.233	0	1
Grade Point	Continuous variable on the Grade Point for 3 major modules in Economics	3.2165	0.545	1.65	4.00
	Index Score on the Grade Point	100.0	16.957	51.30	124.36

Appendix 2: Questionnaire

This voluntary survey is conducted by Wan Chang Da (wanchangda@nus.edu.sg), which is part of EC5660 Independence Study Module. Your cooperation in completing the questionnaire is much appreciated. All information provided will be kept strictly confidential and will only be used for statistical analysis. Thank you for your kind cooperation.

Please tick (√) appropriately. **Gender:** ☐ Male ☐ Female

Ethnicity: ☐ Malay ☐ Chinese ☐ Indian Others:_____

Age: _____ **Nationality:** _____ **Hometown:** ☐ Urban ☐ Sub-urban ☐ Rural

Birth order: I am the _____ child in my family. (*e.g. 1st child*)

Entry qualification for university:
☐ STPM ☐ A-levels ☐ Malaysian Matriculation (MM) ☐ Diploma Others: _____

Subjects taken at STPM/A-levels/MM and Grades:
(*Diploma holders proceed to next question*)
E.g. *General Paper* *A*
_____ ___ _____ ___
_____ ___ _____ ___
_____ ___ _____ ___

Cumulative Academic Points for university entrance: _____ on the scale of _____
(*For diploma holders only*)

National Service:
☐ ≈ 2 years ☐ 3 months ☐ Deferred ☐ Not applicable

Working experiences before entering university:
☐ Yes ☐ No If yes, total working duration is _____ months

Accommodation during Year 1 in university:
☐ Stayed in hall/residential college ☐ Rented accommodation near campus
☐ Stayed at home ☐ Stayed with friends/relatives

If you have roommate(s) during Year 1 in university, how would you describe the relationship with him/her/them?
☐ No roommate
☐ Very bad ☐ Bad ☐ Moderate ☐ Good ☐ Excellent

Where was your usual study place during Year 1 in university?
☐ Library ☐ Own Room ☐ Study Room in Faculty
Others: _____

How would you rate your study environment during Year 1 in university?
☐ Very bad ☐ Bad ☐ Moderate ☐ Good ☐ Excellent

No. of hours devoted for revision/study during the semester (per week) in Year 1:
☐ <5 hours ☐ 5–10 hours ☐ 11–20 hours ☐ >20 hours

No. of hours devoted for revision/study two weeks before exam (per week) in Year 1:
☐ <5 hours ☐ 5–10 hours ☐ 11–20 hours ☐ >20 hours

During Year 1 in university, what is your source of allowances (pocket money)?
☐Parents/Family ☐Scholarship ☐Study Loan ☐Part-time job Others: _____

On average, how much do you spent within a month during Year 1 in university? (*excluding tuition fees and accommodation*) $ _____

On average, how much do you spent on mobile phone bill (including SMS, MMS etc.) within a month during Year 1 in university? $ _____

Reason in choosing to study Economics:
☐Personal interest ☐Useful subject ☐Good career prospect Others: _____

What is your level of interest in economics?
☐Very bad ☐Bad ☐Moderate ☐Good ☐Excellent

List of Modules and their Grades:
Microeconomics (EC 2101 or EXEE 1103) _____
Macroeconomics (EC 2102 or EXEE 1104) _____
Statistics / Econometrics (EC 2303 or ESEE 1103) _____
Quantitative Methods / Mathematics (MA 1101/1102 or ESEE 1101/1102) _____
Sociology (SC 1101 or EXEE 2106) _____
Principles of Accounting (FNA 1002 or EXEE 1105) _____
Other Modules taken in Year 1 and their Grades:
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____

I have faced the following problems in Year 1 *(possible to tick more than one)***:**
☐Financial (*e.g. financial difficulties*)
☐Health (*e.g. stress, frequently falling sick, depression*)
☐Environment (*e.g. difficulties adjusting to lifestyle, getting along with friend*)
☐Family (*e.g. home-sickness*)
Others:_____

Participation in extra-curricular activities during Year 1 in university:
☐No involvement ☐Minimal ☐Moderate ☐Active ☐Very active

Thank you for your participation.

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Performance Determinants in Undergraduate Economics Classes: The Effect of Cognitive Reflection

Alexei Orlov and John Roufagalas

Abstract

Economics classes claim to develop students' "analytical" abilities and "problem-solving" skills. Assessment of such claims is rather difficult, since it requires measurement of advanced thinking processes. Aptitude tests, such as the SAT, ACT (standardised tests for college admissions in the U.S.), and GRE (a standardised test for post-graduate admissions), purport to provide measures of such processes, but their questions refer to relatively simple thinking processes. Frederick (2005) has developed the "Cognitive Reflection Test" (CRT) to measure human ability to think deeper. The test contains questions whose apparent answers are incorrect and therefore further reflection is needed to arrive at the correct answers. Many economic problems fall into such a category. Our results suggest that CRT scores are higher and have a significant positive effect on exam performance in upper-level economics classes. In these classes, students with the highest CRT score outperform, on average, students with the lowest CRT score by more than half a letter grade, everything else the same.

JEL classification: A22, C13

1. Introduction

The terms "analytical abilities" and "problem-solving skills" appear, almost universally, among the goals of undergraduate economics classes. The nature of economic problems and the methodology of economics are well suited for the development and honing of such skills and abilities. Heterogeneity, along several dimensions, among students implies that they will face varying degrees of difficulty in developing these skills and abilities. Such difficulty may explain why some students fall in love with economics, while others develop a strong distaste for the subject.

A few questions naturally arise. First, is there a relationship between students' analytical/problem-solving abilities and their performance in economics classes? If so, is this relationship economically and statistically significant even after controlling for other factors that may affect student performance? Second, do students exposed to Principles of Economics exhibit improved analytical/problem-solving skills? Third, if they do, what is the most plausible explanation for this improvement and are these improved skills associated with better performance in subsequent economics courses? To answer such questions, measures of the analytical/problem-solving predisposition or exposure and student performance, as well as performance determinants, have to be discussed and decided upon.

Frederick (2005) analyses decision-making processes and identifies a category of problems, whose statement suggests that they are simpler than they actually are. As such, the first answer that comes to mind is incorrect. Further thinking, or "cognitive reflection" as Frederick calls it, is needed to arrive at the correct answer. Frederick has developed the "Cognitive Reflection Test" (CRT) as a way to measure

a person's ability to arrive at the correct answer by cognitive reflection. It is interesting to note that many economic problems have the characteristic that the intuitive answer that first comes to mind is usually wrong and further reflection is needed to arrive at the correct one.[1] Hence, it is our claim that the CRT tests students' disposition/aptitude towards the kinds of analytical abilities and problem-solving skills that are associated with economics. Our working hypothesis is that students performing better in the CRT will, on average, perform better in economics classes. Just as most of the literature on this topic, our paper does not take a stand on the direction of causation between cognitive reflection and performance, as our goal is to investigate the association between the two while controlling for as many other variables for which we have collected data, in addition to the CRT, that may affect student performance.

Siegfried and Fels (1979) review the literature and enumerate the factors that may affect student performance in economics classes, especially principles. These factors are classified in four categories: Student Human Capital, Faculty Human Capital, College Environment, and Student Effort. In the subsequent three decades more research on some of these factors has been carried out. Table 1 provides a summary of Siegfried and Fels' (1979) findings with respect to the factors affecting students' performance. The table also summarises findings reported in the more recent extant literature regarding these as well as several additional factors. Papers cited in the fourth column contain additional references.

Table 1: Literature Review

Category	**Factor**	**Effect on Student Performance in Siegfried and Fels (1979)**	**Recent Literature**	
			Author(s)	**Effect on Student Performance**
Student Human Capital	Entrance exam scores (Verbal and Math SAT, ACT)	Strong positive effect; Verbal SAT has a stronger effect than Math SAT	Ballard and Johnson (2004)	Strong positive effect for Math SAT
	High school rank	Positive impact		
	Student maturity	No effect	Anderson, Benjamin and Fuss (1994)	Positive effect
	Socioeconomic background	No effect		
	High school economics	Inconclusive	Anderson, Benjamin and Fuss (1994)	Positive effects when students score high
	Pre-test score	Positive and significant effect on post-test scores		

[1] Here are two examples: (A). The Bond Price – Yield relation in the financial markets. The immediate answer to the question: "What happens to yields when bond prices increase?" is often: "Yields increase!"
(B) Comparative Advantage. "If a country has an absolute advantage in both tradable products over its partner, is trade still mutually advantageous?" For many students not trained in economics (and some trained!) the intuitive answer is "No". Many other examples can be given.

	Gap closing measures	Knowing more at the beginning implies less added knowledge		
Faculty Human Capital	Years of teaching	Positive	Hoffman and Oreopoulos (2006)	No effect
	TUCE (Test of Understanding College Economics) scores by faculty	Positive		
	Graduate school grades	Positive		
College Environment	Class size	No effect	Raimondo, Esposito and Gershenberg (1990), Monks and Schmidt (2010)	Negative effects on (a) essay exams, (b) future intermediate macroeconomics performance, and (c) self-reported learning outcomes
	Larger colleges	Positive		
	High school-wide SAT scores	Positive		
	Two semester series	More understanding than one course		
	Choice of textbook	No effect		
Student Effort	Study time	No effect		
	Attendance	No effect	Marburger (2001), Stanca (2006), Arulampalam, Naylor and Smith (2007)	Positive effects
	Class Loads	No effect		
	Average GPA	Positive effect	Grove, Wasserman and Grovner (2006)	Positive effect
Additional Factors	Student gender		Anderson, Benjamin and Fuss (1994), Ballard and Johnson (2004), Borg and Stranahan (2002), Robb and Robb (1999)	Females score lower
	Instructor gender		Hoffman and Oreopoulos (2007)	Small positive effect on same gender students
	Student and instructor personality type		Borg and Stranahan (2002), Borg and Shapiro (1996)	Introvert, sensing/judging students perform better

Some of the above effects are statistically significant but quantitatively small[2]. When both statistical and quantitative significance are taken into consideration, it seems that average (college) grade point average (GPA), high school GPA or rank, verbal and mathematical aptitude, student gender and student attendance are the most significant factors among those explored in the literature.

None of the above factors is directly associated with a student's ability to analyse and solve problems. It can be argued that factors such as mathematical ability and high school GPA or rank may be proxies for these types of ability. It is our argument that the higher-level analytical skills used in economics are different from the lower-level learning skills used in high school.[3] Hence, we claim that using the CRT results provides information about a student's analytical aptitude and can predict the student's performance in economics classes.

Our goal is to examine whether cognitive reflection, as measured by the CRT, can predict the student's performance in an economics class. Our results indicate that the CRT measure is not statistically significant in predicting exam performance in principles classes. Students entering upper-level classes (one of which is required for all business majors, and the other is an elective) are able to score better in the CRT. An upper-level student who answers all three CRT questions correctly is expected to perform up to approximately 8-10 points (i.e. almost a letter grade) better in the exams than a student who answers all three questions incorrectly.

The rest of the paper is organised as follows: first, we introduce the CRT and provide an explanation of the decision model that it may reflect. Second, we briefly present our sample, followed by a discussion of the model and methodology. Finally, we discuss the results and present suggestions for further research.

2. Decision-making and the Cognitive Reflection Test (CRT)

Brain scanning techniques are greatly advancing our knowledge of the areas of the brain responsible for the various types of decision-making. Cohen (2005) reviews this knowledge and convincingly claims that decisions are the result of different, possibly competing, decision systems in the human brain. Greatly simplifying Cohen's arguments, we construct a model of decision-making consistent with his claims. According to this model, there are two decision-making systems associated with two different areas of the human brain: the pre-frontal lobe (the evolutionary newer part of the brain), and the subcortical structures (the evolutionary older part that includes areas such as the striatum and the brainstem). The subcortical structures are responsible for emotional, reflexive, routine types of decisions. These decisions are made fast and sequences of such decisions can be made in a parallel fashion, which implies that their cost is very low.

The prefrontal lobe is a more complex area. It contains what we can call a decision "controller" and a decision "processor." The processor is capable of higher-power thinking, analysis and problem-solving. It can face, and potentially solve correctly, previously un-encountered problems and come up with innovative solutions and ideas. But this processor requires concentration and can only deal with one decision at a time, i.e. it operates serially. As such it implies high costs of processing.

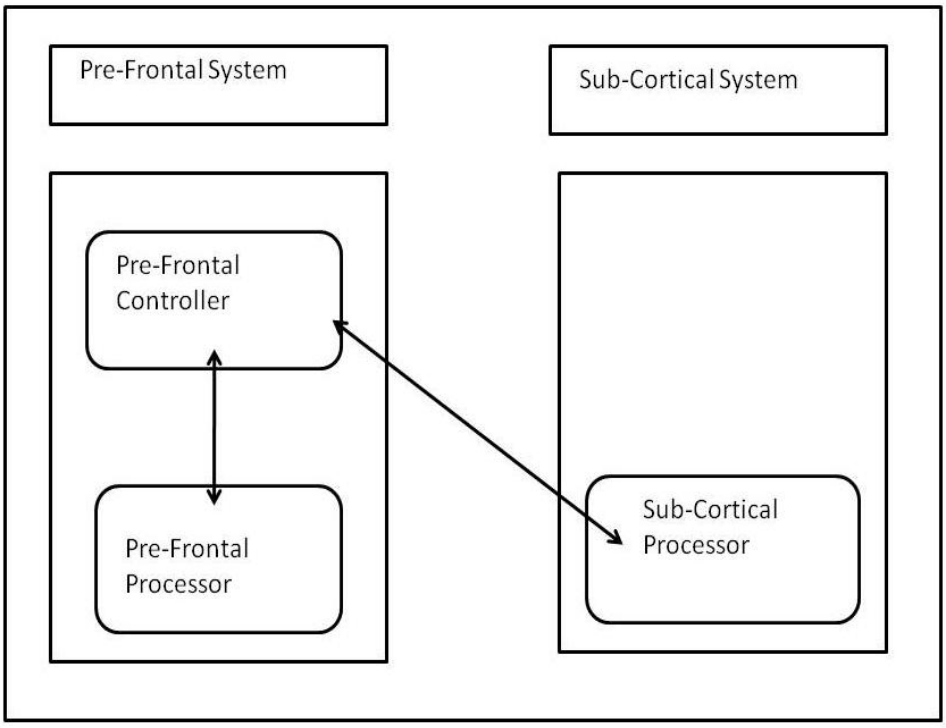
[2] For example, Stanca (2006) argues that a student with perfect attendance (100%) is expected to score 1.2% higher than a student with average attendance (70.8%). In the US semester system, with a class meeting three times per week for 14 weeks, each class meeting is approximately 2.38% of the overall attendance. Even if we round this number to 3% (to account for exam time, cancelled classes etc), skipping a 50-minute class is expected to cost the student 0.12% of the final grade, a small effect.

[3] We have in mind something like the "proficiencies" discussed in Hansen (2001), which in a sense are parallel to the taxonomy in Bloom (1956). Low level skills involve "Accessing existing knowledge" and "Displaying command of existing knowledge," while higher level skills involve "Interpreting existing knowledge," "Interpreting and manipulating economic data," "Applying existing knowledge," and, finally, "Creating new knowledge."

The "controller" function of the pre-frontal cortex is responsible for decision allocation and evaluation: as the need for a decision arises, the controller makes an initial evaluation (based on some criteria) and allocates the actual decision either to the pre-frontal processor or to the subcortical structures. Presumably, the processor makes a rough evaluation of the expected benefits or the size of the stakes involved in the decision and decides where to allocate it. When the actual answer is received, the controller evaluates it and either announces it or remits it to the high-order processor for further processing. Figure 1 presents a graphical representation of the model.

Learning is presumably a process through which routine decisions are relegated from the high-order processor to the subcortical structures. For example, multiplication tables for a 7-year-old are most probably processed in the pre-frontal processor. For most educated adults the routine calculations involved with multiplication tables have been relegated to the subcortical structures.

Figure 1: Cohen's Brain Decision-Making Model



Source: Authors' adaptation of arguments in Cohen (2005).

Heterogeneity with respect to costs of processing and benefits of specific decisions imply that different individuals will allocate their decisions differently and they may come up with different answers when faced with the same problem. An example from finance may illustrate the point: consider two investors with the same portfolio decision - to buy 1000 shares of company X. The decision may be made in the subcortical structures using a simple rule like: "If the share price has increased in the last two weeks, buy; otherwise do not buy." Or it can be made in the pre-frontal processor by collecting information about the prospects of company X, calculating financial ratios, estimating the effect of the overall economy, and so on. The investor with high cost of using the pre-frontal processor and with a controller that estimates that stakes involved (such as the probability of losing a large chunk of the investment, etc.) are relatively small will most likely allocate the decision to the cheaper subcortical structures. On the other hand, an investor who considers the cost of using the pre-frontal cortex relatively low and the stakes involved relatively high will most likely use the pre-frontal processor.

Figure 2: The Cognitive Reflection Test (CRT)

1. A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost?

   _____ cents

2. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?

   _____ minutes

3. In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?

   _____ days

Source: Frederick (2005)

Frederick (2005) has identified a set of three simple questions, shown in Figure 2, that apparently the controller initially estimates can be solved by the subcortical structures.[4] Based on learned routines, such as averages, analogies, proportions, etc., the subcortical processor provides fast, reasonable-looking answers, which are actually incorrect. In particular, for Question 1, the automatic answer is 10 cents, the result of a simple subtraction of $1.00, the price of the bat, from $1.10, the price of the bundle. The actual answer is $1.05 for the bat and $0.05 for the ball, which can be found by solving a simple system of two equations with two unknowns. For question 2, the "apparent" (and incorrect) answer comes from analogies that imply 5/5/5 should be analogous to 100/100/100, hence 100 minutes. The correct answer is 5 minutes, which is found after noting that it takes each machine 5 minutes to make 1 widget and that machines can work simultaneously. Finally, in Question 3, the automatic answer comes from proportions: if it takes 48 days to cover the entire lake, it would take 24 days (or half of 48) to cover half of the lake. The correct answer is, of course, 47 days: the patch would double in size on day 48 and thus cover the entire lake.

Presumably, the pre-frontal controller evaluates the answers. Some of the test-takers provide these incorrect automatic answers either because the controller considers them correct, or because the controller lacks the skills to evaluate them, or the controller thinks that it is too costly to evaluate them in detail. For some other respondents, the controller evaluation demonstrates that the answers are incorrect and the problems are relegated to the pre-frontal processor. These respondents will most likely come up with correct answers. This is obvious from the reaction of the respondents when the correct answers are explained to them.

As was pointed out above, many economics problems have the characteristic that routine reflexive answers are incorrect and more cognitive reflection is needed to come up with the correct answer. It is

[4] Frederick (2005) has developed his own terminology about the brain systems that answer questions. He uses the term "System 1" for what we call subcortical structures, and the term "System 2" for pre-frontal processing.

our hypothesis that students who are more "reflective" in the manner measured by the CRT will perform better in economics classes. It should be clear from the preceding description of the CRT that to score high on the test, the respondents need to resist the urge to provide apparent and incorrect answers. Respondents can arrive at correct answers only upon further reflection, which requires a higher level of thinking. Thus the CRT intends to measure – and does measure – "the ability or disposition to resist reporting the response that first comes to mind" (Frederick, 2005, p. 35).

The CRT has been shown to be both reliable and consistent. Reliability of the CRT can be seen in Frederick's (2005) comparison of CRT with four other measures of cognitive ability. All alternative measures correlate positively and significantly with the CRT. Frederick also documents a strong correspondence between performance on the CRT and time preference (or patience), thereby confirming the notion that people with higher cognitive abilities are more patient, i.e., have lower discount rates. Conversely, the "cognitively impulsive" group (those scoring low on the CRT) is found to be less patient. Frederick's (2005) study of the links between the CRT and time preferences, and the CRT and risk preferences attests to the consistency of the CRT measure.

3. Data

Various measures of student performance have been proposed: Letter Grades (A-F), Percent Total Score (0-100), Percent of Correct Exam Questions (based on exam scores only), etc. The choice of measure determines the econometric method of analysis used (e.g. Ordered Probit models are used with Letter grades), but no measure has been proven superior. Hence, the choice of measure hinges on data availability, though percent total score or percent of correct exam questions contain more detailed information. As argued below, our data allow us to use a more detailed measure.

We administered the 3-question CRT in all our Fall 2006 and Spring 2007 classes during the first week. The classes included: ECON 105: Principles of Macroeconomics (4 sections), ECON 330: Money and Banking (2 sections), and ECON 340: Global Economy (2 sections). ECON 105 and 340 are required for all business students and are General Education options for the rest of the university. They have no prerequisites, but students typically take ECON 340 after the Principles sequence, and in the sequence they take Principles of Macroeconomics before Principles of Microeconomics. ECON 330, an intermediate-level course, has ECON 105 as its prerequisite, is required for all economics majors, and attracts very few non-economics majors.

Our principles course is taught as an average, run-of-the-mill course with the use of McConnell and Brue's textbook. Money and Banking is also a standard course that uses Mishkin's textbook. All sections of the Global Economy and Business course are taught using Hill's "Global Business Today". The exam questions in all of our classes are a mixture of analytical and non-analytical (definitional/term recognition) questions, many of which come directly from the textbooks' test banks.

In ECON 105 and 330, attendance is required and monitored via the use of a "clicker" system. Each student is required to purchase a "clicker", which, via a remote sensor communicates with the class computer. At the beginning of each lecture, a 3-7 question quiz on past material was administered. Performance on the quizzes and attendance accounted for 20% of the final grade in the ECON 105 class, and 10% in ECON 330.The variable ATTEND describes attendance frequency.

At the beginning of each semester the registrar routinely provides faculty with class rosters that contain information about the students' majors. Based on these rosters, we assigned students into colleges. These Colleges are: Business and Economics (COBE), Information Systems and Technology (CIST), Visual

and Performing Arts (CVPA), Arts and Sciences (CAS), Education (EDUC), and Human and Health Sciences (CHHS). Students who did not declare a major were classified as Pre-major.

We were also provided data from the registrar's office that included (a) the gender of the student; (b) SAT[5] scores, verbal (SAT_V), maths (SAT_M) and total (SAT); (c) high school or transfer grade point average (HS_GPA); (d) whether the student transferred into the university; (e) the number of credits completed when the student enrolled in the class (CREDITS) and (f) the student's total GPA at the end of the semester (GPA). Note that some of the data were missing, which affects the size of the sample in some of the regressions below.

Our choice of control variables is motivated in no small part by the extant literature. Differences in student performance between male and female students have been documented by Anderson *et al*. (1994), Robb and Robb (1999), and Borg and Stranahan (2002), among others. Siegfried and Fels (1979) emphasise the importance of the initial level of human capital – as measured, for example, by verbal, maths, and total SAT scores – when trying to account for student performance. In addition to the SAT scores, we also use high school or transfer GPA as a proxy for the initial level of the students' analytical abilities. Previous studies suggested that attendance may affect student performance (e.g. Marburger, 2001; Stanca, 2006; Arulampalam *et al*., 2007). Each student's total GPA at the end of the semester is a measure of student effort; the use of this variable has been advocated by Siegfried and Fels (1979) and Grove *et al*. (2006). Finally, we believe that students' college experience, which we measure by the number of credits completed, should also belong in the set of control variables when trying to account for student performance.

Student gender was described by a dummy variable (GENDER), which took the value of 1 if the student was female. Similarly, dummy variable TRANSFER takes the value of 1 if the student transferred into the university. Dummy variables ECON 330 and ECON 340 were introduced to capture the difference of these courses from the excluded category: ECON 105: Principles of Macro. With these variables we intend to capture the effects of (a) different instructors; (b) different attendance policies; and (c) different level of instruction. One co-author has taught all sections of the Principles and Money and Banking classes, while the other co-author taught all Global Economy classes. Thus, the dummy variables for ECON 330 and ECON 340 represent different instructors as well. In all sections of each course we used the same textbook and the same exams.

Our main focus is the explanatory variable called "CRT Score" which takes values (0, 1, 2, 3) to signify the number of correct answers. We use exam averages (i.e. percent correct answers averaged over all exams, per student), as the dependent variable. Our choice of dependent variable is motivated by the fact that final grades across different classes are determined differently. For example, attendance and open-notes (but limited-time) quizzes affect principles final grade, while presentations and in-class exercises affect ECON 340 grades. We want to preclude items unrelated to analytical ability, such as attendance or public speaking skills, from affecting our results.

Table 2 presents information about our sample and shows that about 40% of the sample are female and the majority of our students, especially in ECON 340 and ECON 330, are College of Business and Economics students.

[5] The SAT is a standardised test used in the United States for college admissions.

Table 2: Sample Information

	ECON 105	ECON 340	ECON 330	TOTAL
Sample	199	67	46	312
Gender				
Females	83	30	14	127
Males	116	37	32	185
Colleges				
COBE	92	59	41	192
CIST	5	3	0	8
CVPA	19	1	0	20
CAS	44	4	4	52
CHHS	5	0	0	5
EDUC	11	0	1	12
Pre-major	23	0	0	23

Source: Authors' calculations.
Note: Table 2 presents information about the size of the sample and the distribution of students with respect to classes, gender, and college.

Table 3 shows enrollment data for the various classes included in the sample. It can be seen that initial enrollment ranged from a low of 22 students to a high of 95 students, i.e. we have a mixture of small and larger classes. The second column shows the distribution of the 312 observations used in the sample. The sample excludes the students who did not have a CRT score (i.e. they were absent when the test was administered, column 3) and/or did not complete the course (i.e. did not take all the exams and did not have a final grade, column 4).

It also shows how many of the students who did not complete the course had taken the CRT test (column 5), as well as the number of students who failed the course (column 5). The failing students are part of the sample. Note that addition of the columns "Used CRT Responses", "Dropped; CRT Taken" and "No CRT Taken" yields the initial enrollment.

As can be seen, only 15 students, of a total of 379, failed to complete the courses, i.e. dropped out, and another 14 received a failing grade. Attrition does not seem to be a significant problem in our sample.

Table 3: Enrollment Data

Term/Class	Initial Enrollment	Used CRT Responses	No CRT Taken	Dropped Total	Dropped; CRT Taken	Failed
Fall 2006						
ECON 105–09	40	40	0	0	0	0
ECON 105–10	95	76	16	4	3	6
ECON 330–01	22	21	1	0	0	1
ECON 340–01	58	39	17	6	2	2
ECON 340–05	37	28	9	2	0	2
Spring 2007						
ECON 105–08	39	31	8	0	0	0
ECON 105–11	57	52	3	3	2	3
ECON 330–01	31	25	6	0	0	0
TOTAL	**379**	**312**	**60**	**15**	**7**	**14**

We split the overall sample into two sub-samples: one includes only the principles classes (Principles Level), while the other includes the students in the ECON 330 and 340 classes (Upper Level).

Table 4: Descriptive Statistics

	Total Sample			Principles Level			Upper Level		
	Obs	Average	Std Deviation	Obs	Average	Std Deviation	Obs	Average	Std Deviation
Exam Avg.	312	77.03	10.13	199	76.96	9.91	113	77.13	10.57
CRT Score	312	0.67	0.91	199	0.50	0.79	113	0.97	1.04
SAT_V	238	495.37	70.88	161	497.57	69.92	77	490.77	73.08
SAT_M	238	510.33	67.26	161	508.88	66.14	77	513.37	69.87
SAT	238	1005.71	122.95	161	1006.46	119.35	77	1004.16	130.94
HS_GPA	304	3.00	0.42	197	3.02	0.39	107	2.96	0.47
CREDITS	311	45.93	31.36	198	29.58	25.17	113	74.59	17.52
ATTEND	245	0.82	0.17	199	0.83	0.16	46	0.77	0.19
TRANSFER	312	0.12	0.33	199	0.10	0.30	113	0.15	0.36
EXECGPA	312	2.89	0.61	198	2.86	0.66	113	2.96	0.50

Source: Authors' calculations.

Note: The table gives the number of observations, the mean and standard deviation of the various variables in the 3 samples.

Table 4 presents descriptive statistics for the variables in the three samples.[6] In all samples the average exam grade was about 77 points. SAT scores are very similar, with verbal in the 490s and maths at around 510. High school or transfer GPAs are also similar, averaging around 3.0. As expected, students in the upper-level classes have more credits, about 75; while the average principles student has only 30

[6] It should be noted that our paper does not include all of the variables that the past research on student performance has suggested over the past three decades (summarised in Table 1), and thus there is still a possibility of an omitted variable bias. We do not include some of the variables in our study for two (often overlapping) reasons: (i) some of the variables were deemed unimportant by the extant literature in accounting for student performance, and (ii) we do not have data for some of the variables. All in all, however, we believe that our study contains most of the important control variables.

credits (and is barely a sophomore[7]) before (s)he takes the Principles class. The attendance frequency for principles classes was about 83%, which reflects the fact that attendance was mandatory. Finally, about 10% to 15% of the students are transfers. Variable EXECGPA represents the EXcluding EConomics GPA, i.e. the student's GPA at the end of the semester in which (s)he enrolled in the respective economics class, excluding the grade (s)he received in the economics class. The value of EXECGPA remains roughly constant among the three samples at about 2.9.

Of particular interest is the average CRT score. Overall, the average student answered about 2/3 of questions out of possible 3. Sample decomposition shows that principles students answer about half a question correctly (0.50), while upper-level students are able to improve their score by almost 100% and answer about 1 question correctly (0.97).

4. Model and methodology

The goal of the analysis is to determine whether student performance in the 3-question CRT score has any power in predicting student exam performance, above and beyond the usual variables used in the literature. The model to be used is:

$$\text{Exam Average} = f(\text{CRT score, control variables})$$

Control variables include SAT scores, high school GPA, whether the student transferred, the gender of the student, and the number of college credits the student has accumulated.

Table 5 presents the simple correlation coefficients among the various variables in our model.

Table 5: Pearson Correlation Coefficients

	Exam Average	CRT Score	Gender	HS GPA	EXECGPA	SAT_M	SAT_V	Credits	EC 330	EC 340
Exam Average	1.0000	0.2519 <0.0001	0.0658 0.3154	0.2508 0.0001	0.4288 <0.0001	0.3130 <0.0001	0.4020 <0.0001	0.1928 0.0030	0.0023 0.9719	0.0434 0.5075
CRT Score		1.0000	–0.1877 0.0039	0.1020 0.1189	0.1423 0.0292	0.4399 <0.0001	0.2992 <0.0001	0.2141 0.0010	0.1115 0.0881	0.1387 0.0336
Gender			1.0000	0.0072 0.9121	0.1270 0.0518	0.2547 <0.0001	0.1154 0.0775	0.0199 0.7607	–0.0039 0.9517	–0.0794 0.2250
HS GPA				1.0000	0.3301 <0.0001	0.1935 0.0029	0.2670 <0.0001	–0.0159 0.8076	0.0262 0.6894	0.0283 0.6664
EXECGPA					1.0000	0.2187 0.0007	0.1862 0.0042	0.0735 0.2617	0.1059 0.1052	–0.0106 0.8719
SAT_M						1.0000	0.5936 <0.0001	0.0353 0.5901	0.0968 0.1388	–0.0557 0.3951
SAT_V							1.0000	0.0258 0.6935	0.0187 0.7747	–0.0623 0.3417
Credits								1.0000	0.6205 <0.0001	0.3013 <0.0001
EC 330									1.0000	–0.1897 0.0035
EC 340										1.0000

Top number: Correlation Coefficient. Bottom Number: *p*-value for H_0: $\beta=0$

[7] In the second year of university.

As expected, the exam average is significantly correlated with (in diminishing order) the EXECGPA (*r*=42.88%), the Verbal SAT (*r*=40.2%), the Maths SAT (*r*=31.3%), the CRT Score (*r*=25.2%), high school GPA (*r*=25.1%), and the number of credits (*r*=19.3%). Gender and upper-level class dummies are not significantly correlated with the Exam average. It is also interesting to note the CRT scores are significantly correlated with both SAT scores, the EXECGPA and the number of credits (i.e. the college experience) of the student. Note that the correlation coefficient between CRT scores and Maths SAT scores, while statistically significant, is less than 50%, suggesting that the two measures do not reflect exactly the same abilities.

5. Results

Tables 6, 7 and 8 present our regression results. Table 4 above shows that, as expected, students in upper-level classes have accumulated more credits than students in the principles classes; hence collinearity is expected between the variable CREDITS and the ECON 330 and ECON 340 dummies. Indeed, Table 5 shows a simple correlation coefficient of about 62% between CREDITS and ECON 330. Similarly, the correlation between the verbal and maths SAT scores is about 59%. In order to avoid collinearity problems, we use regressions with either total SAT scores or maths SAT scores, and either number of credits or dummies for the upper-level classes.

Notice that college GPA is not part of our control variables set, as inclusion of this variable presents considerable problems. First, there is a conceptual problem with the interpretation of its coefficient. If it is positive and significant it leads to the conclusion that "good students do well in economics and below average students do badly in economics." It is highly likely that this statement holds for every other class as well and it does not explain why a student does well. Second, GPA is a composite of individual class grades that are in part determined by a similar set of variables, such as SAT scores, high school GPA, gender etc. Hence, the GPA reflects how these variables affect performance in the average class included. As a result, the effects of the other control variables are obscured because they affect the dependent variable both indirectly, through the GPA, and directly. Putting it in another way, inclusion of the EXECGPA introduces the so-called "dominant variable" effect (Rao and Miller, 1971, pp. 41-43). Rao and Miller argue in favour of excluding the dominant variable to better understand the underlying relationship.[8]

Given our control variables, Table 6 shows that the CRT score has a marginally significant effect in the overall sample (significant at the 90% level in two regressions and insignificant in the other two). It is worth reminding the reader that it is very difficult to capture the effects of critical thinking on the basis of a rough measure like a standardised test, especially such a simple, three-item test as the CRT. Consequently, this type of measured significance that we find may be all that one can expect, and it is therefore meaningful that any statistically significant correlation was obtained.

Inspection of Tables 7 and 8 reveals that the CRT score has no significant effect on student performance in the Principles level classes, but a strong positive effect on the upper-level classes. The effect is also large quantitatively: for each CRT question an upper-level student answers correctly, he or she is expected to obtain, on average, a 2.5 to 3 percentage points higher exam grade overall. In other words, a student who answers all 3 CRT questions correctly is expected to achieve a grade higher by almost one whole letter grade. This effect is so strong that it carries over to the whole sample, although with lower significance and about two-thirds of the size.

The difference between the principles and upper-level cohorts might arise for a number of reasons. Upper-level courses are designed in ways that require problem-solving ability, especially ECON 330,

[8] Inclusion of college GPA measures in ECON performance equations nearly doubles their *R*-square levels, strongly suggesting a dominant variable effect.

while lower-level courses often do not require this ability. Such a distinction could manifest in the differences in the assessment format: exams in upper-level courses are more likely to emphasise and reward problem-solving abilities. (In our case this explanation is less plausible than the others in light of the fact that exam questions in all classes are a mixture of analytical and definitional questions). It is also likely that students who self-select into the economics major and upper-level courses have better problem solving skills (although it must be pointed out that not every student in upper-level economics courses majors in economics). Finally, students' problem-solving abilities may improve as a result of their learning experience during a principles course.

The results reported in Tables 7 and 8 are based on splitting the sample into the lower-level (or principles) sub-sample and the upper-level sub-sample. Since ECON 340 has no prerequisites (just as principles has none), one may wonder to what extent this course is truly "upper-level". Consequently, as a robustness check, we rerun the four regressions reported in Table 8 excluding the ECON 340 students from the upper-level sub-sample. Without the ECON 340 observations in the sub-sample the CRT effect becomes even stronger.[9] Including only ECON 330 responses almost doubles the magnitude of the CRT effect – from about 3 to more than 5 points. *F*-values are now lower but still significant. Excluding the ECON 340 observations reduces the SAT coefficients by one order of magnitude (i.e. about 10 times) and eliminates their statistical significance. Thus, excluding ECON 340 from the upper-level group makes our results even stronger, and therefore the results reported in Table 8 constitute conservative estimates of the CRT effect.

The tables show a number of other interesting results, some in agreement with the literature and some in contrast. In Table 6 we can see that gender, SAT scores, high school or transfer GPA, and number of credits have positive and significant effects on student performance. Comparison with tables 7 and 8 reveals that most of the statistical significance carries over from the Principles sub-sample. With the exception of the SAT scores, the other three variables are not significant in the upper-level sub-sample.

In contrast with the previous research (e.g. Anderson *et al*., 1994; Borg and Stranahan, 2002; Ballard and Johnson, 2004), we obtain that female students are expected to do about 3% better than their male colleagues. This might be due to the fact that presently there are more women in academe than men and, as a consequence, more high-quality female students who are likely to self-select into higher-paying majors such as economics. The effects of gender are significant in the overall sample, but mostly statistically insignificant in the two sub-samples, though their size is of the same order.

SAT scores have strong effects on performance, which is in line with past research (e.g. Ballard and Johnson, 2004). In principles classes, a student entering with a Maths SAT score of 600, is expected to achieve a grade about 6 points higher than a student entering with a Maths SAT of 400 (i.e. the difference of 200 points times the coefficient 0.03). The effect of Maths SATs increases quantitatively in upper-level classes as Table 8 indicates.

The effects of the high school or transfer GPA are strong, statistically and quantitatively, in the principles sub-sample and carry over in the total sample, but are insignificant and smaller in the upper-level sub-sample. This is to be expected, as students with stronger backgrounds are likely to perform better in college, and this starting-point effect should become less pronounced as students advance in their college careers. In the principles sample, each additional HSGPA (high school GPA) point is expected to add about 5 points (i.e. half a letter grade) on the student performance measure. It should be noted that this effect is reduced to 3 points when attendance is taken into consideration.

Unlike the existing literature, we obtain a strong, statistically significant effect of attendance. With the caveats that attendance was required and we have complete data only for the principles classes, and

[9] The results of this robustness check are not reported in the paper to conserve space. We thank one of the referees for suggesting this sensitivity analysis.

hence only the principles sub-sample estimates are reliable, we obtain that complete attendance (i.e. 100% or 1) improves performance by 0.9 points over 90% attendance or 9 points over 0% attendance!

Student college experience, as can be surmised by the number of credits the student had completed before entering the examined courses, also has strong positive effects that are mostly concentrated in the principles sub-sample. This is not surprising, as the marginal impact on student performance of one additional credit-hour earned by a freshman[10] is likely to be higher, on average, than that earned by a junior or a senior[11].

Finally, whether a student has transferred into the university seems to have a negative effect on performance, which is rather large quantitatively but statistically insignificant. The regressions explain 18% to 28% of the performance measure variation (as determined by the Adjusted *R*-squared values) and the *F*-tests of all regressions are highly statistically significant. Regression diagnostics revealed no problems with heteroskedasticity or multicollinearity.

Table 6: Regression results (Overall Sample)

Dependent Variable	**Exam Average**	**Exam Average**	**Exam Average**	**Exam Average**
Constant	34.79***[5.56]	36.84***[5.84]	41.21***[6.45]	33.39***[4.50]
CRT Score	1.05 [1.39]	1.40* [1.83]	1.36* [1.75]	1.31 [1.49]
GENDER	3.04***[2.83]	3.33***[2.83]	3.01** [2.5]	2.50* [1.87]
SAT	0.026***[4.91]	0.026***[4.84]		
SAT_M			0.03***[3.38]	0.03***[2.95]
HS_GPA	3.73** [2.53]	3.52** [2.35]	4.56***[3.05]	4.43***[2.63]
TRANSFER	–2.39 [–1.21]	–2.51 [–1.24]	–3.34* [–1.65]	–3.30 [–1.40]
CREDITS	0.05***[2.74]		0.05***[2.63]	0.06***[2.74]
ECON_330		–0.58 [–.36]		
ECON_340		1.66 [1.04]		
ATTEND				10.36***[2.58]
Obs	236	236	236	197
Adj. R-squared	0.23	0.20	0.19	0.21
F-Value	12.66***	9.69***	10.11***	8.52***

Source: Authors' calculations.
***, **, * signify 1%, 5% and 10% levels, respectively.
Numbers in brackets are *t*-test values.

[10] Student in the first year of university.
[11] Students in third and fourth years of university, respectively.

Table 7: Regression Results (Principles Level Sub-sample)

Dependent Variable	Exam Average	Exam Average	Exam Average
Constant	27.65***[3.81]	35.15***[4.61]	28.91***[3.58]
CRT Score	0.51 [0.58]	0.78 [0.85]	0.54 [0.59]
GENDER	2.37* [1.56]	1.97 [1.40]	2.05 [1.47]
SAT	0.027***[4.58]		
SAT_M		0.032***[2.88]	0.036***[3.22]
HS_GPA	5.56*** [3.22]	6.68*** [3.79]	5.54***[3.04]
TRANSFER	–3.40 [-1.44]	–4.12* [-1.69]	–3.90 [-1.61]
CREDITS	0.11***[3.85]	0.11***[3.92]	0.12***[4.23]
ATTEND			8.92** [2.13]
Obs	161	161	161
Adj. R-squared	0.28	0.22	0.24
F-Value	11.33***	8.64***	8.22***

Source: Authors' calculations.
***, **, * signify 1%, 5% and 10% levels, respectively.
Numbers in brackets are *t*-test values.

Table 8: Regression Results (Upper Level Sub-sample)

Dependent Variable	Exam Average	Exam Average	Exam Average	Exam Average
Constant	46.89***[3.68]	49.92***[4.15]	47.39***[3.85]	49.40***[4.24]
CRT Score	2.91** [1.94]	2.80* [1.85]	2.82* [1.87]	2.60* [1.72]
GENDER	3.31 [1.43]	3.64 [1.68]	3.50 [1.52]	3.84* [1.68]
SAT	0.020 [1.69]	0.022* [1.92]		
SAT_M			0.039* [1.78]	0.046** [2.10]
HS_GPA	0.85 [0.30]	0.99 [0.17]	0.81 [0.29]	0.41 [0.15]
TRANSFER	0.27 [0.07]	–0.26 [–0.07]	0.05 [0.01]	–0.41 [–0.11]
CREDITS	0.05 [0.79]		0.04 [0.69]	
ECON_330		–1.92 [–0.86]		–2.22 [–0.99]
Obs	75	75	75	75
Adj. R-squared	0.18	0.18	0.18	0.19
F-Value	3.71***	3.73***	3.78***	3.88***

Source: Authors' calculations.
***, **, * signify 1%, 5% and 10% levels, respectively.
Numbers in brackets are *t*-test values.

6. Conclusion

This paper proposes to use Frederick's (2005) CRT in accounting for student performance. Our results indicate that the test does indeed have predictive power in the context of student performance, while carrying very low costs of implementation. Frederick (2005) points out that "the CRT is an attractive test: it involves only three items and can be administered in a minute or two, yet its predictive validity equals or exceeds other cognitive tests that involve up to 215 items and take up to 3½ hours to complete (or which involve self-reports that cannot be readily verified)" (p.37).

The results reported in this paper are quite interesting. Higher levels of cognitive reflection help students perform considerably better in upper-level economics classes, though not that much better in the principles courses. It could be that upper-level economics classes require more cognitive reflection than principles classes where a student can do well, sometimes, by using lower-level skills such as memorisation. Alternatively, it may take advanced training in economics for the critical thinking ability to manifest itself. This makes sense especially to the extent that lower-level courses emphasise learning of institutional facts and features of the economy, while upper-level courses emphasise application of economic theory, which arguably is where the correlation with critical thinking occurs. These interesting questions are left for future research; what we hope to have accomplished is to lay a foundation for others to build upon.

Admittedly, most of the literature on student performance in economics classes focuses on principles students. Our study, in its principles sub-sample, verifies most (but not all) of the literature results. SAT scores, high school (or transfer) GPA, attendance, and student college experience have significant positive effects on principles class performance. Unlike most of the literature, which finds that male students achieve up to 5% higher grades in economics as compared to females, we find that females gain 3% more than males in our complete sample. This may reflect changes in student body composition in the last twenty years.

The coefficient on the CRT scores in the regressions for the principles courses is insignificant because, presumably, cognitive skills are not essential to succeeding in those courses. However, those cognitive skills play an increasingly important role as the student advances in his or her college career, and so the CRT scores become significant in the upper-level regressions. This is a novel result relative to the extant literature.

Our review of the extant literature reveals that over the years researchers suggested numerous explanatory variables that may help account for student performance. Needless to say, it is very difficult to uncover new variables that would have a significant effect on student performance after controlling for the "usual suspects". It is therefore quite remarkable that the majority of the regressions reported in this paper produce significant results for the CRT variable at the 90% level or better. Our results seem particularly impressive in the face of our expanded set of control variables and in light of the strong correlations between our dependent variable and the controls.

Two caveats about our results should be mentioned. First, there may be an issue with self-selection in our data. It can be argued that mostly students who do well in principles classes continue on to upper-level classes. Our counterargument is that one of our upper-level classes is a required course for all business students (ECON 340), which means that business students cannot self-select. Also, the regression results show that there is no difference between the ECON 340 and the ECON 330 students (the dummy variable that differentiates them has no statistical significance). We admit that non-business students do not usually enrol in upper-level economics classes and that may still be a source of

self-selection, but we have no way of testing this and we suspect that the effect will probably be very small.

Second, another significant issue is that of causality that was raised against much of the literature by Siegfried and Fels (1979). The issue is this: does cognitive reflection cause course performance, or course performance cause cognitive reflection, or are both performance and cognitive reflection caused by a third variable, such as student effort, which is largely unobserved? While we are aware of this problem, we do not have the data detail needed to deal with it. Hence our results, as almost all other results in this strand of literature, should be interpreted with this caveat in mind.

Future research can build on the analysis presented in this paper in at least two ways. Economics is usually believed to help students master cognitive reflection skills. If this is so, will students exposed to Principles of Economics perform better on the CRT relative to those who didn't have introductory economics? To test this hypothesis one can compare random samples of students who took introductory economics with those who did not. Related to this is the question of whether the students who were successful in acquiring cognitive reflection skills in the principles classes will do well in upper-level economics courses. Students' success at acquiring cognitive reflection skills can be measured by the CRT, and testing the following hypothesis can provide the answer: Students exposed to Principles of Economics who score better in the CRT will perform better in subsequent economics classes.

Taking a somewhat broader perspective, the CRT analysis can help assess if students who are good at cognitive reflection tend to gravitate toward economics and similar "deep-thinking" disciplines. Cross-section variation in CRT scores can be used to explain the students' initial major choice, as well as changes in major during their college career. The CRT may be a predictor of students' success in other social sciences, engineering, humanities, business, etc. If the CRT is found to have such predictive powers, colleges and universities could use the CRT (along with other assessment tools) to help students identify fields of study especially suited to their abilities and interests.

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How Much is Students' College Performance Affected by Quantity of Study?

Hans Bonesrønning and Leiv Opstad

Abstract

Recent educational reforms aim at improving school or college quality by improving students' study incentives. However, surprisingly little is known about the effects of study on grade performance. This paper seeks to fill some of the gap by combining survey and administrative data from one Norwegian business school. A differences-in-differences approach exploiting within-student variation in effort within the same subject across two time periods is used to generate credible evidence. We find that grades are improved when students put in more effort. The estimated effects are of considerable size, although smaller than those reported by Stinebrickner and Stinebrickner (2008).

JEL classification: I20, I21, J24

1. Introduction

Most people would probably agree – from introspection - that study effort is a crucial determinant of academic success. Consistent with this view, economists frequently make such assumptions in theoretical models of education production (see for instance Correa and Gruver (1987); Costrell (1995); Akerlof and Kranton (2002)). Policy makers, on their side, design educational reforms that aim to improve school or college quality by improving students' study incentives. These practices are not strongly supported by the existing empirical evidence. Sigfried and Fels (1979), in an early survey of the literature, conclude that student effort does not seem to be related to performance on standardised tests, but that class attendance does seem to be important for performance on some tests. In a famous contribution, Schuman *et al*. (1985) conclude, in a ten year study where they investigate the relationship between study effort and student performance at the University of Michigan, that there is no positive relation between study time and Grade Point Average (GPA); (see also the follow-up discussions in Hill (1991), Rau and Durand (2000), and Schuman (2001)). Glearson and Walstad (1988), and Krohn and O'Connor (2005) report a negative association between student performance and study time. On the other hand, a number of studies (i.e. Park and Kerr (1990); Romer (1993); Marburger (2006)) report positive correlations between attendance and student performance. Betts (1996) finds a positive effect of homework on high school students' maths performance.

The correlation between student performance and student effort could take any sign in non-experimental data. Most likely there will be a positive correlation if more able students study harder than less able students and a negative correlation if less able individuals systematically compensate for these disadvantages by putting in more effort than more able individuals. These endogeneity problems; which are well recognised by many of the authors cited above, are hard to deal with. In a recent contribution, Stinebrickner and Stinebrickner (2008) exploit random assignments of roommates at Berea College in the United States. Students are portioned into groups that are identical in all respects

except that the students are assigned roommates of a different observable type: some roommates have a videogame, others don't. Stinebrickner and Stinebrickner show that students who are assigned a roommate with a videogame perform poorer than students who are assigned a roommate without such a game, and, by using the roommates' videogame as an identifying variable in an IV approach, they provide evidence that the negative effect on performance is mediated through the students' study efforts. Their IV-estimates are almost 10 times the OLS-estimates, indicating that the returns to study effort are very large (one standard deviation in effort transforms to 0.9 standard deviations in performance) and that the endogeneity problems are quite severe.

In the present paper, we seek to generate credible estimates of effort effects by exploiting within-student variation in effort allocations within one subject for two subsequent periods. This fixed-student, fixed-course approach addresses the most nearby endogeneity problems by differentiating away important time-invariant unobservable factors such as student ability.

However, there are other and less obvious endogenity problems related to "dynamic selection effects" to worry about. Examples are that students may respond (non-randomly) to difficult classes or bad grade shocks by increasing their efforts. Stinebrickner and Stinebrickner (2008) provide evidence that such effects explain much of the gap between the OLS- and IV-estimates in their study. They warn that fixed effect approaches might magnify the endogenity problems that are related to dynamic selection.

In our study, the students sort non-randomly into the groups of students that increase or respectively decrease their effort from the first to the second period. We could think of at least two reasons why students make such adjustments. One is that they respond to the information content in the result from the mid-semester test, another that they differ with respect to their time discount rates. To clarify where the dynamic selection effects might originate, we focus here on the latter case (in the empirical analyses we consider both cases). Myopic students most likely provide more effort in the second than in the first period. If the returns to second period effort increase in the level of first period efforts, myopic students will experience small returns to the second period efforts. In comparison, students working hard right from the beginning of the semester might experience much larger returns to their efforts in the second period. An instrumental variable approach might provide a solution to this problem, but has the unattractive feature of providing an average effort effect. An IV- approach then conceals that the returns to own effort differ across student subgroups in potentially important ways. Our strategy is therefore to break the sample into student subgroups that are reasonably homogenous with respect to their time discount rates.

We find a significant and positive relationship between study efforts and test scores. Our results indicate that one standard deviation in effort translates into 0.25 standard deviations in performance on average. The effects are larger than this for students who put in a lot of effort in the first period, and smaller than this (and insignificant) for students who put in relatively more effort in the second period. These results thus differ from the much cited Shuman *et al*. study (1985) by finding positive effects of study effort on performance, and from Stinebrickner and Stinebrickner (2008) by finding smaller effects than they do.

The remainder of this paper proceeds as follows. First, we present our data and then offer a few theoretical considerations. The econometric approach is then laid out before the results are presented and conclusions are drawn.

2. The data and some institutional details

The data for this study comes from Trondheim Business School, which is located in the middle of Norway. We highlight one institutional detail that might be important in the given context. The students are graded according to their performance at a final exam. There are no midterm exams, and the performance in class does not count. The results reported in this study are conditional upon the study incentives provided by this system.

The data cover the cohorts of students starting in the falls of 2005, 2006 and 2007. The survey data are collected for the purpose of investigating the students' study habits. For this project, these data are mixed with administrative data for the students' prior achievements in the upper secondary school.

Among the four courses the students take in the fall semester, Macroeconomics is the only course with a mandatory mid-semester test (the test was introduced for the students starting in 2006). The students participating in the Macroeconomics course are asked about their efforts twice; the first time in connection with the mid-semester test and the second time at the end of November, just before the exam. In the last of these surveys, the students were also asked for detailed information about the time allocations to all the four different courses they took that fall, as well as the total time allocated to studying. Approximately 60% of all entering students have participated in the surveys. The sample contains a little more than 150 students in Macroeconomics – for which we have complete lists of data. The grade point averages (GPA) from upper secondary school do not differ much across students who participated in the survey and students who did not participate: the average GPA for all students is 53.76, while participating students have an average GPA of 53.70. A reasonable hypothesis is that students who participated in the surveys differ from non-participating students with respect to study effort. We return to this issue in the result section.

Effort is about both the quantity and efficiency of time. There is no consensus on the relevant dimensions of time efficiency (which, for instance might be determined by the use of adequate learning strategies, access to academic input, and so on). No attempts are made to capture such features. The students are asked the following questions: "How many Macroeconomics lectures per week have you attended?" and "How many hours per week have you spent on out-of-classroom work in Macroeconomics?" The same types of questions are asked for the three other subjects. We use the average attendance rates in lectures (ATTENDANCE) and the hours per week the student spend working on their own (STUDY) to measure the variables of interest. It is well-documented that reporting error from retrospective questions might be substantial. We discuss remedies to deal with such problems in the next section.

Table 1: Descriptive Statistics for the Within-Course Analysis

	Mean	Std. Deviation	N
Gender	0.46	0.50	153
GPA	53.78	3.54	153
Test October – correct answers	16.17	4.94	153
Exam December – correct answers	20.58	4.65	153
STUDY (per week) after mid-semester	3.54	2.45	153
STUDY (per week) before mid-semester	3.19	1.89	153
ATTENDANCE (percentage) after mid-semester	88.21	11.92	153
ATTENDANCE (percentage) before mid-semester	88.32	12.81	153
ΔATTENDANCE	–0.11	9.20	153
ΔPERFORMANCE	4.41	5.63	153
Expected performance – actual performance/mid-semester	–2.32	4.64	153

According to Table 1 attendance rates are 88 percent in Macroeconomics classes, with only minor differences between the pre- and post-mid-semester periods. The students spend on average 3.2 hours per week on STUDY before the mid-semester test and 3.5 hours after the mid-semester test.

The administrative data provide information about the students' multiple test scores for Macroeconomics (both at the mid-semester test and the exam), their course grades at the Business School, their Grade Point Average from upper secondary school, and their gender. Both the mid-semester test and the exam are multiple choice tests with 32 questions. The questions are not identical, but related to the curriculum covered at the time of the test. The average student performance in the mid-semester test and the exam are 16.2 points and 20.6 point respectively. The Business School admits high performing students from upper secondary school. Thus, the average student has a performance level of 53.2 points (the sum of the grades (scale 6-0) for 10 subjects), which says that the average performance level is somewhat better than "B", while the average student in upper secondary school achieves between "C" and "D". Thus, the Business School students have higher abilities and most likely, have put in more substantial effort in their prior schooling career than the average upper secondary student. There is a slight majority of girls (52 percent).

Table 2 provides descriptive statistics for two of the other courses that the students take in the same semester. We use these data in the introduction of the results section, and in the appendix to the paper.

Table 2: Descriptive Statistics for the Across-Course Analysis

	N	Minimum	Maximum	Mean	Std. Deviation
Male	377	0	1	0.47	0.50
GPA	375	43.50	69.60	53.07	4.14
Grade Macroeconomics	416	0	5	3.12	1.15
Grade Investment Analysis	395	0	5	2.42	3.08
Grade Accounting Information Systems	255	0	5	2.95	1.25
STUDY Macroeconomics	299	0.00	12.50	3.27	2.19
STUDY Investment Analysis	290	0.00	20.00	4.96	3.52
STUDY Accounting Information Systems	150	0.00	10.00	1.55	1.71
ATTENDANCE Macro	302	20.00	100.00	87.74	12.34
ATTENDANCE Finance	291	6.67	100.00	79.59	16.13
ATTENDANCE Accounting Information Systems	150	0.00	100.00	55.89	31.37
ΔSTUDY (Macro – Finance)	288	–18.00	4.00	–1.70	3.11
ΔSTUDY (Macro-Accounting Information Systems)	148	–9.00	9.00	1.92	2.21
ΔATTENDANCE (Macro-Finance)	291	–46.67	86.19	8.18	15.99
ΔATTENDANCE (Macro-Accounting Information Systems)	150	–13.33	88.89	32.54	27.25
ΔGRADES (Macro- Finance)	388	–5.00	4.00	0.63	2.88
ΔGRADES (Macro – Accounting Information Systems)	252	–3.00	4.00	0.34	1.28

3. The allocation of student effort: a few theoretical considerations

Our main purpose is to quantify the effects of study effort on student performance. Most likely, these effects differ across students and across subjects. To fix ideas we shortly consider the individual student's effort decision problem. This is discussed in length by several authors, such as Fredrick and Walberg (1980), Becker (1982), Correa and Gruver (1987) and Krohn and O'Connor (2005). Here we make use of a very parsimonious model where the individual student is portrayed as a rational person that cares about the grades in all subjects, as well as leisure time. The grade in a given subject is assumed to be an increasing function of student ability and the effort allocated to that subject (the achievement production function), conditional upon teacher and peer quality. In the simplest set-up, the individual student determines the effort allocation across subjects and leisure time by maximising his/her utility function subject to the achievement production functions for all subjects and a time constraint. This implies that the optimal efforts and the optimal grades will be functions of student ability, teacher and peer quality, and the characteristics of the achievement and utility functions.

It follows that the observed effort, as well as the observed returns to studying effort will vary across students. Without adding more structure to the model, it is hard to make more precise predictions. For instance, we cannot say whether high ability students will put in more or less effort than low ability students. If effort and ability are complementary inputs; high ability students will experience higher returns to additional effort than low ability students for the same level of effort. Preferences also matter: students with strong performance preferences might put in a great deal of effort and experience decreasing returns to additional effort (these students might have to put in much more additional effort to increase their performance from grade B to grade A).

The model presented above is appropriate for discussing individual student's effort allocations across subjects in a given period of time. To portray the individual student's allocation of effort within a subject across the semester, we introduce the student's subjective time discount rate. A myopic student might be unwilling to allocate much time to study at the beginning of the semester (the first period), but might be willing to increase her/his effort nearer to the exam (the second period). All students, independent of their time discount rates, might experience that the returns to their own effort are larger in the first period compared to the second period if the course material is more difficult towards the end of the course. In addition, myopic students might experience smaller returns in the second period due to the time profile of their effort allocations. This happens if the returns to the effort put in during the second period depend on the level of effort put in during the first period. Formally, this feature might be captured by introducing the effort for two periods - together with an interaction term between the effort levels in the two periods - as arguments in the achievement production function. One potentially important implication for the empirical analysis should be noted. Using within-student difference in effort across two subsequent periods to identify the effects of study effort on performance means that estimates will depend on the fraction of myopic students to all students.

This theoretical discussion has left out several important issues. A couple of examples should be mentioned. First, students might reallocate effort from studying to leisure if they realise increasing returns to their own leisure time (the situation exploited by Stinebrickner and Stinebrickner (2008)). Second, peers and teachers might influence the effort allocations. For instance, good peers might induce students to increase their efforts during a semester, or a good teacher might have positive effects on the returns to student effort.

4. The econometric approach

Identification

We start out from a simple value added education production function (EPF) for each of the courses:

$$A_{i,j} = \alpha_{0,j} + \alpha_{1,j}E_{i,j} + \alpha_{2,j}X_{i,j} + \alpha_{3,j}S_j + \varepsilon_{i,j} \quad (1)$$

where $A_{i,j}$ denotes achievement for student *i* in course or period *j*, $E_{i,j}$ denotes student effort in course or period *j*, $X_{i,j}$ is a vector of individual and family background characteristics including the student's GPA, and *Sj* denotes a vector of college inputs. ε is the residual.

This is a reduced form education production function augmented with student effort. Sometimes the chosen formulation is referred to as an attainment model because the lagged dependent variable is included among the independent variables. The merits of this approach are much discussed (see for instance, Allison (1990), Hanushek (1986) and Todd and Wolpin (2003)). Here, this specification is chosen because it is a convenient starting point for clarifying the assumptions that are necessary for the differences-in-differences approach. As stated above, student effort is determined by student preferences and other student characteristics that are unobservable to the researcher, implying that the estimated effects of effort on student achievement are biased. The estimates will be biased downwards if effort is negatively related to student ability, and only imperfect measures of student ability are included among the covariates. There will be an upward bias if high ability students reinforce their genetic advantages by putting in more effort than less able students.

Taking the difference in achievement across two subjects – or across two periods for the same subject - we arrive at:

$$A_{i,j} - A_{i,k} = \gamma_{0,jk} + (\alpha_{1,j}E_{i,j} - \alpha_{1,k}E_{i,k}) + (\alpha_{2,j} - \alpha_{2,k})X_{i,j} + (\alpha_{3,j}S_j - \alpha_{3,k}S_k) + \vartheta_{i,j} \quad (2)$$

where υ is a residual involving the difference between error terms. Assuming that the returns to students and background characteristics are equal across the two subjects/periods, the observable background characteristics cancel out ($\alpha_{2,i} = \alpha_{2,k}$), and moreover, the residual contains no elements that causes it to be correlated with individual student's effort. This is one of the assumptions that are required for this specification to generate credible effort estimates.

An additional reason why equation (2) might generate biased effort estimates is that adequate measures of teacher quality are not available. The relationships between teacher quality and student effort are complicated. The characteristics of the education production function and the students' utility functions are important. For instance, teacher quality might be complementary to student effort, implying that the returns to student effort increase when teacher quality increases. But not all students might respond to higher teacher quality by putting in more effort; generally the response depends on the characteristics of their utility functions. Equation (2) cannot fully address this problem. Thus, there is a potential omitted variable problem. However, in the fixed-student, fixed-course approach the teacher characteristics (which are the same in both periods) are - under reasonable assumptions - differentiated away. It remains though that our results are conditional upon the teacher quality at the Trondheim Business School, and cannot be broadly generalised.

Thereafter we impose the important DD-assumption that the returns to the effort put in, in both subjects/periods, are equal: $\alpha_{1,i} = \alpha_{1,k} = \gamma_1$. The differences-in-differences (DD) equation to be estimated is then:

$$A_{i,j} - A_{i,k} = \gamma_0 + \gamma_1 \Delta E_{i,jk} + \vartheta_{i,jk} \quad (3)$$

Equation (3) is our favored specification for the fixed-student, fixed-course approach. In this case the variation in $\Delta E_{i,jk}$ comes from students who put in different amounts of effort in subsequent periods within one course.

One concern with this strategy is that the Macroeconomics course might be more difficult in the second period, implying that the assumption that the returns to the effort put in during the two periods are equal is not fulfilled. To evaluate the restrictiveness of this assumption we estimate:

$$A_{i,j} - A_{i,k} = \gamma_0 + \alpha_{i,k}(E_{i,j} - E_{i,k}) + (\alpha_{1,i} - \alpha_{1,k})E_{i,j} + \mu_{i,jk} \quad (4)$$

Equation (4) is a reformulation of equation (2) with $\alpha_{2,i} = \alpha_{2,k}$, $\alpha_{3,i} = \alpha_{3,k}$, and $\alpha_{1,i} \neq \alpha_{1,k}$.

Another remaining concern is whether the within-student, within-course, between-periods variation in effort is reasonably exogenous to student performance, that is, the concern is whether the explanatory variable in equation (3) is uncorrelated with the residual. We provide several pieces of empirical evidence to shed light on this issue. First, we investigate whether the change in effort is related to the available observable student characteristics. Second, we seek to evaluate whether the estimates are conditional on the students' subjective time discount rates. There are several potential approaches. Inspired by Schmidt (1983) and Borg, Mason and Shapiro (1989) who emphasise that average effects of study effort might be misleading, we seek to evaluate the importance of the unobserved time discount rates by providing separate effort estimates for subgroups of myopic and non-myopic students. Regrettably, these subgroups cannot be identified with great precision, but we try to approximate the two subgroups in two exploratory exercises. First, we separate the students according to their choice of an additional elective course in the fall semester. At the start of the semester some students choose a "difficult" course, others choose an "easy" course, thus revealing some of their effort preferences. Second, we separate students according to their study time allocations across the two period of the semester, one subgroup consisting of students who increase their efforts in the second relatively to the first period, and one subgroup that decrease their efforts in the second period.

Measurement error

The variable of interest – the students' effort - is likely reported with error; implying that the estimates of effort on college grades have a downward bias. The most adequate way to reduce measurement errors of this type would be to collect time-use information at more than one point in the study (see Stinebrickner and Stinebrickner (2003, 2004)). No such additional information has been available. Note however that if students systematically underreport their efforts (across courses or across periods of time), the DD-approach effectively does away with this bias. Some additional steps are nonetheless taken to minimise the measurement problems. The most important is that we examine the robustness of our results by excluding outliers.

5. Results

OLS estimates for all courses

The value added education production function, as portrayed in equation (1), is estimated by OLS. This exercise has two purposes. One is to provide a point of reference for the DD-estimations. The other is to provide some indications as to whether the returns to study effort vary across different subjects. Equation (1) is therefore estimated for the two courses Investment Analysis and Accounting Information Systems in addition to Macroeconomics, and in all cases we use college grades as our outcome variable (because no other information is available for the two former courses). All courses at the Business School are graded on the same A-F scale, where A is the best grade and F is failure. In this paper the grades are converted to a 5-0 scale, where 5 is equivalent to A, and 0 is equivalent to F. The results reported in Table 3 show that there is a significant association between attendance and

performance in a majority of the courses. STUDY is positively associated with performance in all courses, but the estimates and their precision vary much across the subjects. One standard deviation in STUDY transforms into 0.13, 0.09 and 0.01 standard deviations in the grades in Accounting Information Systems, Macroeconomics, and Investment Analysis respectively. In none of the cases are the STUDY estimates significantly different from zero.

Serious objections, for instance related to the use of grades that reflect the teachers' grading practices, can be raised against these analyses. Since the main body of the analyses in this paper uses student scores on multiple tests as outcome variables, we do not address these concerns. This exercise is included mainly to draw attention to the fact that the effort estimates are conditional on the subjects investigated. This should be kept in mind when we now turn to Macroeconomics for the DD-analyses.

Table 3: OLS estimation results for the value added education production function

	Macroeconomics	Investment Analysis	Accounting Information Systems
Male	0.212	0.256	–0.050
	(0.131)	(0.189)	(0.194)
GPA	0.066	0.076	0.057
	(0.016)	(0.022)	(0.026)
Attendance	0.023	0.015	0.010
	(0.006)	(0.006)	(0.003)
STUDY	0.048	0.008	0.101
	(0.032)	(0.017)	(0.056)
R^2_{adj}	0.131	0.058	0.110
N	264	258	138

Note: Standard errors in parentheses

Exploiting within-student, within-course, between-periods variation

Table 4 reports the results from the DD-analysis for the Macroeconomics course. These are our main results. As already noted we use the difference in the number of correct answers in the two multiple choice tests as our outcome variable. This measure is superior to a grade-based measure that typically suppresses much information and is subject to much more subjective judgments. It is evident that an increase in study effort leads to better test performance. The effect; which is significant at the 1 percent level, is of considerable size: using the results from the most parsimonious specification, we find that one standard deviation (2.45 hours) increase in study effort per week increases test performance with 0.26 standard deviations in the December test. This estimate, which is almost three times the OLS-estimate reported above, is not much affected when controls for different cohorts and for student background characteristics are added – indicating that there is no serious sorting on observables into effort changes.

Our OLS estimates reported in Table 3 are of approximately the same size as those reported by Stinebrickner and Stinebrickner (2008). As in their study, the estimates increase substantially when we address the endogeneity problems. However, while their IV-estimates are nearly 10 times their OLS-estimates, our DD-results are a little more than 3 times the OLS-estimates. There are several potential

explanations for this difference. One is that we have been unable to do away with all the endogeneity problems. Below we perform some exercises that might potentially shed light on this issue. We start by examining the likelihood that the assumptions underlying the DD-approach are fulfilled.

Table 4: Differences-in-differences estimation using Macroeconomics after and before the mid-semester test

	All students	All students	All students	All students	Students in [20%, 80%]
ΔATTENDANCE	0.081	0.080	0.083	0.080	0.117
	(0.045)	(0.045)	(0.047)	(0.049)	(0.057)
ΔSTUDY	0.490	0.479	0.447	0.588	0.491
	(0.184)	(0.187)	(0.194)	(0.251)	(0.288)
2008-cohort		–0.283	–0.165	0.018	0.247
		(0.809)	(0.842)	(0.871)	(1.090)
Gender			0.062	0.006	1.438
			(0.829)	(0.834)	(1.075)
GPA			0.116	0.115	–0.095
			(0.112)	(0.112)	(0.369)
STUDY				–0.194	–0.132
				(0.224)	(0.255)
ATTENDANCE				–0.001	0.043
				(0.038)	(0.046)
Constant	4.113	4.262	–2.188	–1.464	4.726
	(0.402)	(0.587)	(6.003)	(6.898)	(19.613)
R^2_{adj}	0.048	0.043	0.032	0.025	0.032
N	183	183	176	176	104

The specifications reported in the three first columns of Table 4 apply the assumption that the returns to own study effort are equal across the two periods of time, that is, before and after the mid-semester test. This seems like a reasonable assumption, but it might nevertheless be argued that the Macroeconomics course is tougher towards the end of the course compared to the beginning – or that students who have put in little effort in the first period do not stand on firm ground; which potentially implies that the returns to their own effort are smaller in the second period. To evaluate this claim, we have included the level of study in the first period among the explanatory variables (i.e. we have estimated equation (4)). There is some weak evidence that the returns to study effort are larger in the first period (0.588) compared to the second period returns (0.588-0.194 = 0.354), but the estimated coefficient for the *level* variable STUDY of -0.194 is of poor precision and not significantly different from zero. Thus, the hypothesis that the returns are similar for the two periods is not formally rejected.

Another crucial identifying assumption is that the changes in effort between periods are not due to student characteristics that are correlated with student performance. As mentioned above, several steps are taken to evaluate the restrictiveness of this assumption. First, note that neither gender nor the GPA from upper secondary school is significantly associated with the change in test performance (see Table 4, column (3)). Although the estimated ΔSTUDY-coefficient decreases by nine percent when these controls are included, the estimate is still significant at the 1 percent level. Thus, there are no strong indirect indications that the changes in effort from the first to the second period are associated with observable student characteristics.

More direct evidence is provided from an equation with ΔSTUDY as the dependent variable and student characteristics as independent variables. As can be seen from Table 5, neither gender nor GPA is significantly associated with the change in study effort, which is as expected from the results reported above.

Table 5: The Determinants of the change in study efforts across two periods for Macroeconomics

	All students
Gender	0.005
	(0.335)
GPA	0.013
	(0.047)
Expected performance-Actual performance	0.052
	(0.036)
Constant	–0.262
	(2.562)
R^2_{adj}	0.00
N	152

Nonetheless, it remains that some students for various reasons change their level of effort across the periods. One hypothesis is that this variation reflects students' responses to the information content in the mid-semester test result (see Krohn and O'Connor (2005)). More specifically, students who perform poorer than expected in the mid-semester test might decide to increase their effort in the subsequent period. Since the students in the first questionnaire are asked about their expected performance in the mid-semester test, we use this answer to generate an additional explanatory variable, which is the difference between expected and actual performance in the mid-semester exam. This new explanatory variable is positively correlated with ΔSTUDY, implying that students who perform poorer than expected at the first test increase their efforts in the next period. This finding is consistent with the findings reported by Krohn and O'Connor (2005). The estimated coefficient is rather small and not significantly different from zero, probably reflecting that the reported expectation is a noisy variable. It is not clear what we econometrically should make of this finding.

A different hypothesis is that the most ambitious/less myopic students work hard right from the beginning of the semester, and thus, do not change their effort much from the first to the second period, while the less ambitious students increase their effort nearer to the exam. The estimated

average effect conceals that the effort returns differ across these student subgroups in potentially important ways. To deal with this worry, we first break the sample into two; one subsample consisting of students who increase their effort in the second period, and one subsample consisting of students who decrease their effort in the second period. The estimated effort coefficient for students who decrease their effort in the second period is significant at the 1 percent level and equal to 0.776. The effort estimate for the other subsample is 0.350 and statistically insignificant.

The exercise above can be criticised for separating the students according to an endogenous variable. A more attractive approach is to use the revealed effort preferences that originate from the students' choices of elective courses. At the start of the fall semester, the students choose between Accounting Information Systems and Organizational Psychology, of which the former has the reputation of being the more challenging course. Consistent with this, the students also report much higher efforts for the former. When estimating the returns to study effort in Macroeconomics separately for the subgroups of students that are enrolled in the Accounting Information Systems and the Organizational Psychology courses we find estimates of 0.538 (0.200) and 0.276 (0.510) respectively. The findings from these two exercises (which neither is reported in the tables) are consistent with the hypotheses that students who work relatively hard from the beginning of the semester or are characterised by strong work ethics experience higher returns to their effort than students who put in less effort right from the beginning of the semester. Schmidt (1983) finds that studying for the final examination may have a negative marginal product for weak students. This finding is more extreme than those reported above, but has the same flavour to it.

Finally, there is a sample selection issue to be analysed. A little less than 40 percent of the students did not provide data, either because they were unwilling to do so or because they were absent from class on the day in November when the last round of survey data were collected. Neither of these two events is likely random. For instance, we might conjecture that at least some of the absent students provide less effort than the average student; (see Becker and Powers (2001)). To evaluate this hypothesis we have exploited that the first survey was "almost mandatory": it was provided together with the mandatory mid-semester test, implying that almost all students have reported the effort they put in during the first part of the semester. Table 6 reports summary statistics separately for students who participated and students who did not participate in the second survey. While the two subgroups of students have approximately the same average GPA, the participating students perform better than the non-participating students in the mid-semester test, and consistent with this, they put in more effort prior to the test. Since non-participating students put in relatively little effort prior to the mid-semester test, it seems likely that their returns to additional effort in the second period are below the average for the participating group of students, implying that our average STUDY-estimate is somewhat biased upwards.

Table 6: Participants and non-participants in the second survey

	All	Participants	Non-participants
GPA	53.76	53.70	53.88
Study	3.12	3.28	2.86
Test result	15.17	16.06	13.85
Expected test result	13.42	13.97	12.49
Number of students	307	195	112

Finally, more insights into the importance of student effort can potentially be gained by exploiting the variations in effort allocations across different subjects/courses. We have performed these exercises, but, it turns out that this approach does not fulfill the identifying assumptions to any reasonable degree. Since it might be useful to see where the problems originate, we present the results from one of these exercises in the Appendix.

Comparison with the Stinebrickner and Stinebrickner study

Our most credible estimates - one standard deviation in study effort transforms into 0.25 standard deviations in performance in Macroeconomics - is a little less than ⅓ of the Stinebrickner and Stinebrickner's (2008) effect of STUDY on GPA. Indirectly we have pointed to a number of potential explanations for this difference. First, some of our evidence indicates that the effort returns differ across subjects. The Stinebrickner and Stinebrickner study might have included subjects with higher returns to study effort than the Macroeconomics course investigated here. Second, student quality might differ between the universities/colleges under study: when we break our sample according to the GPA from upper secondary school, it is evident that the returns to studying effort are higher for students in the middle of the GPA distribution than for students located in the tails. Appendix Table 1 provides evidence from exploiting between-course variation in effort, that students between the 2nd and 5th deciles of the GPA distribution experience marginal returns to STUDY of the same size as that reported by Stinebrickner and Stinebrickner (2008). Third, our results indicate that it matters how the effort is allocated across the semester. Students putting in relatively more effort from the beginning of the semester seem to experience higher returns than students who put in relatively little effort from the beginning of the semester. A larger fraction of the students in the Stinebrickner and Stinebrickner study might have put in more effort early in the semester. This is not an unlikely conjecture. As noted in section 2, the grading in Trondheim Business School is entirely based on performance in the final exam, indicating that the incentives for putting in study effort right from the start of the semester are weaker than at Berea. Finally, the DD-approach might not have done away with all the unobserved student characteristics that bias the estimates downwards. More research, using IV- and DD- approaches, is required to pin down the exact size of the study effort effects.

6. Conclusion

In many countries, policy makers are looking for reforms that will improve academic performance of (higher) education institutions. Incentive-based reforms with the aim of increasing students' effort are among the most popular proposals. Unfortunately, we do not know much about how such reforms will work. One part of these discussions is about the kind of incentives that are likely to be the most effective. At a more fundamental level, no incentive-oriented policies in higher education are likely to succeed if college outcomes are driven by background factors that are determined before students arrive at college. The existing empirical evidence provides no consistent evidence.

In this paper we seek to fill some of the gap. Using data for two subsequent cohorts of students in a Norwegian business school we show that student effort is an important determinant of test scores/college grades. The average returns to the study effects seem to be quite large in the second year Macroeconomics course. One standard deviation in study time per week transforms into approximately 0.25 standard deviations in performance. These results might indicate that incentives directed towards students' study effort will improve their performance.

Can we believe the results? The present study solves the most obvious endogeneity problems - related to unobservable student characteristics - by utilising within-student variations in effort allocations within the same subject for different time periods. There is a remaining problem related to

unobservable characteristics of the students, notably their subjective time discount rates. Some exploratory analyses indicate that myopic students experience less returns to their efforts than students with lower time discount rates. The estimated average effect of study effort thus is conditional on the share of myopic students in the investigated sample. More research is needed to settle this issue.

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Appendix 1: Exploiting within-student, across-subjects variation

Table A1: Heterogeneous effects across the GPA distribution. Across-subject variation using Macroeconomics and Accounting Information Systems

	[20%, 80%]	[20%, 50%]	[50%, 80%]
ΔATTENDANCE	0.002	–0.008	0.004
	(0.005)	(0.009)	(0.006)
ΔSTUDY	0.188	0.338	0.028
	(0.085)	(0.131)	(0.132)
ATTENDANCE	–0.016	–0.013	–0.020
	(0.011)	(0.017)	(0.016)
STUDY	–0.068	–0.166	0.019
	(0.085)	(0.164)	(0.104)
R^2_{adj}	0.042	0.009	0.000
N	83	47	36

Note: Cohort dummies included as control variables are not reported in the table. Standard errors in parentheses.

More insight into the importance of student effort can potentially be gained by exploiting the variations in effort allocations across different subjects/courses. Here we shortly present the results from such an exercise. We can choose from a menu of three courses; Macroeconomics, Investment Analysis and Accounting Information Systems. Table 2 provides the essential descriptive statistics for the two "new" courses. Attendance is 80 percent in Investment Analysis classes, and 56 percent in Accounting Information Systems classes. The variation in attendance is substantial across the subjects. Also the between-student variation in attendance within each of the courses is of some considerable size, as indicated by the standard deviations of 12-30 percent. STUDY varies from slightly more than 5 hours per week in Investment Analysis, to 3.2 hours in Macroeconomics, and about 1.5 hours in Accounting Information Systems. (The differences in STUDY across the courses partially reflect that the courses are of different size: Investment Analysis gives 10 credits, Macroeconomics gives 7.5 credits, and Accounting Information Systems 5 credits.)

No multiple choice test results are available for the DD-analyses that exploit between-course effort variation. In this case we therefore make use of the students' grades. The average performance in the three courses varies from 3.12 in Macroeconomics, to 2.42 in Investment Analysis, with Accounting Information Systems in a middle position with an average of 2.95.

Within the available range of courses, Macroeconomics and Accounting Information Systems stand out as the most similar courses: they have approximately the same average returns to GPA (see Table 2), and the marginal returns to GPA do not differ much (see Table 3). The DD-approach also imposes the requirement that the returns to own effort are equal across the two subjects. To provide some indications whether this requirement is likely to be fulfilled, we have estimated "effort equations" for the three courses under consideration; that is, the effort put into the course is regressed against GPA and gender. The results from these exercises are reported in Table A2.

Table A2: OLS estimations of efforts against student background characteristics for all courses

	Macroeconomics		Investment Analysis		Accounting Information Systems	
	Attendance	STUDY	Attendance	STUDY	Attendance	STUDY
Male	–0.904	–0.099	2.28	–0.019	–8.68	0.088
	(1.51)	(0.267)	(1.95)	(0.435)	(5.26)	(0.290)
GPA	0.04	0.042	–0.03	–0.014	–0.71	0.062
	(0.18)	(0.031)	(0.23)	(0.054)	(0.71)	(0.039)
R^2_{adj}	0.00	0.01	0.01	0.03	0.01	0.01
N	266	266	264	264	142	142

Note: Standard errors in parentheses

There appear to be no statistically significant effects of GPA on study effort; which is similar to the findings reported by Stinebrickner and Stinebrickner (2008). However, for Macroeconomics and Accounting Information Systems the positive signs of the GPA estimates in the STUDY equation indicate reinforcing responses. Note also that attendance is not systematically related to the background characteristics for any of the courses.

The left hand side of Table A3 reports the results from estimating equation (3) with Macroeconomics and Accounting Information Systems as the two subjects. By controlling for cohorts (column (2)), the ΔSTUDY estimate is 0.068, and not significant at conventional levels. One standard deviation in the ΔSTUDY variable transforms into 0.1 standard deviations in ΔGRADE. This effect is between ½ and ⅓ of the effect estimated from within-course variation in effort.

Table A3: Differences-in-differences estimation using Macroeconomics and Accounting Information Systems

	All students	All students	All students	All students	Students in [20%, 80%]
ΔATTENDANCE	0.005	0.005	0.005	0.004	0.003
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)
ΔSTUDY	0.078	0.067	0.126	0.126	0.159
	(0.045)	(0.045)	(0.064)	(0.066)	(0.080)
2008 cohort		0.142	0.439	0.325	–0.251
		(0.346)	(0.343)	(0.392)	(0.496)
2007 cohort		0.431	0.122	0.059	0.036
		(0.342)	(0.349)	(0.384)	(0.516)
ATTENDANCE macro			–0.002	–0.003	–0.014
			(0.008)	(0.008)	(0.011)
STUDY macro			–0.077	–0.084	–0.036
			(0.063)	(0.065)	(0.081)
Gender				0.205	–0.144
				(0.212)	(0.260)
GPA				–0.001	–0.046
				(0.031)	(0.072)
R^2_{adj}	0.021	0.026	0.024	0.008	0.024
N	143	143	143	143	83

Note: Standard errors in parentheses

The results from estimating the less restrictive equation (4) are reported in column (3). The ΔSTUDY estimate is then 0.126 with *p*-value 0.05. For the current specification, this is the estimate for the effort returns in Accounting Information Systems. The sign of the STUDY coefficient is negative, indicating that the returns to STUDY might be smaller in Macroeconomics than in Accounting Information Systems (0.126 – 0.084 = 0. 042). Notice however that the coefficient for STUDY is not significantly different from zero.

The effects of studying time do not differ much between column (3) and the OLS estimations reported earlier. The column (3) estimate of 0.126 is approximately equal to the OLS estimate for Accounting, and taking the insignificant estimate for the level variable STUDY in Macroeconomics into account, the estimated STUDY effect for this course is close to the OLS estimate of 0.048. In one interpretation, the DD estimations reported in columns (1) and (2) thus provide an imprecise average of the returns to effort for the two subjects. The estimated average effort effect on performance is much smaller than the within-course estimate for Macroeconomics, indicating that this approach is unable to do away with unobserved student characteristics that bias the estimated coefficient downwards.

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Teaching Profit Seeking as the Source of Growth

David Kauper

Abstract

This paper offers an alternative to the typical presentation of economic growth theory in standard introductory textbooks. The standard textbook presents neoclassical production functions with diminishing marginal returns and predictions of convergence. For many students, the incentives to learn this are weak since the theory is abstract and its initial predictions inaccurate. A few changes to the presentation can create clarity and believability. One change is to present both creative destruction and rent seeking as possible paths of the profit motive. In this case, not only can students find greater consistency with their own observations, whereby profits can be well-earned or ill-gotten, but students can find consistency with the cross-country data and the simultaneous existence of converging and diverging countries. Students will be more motivated to understand neoclassical production functions with diminishing returns, since they are relevant for all countries of the world, not just an abstract few.

JEL classification : A22

1. Introduction

Much of the emphasis of improving classroom effectiveness has been on style and technique—how to motivate students; how to identify and accommodate individual learning styles; how to move beyond the "chalk and talk" using discussions, simulations, technology, and peer and experiential learning (for example, see McKeachie *et al*., 2006 and Lowman, 1995). Less emphasis has been put on content.

Colander (2004) argues "that content, not form is what is central to economics teaching." He concedes that students need to be motivated, but that good content will convince students of the subject's importance even when that content is poorly delivered (ibid, p. 63). Economic knowledge has been constructed over centuries and is continually growing. Faculty should distil this information for students so that they can make practical use of it, even when it necessitates learning terminology and memorising models. He summarises: "To be a good teacher one must have something to teach…" (ibid, p. 73).

My goal in this paper is to improve the distillation of the content in Introductory Macroeconomics by reorganising typical textbook treatments so as to facilitate student learning. Despite other options, textbooks typically follow the historical progression of the neoclassical growth literature. The seminal works of Solow (1956) and Swan (1956) centre on the accumulation of physical capital and this emphasis has continued in the literature for decades, such as in the highly cited papers, Barro (1991) and Barro and Sal-i-Martin (1992), Mankiw *et al*. (1992), Young (1995), and DeLong (1997). Unsurprisingly, the accumulation of physical capital and exogenous technological change alone were not enough to explain the empirical data. As the literature sought further refinements, it added

endogenous growth, human capital and institutions to the models (Romer, 1986 and 1990; Grossman and Helpman, 1991; Becker, 1964; and Knack, 2003, *et al*.)

There are some pedagogic drawbacks to following the historical literature. One is an overemphasis on capital accumulation, despite our current understanding of the importance of technology, human capital and institutions. Another problem is that the first test of our growth model fails for our students. We fail to find absolute convergence, when we should be testing for conditional convergence.

I sense that students reject the economics *we teach* because it poorly describes the world they know. They know a world where the latest technology means more to their lives than does a large factory. They know of a wealthy United States, a rising China and an impoverished Haiti. We can explain that world with current economic theory, but not using a model from 1956; no matter how important that model is to our current economic understanding.

I propose that we teach production functions and conditional convergence, but in a sequence in which we transition from students' observations to researchers' models, instead of jumping to oversimplified abstract models and then refining them. From students' observations we can identify sources of growth, then categorise them using economic terminology and finally integrate them into production functions and economic models. In this way, we can minimise the number of students whose attention we lose because our interim story is so unfamiliar and incomplete.

My proposed presentation starts with firms' profit seeking as a choice between production and predation, or alternatively, creative destruction and rent seeking. Creative destruction generates growth and several sources are enumerated: investment in physical capital, human capital and technology; increased savings rates; and establishment of efficient institutions, in other words institutions that encourage creative destruction and discourage rent seeking. Some sources of growth exhibit increasing returns while others exhibit decreasing returns. Depending on the particular combination of sources of growth pursued, countries might quickly or slowly converge or diverge.

None of this is new economic theory. Thomas Carver argued for the benefits of *production versus predation* in 1917. Joseph Schumpeter popularised the term *creative destruction* in 1942 and Anne Krueger popularised the term *rent seeking* in 1974. Economists have long written about these sources of growth. Adam Smith wrote about the importance of physical capital, saving and investment in *Book II: Of the Nature, Accumulation, and Employment of Stock*, of what today would be called human capital and technology in *Book I: Of the Causes of Improvement in the productive Powers of Labour, and of the Order according to which its Produce is naturally distributed among the different Ranks of the People*, and of institutions in *Book IV: Of the Systems of political Economy*, and *Book V: Of the Revenue of the Sovereign or Commonwealth* (1776).

For centuries we have known that investment returns depend on the size of the economy. In 1776, Adam Smith saw larger markets allowing increasing returns in the specialisation within pin manufactories (Warsh, 2006). In 1817, David Ricardo taught us the importance of diminishing marginal returns in determining rents. Hundreds if not thousands of writers since Smith and Ricardo, and since the Marginalist Revolution, have worked to model and quantify these variables and their interrelationships.

In that empirical and theoretical work, economists have already proposed a world of convergence, divergence and experiences in between. Abramovitz (1986), Young (1995) and many others have described and explained convergence. Paul Romer (1986 and 1990) and Aghion and Howitt (1997) explicated endogenous growth. Many, including Rosenstein-Rodan (1943), Lewis (1954) and Murphy *et al*. (1989), have offered explanations of poverty traps. Economists have argued that the patterns of growth are varied and depend on multiple variables. Mankiw, Romer, and Weil (1992) take Solow

(1956) and his residual seriously and find strong empirical evidence for conditional convergence. Hausmann *et al*. (2006) approach diverse empirical patterns with a trouble-shooting guide of growth diagnostics.

While much work remains, economists have a strong, workable understanding of the mechanisms of growth. However, I recommend against teaching it the way we understand it. We learn new material by building on current understanding (Bain, 2004). Undergraduates' initial understanding is very different from professional economists'. Economists start with models of production functions and build upon them with capital, technology and saving. Solow leads to Paul Romer, then Mankiw, and then Rodrik. Undergraduates are not entering the classroom with Solow. They come with models of rich and poor, good and bad, and money paid to businesses such as Walmart and McDonald's. In order to bring them to our economic understanding, replete with formal, mathematical models, we must start with theirs.

In the remainder of the paper, I characterise our students and their mental models, summarise the treatment of growth in the typical introductory textbook, and outline my proposed treatment, followed with conclusions.

2. Teaching Content: Know Your Audience

Students have been learning how the world works for approximately two decades before they enter the classroom to learn economics. The students are confident in their ability to navigate this world and they have also learned that often others are wrong, whether by accident, naïveté or intention. When students hear something inconsistent with their own views, some struggle to learn it and others simply learn it superficially without changing their own views of the world (Bain, 2004). They memorise simply to pass the course, but they do not believe it.

This creates a challenge for teachers who want the trusting students to have an easier time learning and the cynical students to benefit in the long run from our best, current economic theory. One approach starts with what students already know, challenges them with questions that their current mental models cannot satisfactorily answer, and then adds new content that builds upon their existing models such that it can better resolve inconsistencies (Bain, 2004, chpt 2). This is generally how knowledge is constructed anyway (ibid, p.26), however in a well-designed course the instructor, as the expert, guides the students through the process (Colander, 2004, p. 67). So, we should start with the initial mental models of our students, not our discipline, and build upon them to create our economic models.

Possibly the most common preconceived attitudes brought by students are their judgments regarding the social value of free-market capitalism. Some students arrive with supreme faith in the power of markets to generate efficiency or socially optimal outcomes. They are likely to expect course content to validate this and when it does not, they could dismiss the instructor as just another liberal professor.

Liberal students are also easily disappointed in an economics course. They might arrive viewing businesses as cold-hearted with socially inefficient and unjust outcomes since, in their view, the wealth of the business owners is created by the toil of the workers. In this zero-sum-game world, the rich have gained at the expense of the poor, whether at the individual or national level. The professor that extols the virtues of profit-maximising self-interest is easily dismissed as an unfeeling, shallow-minded economist.

Both extremes reflect some truth and acknowledging that can make a course more effective. Increasing productive efficiency and product development benefits society and can enrich individuals as well as corporations. However, wealth can come at the expense of others. Monopolists transfer welfare from consumers, as can any firm with asymmetric information. If profit seeking is introduced as neutral, then all interested students' views are validated. After the students see that their basic observations are

correct, then more material can be added to make the transition to the typical economic model of wealth-generating profits complete with caveats. This should encourage the students to take our knowledge more seriously. We are supplementing their knowledge, not taking away from it.

How else do students learn? Permanent learning occurs when new material is connected to existing (Lowman, 1995, p. 135). This principle is relevant not only for building upon the students' existing mental models, but also for the development of the new economic material in the course. Students have already seen thriving businesses in action; they have been to restaurants, retail stores, beauty salons, etc. These businesses have the manifestations of economic growth, they have physical capital and technology, and the workers have skills. At some level, the students realise that this increases worker output, so this is a good place to start. The students can visualise these sources of growth and then learn to think of them in economic ways, using economic terminology.

When the ideas are dissimilar, students will learn them more easily if they are connected by a common theme (ibid, p.135). Various business activities can be lumped together as profit seeking, even if it does not generate economic growth. All of the various sources of growth can be lumped together as ways to increase the supply curve. The varied combinations of national output levels and growth rates can be seen as the interplay between sources of growth with diminishing returns and those with increasing returns. With just a few themes, we can recreate the myriad of business activities seen by students as well as the panoply of national experiences.

3. The Typical Intro Textbook Sequence

When addressing economic growth, the typical introductory textbook discusses the importance of growth, then presents the aggregate production function and uses it to demonstrate an abstract process of economic growth—i.e. shifts of curves and movement along curves. The typical textbook then concludes by discussing the weaknesses of the model; see Baumol and Blinder (2008), Case *et al.* (2009), Colander (2009), Hubbard and O'Brien (2009), Krugman and Wells (2009), Mankiw (2001), Parkin (2010), and Stiglitz and Walsh (2002).

Learning about growth is motivated by the importance of growth. Our standard of living is determined by the amount of output per person. This standard of living has risen over the decades due to growth of labour productivity. Even small differences in growth rates have an enormous impact on living standards, as can be seen in the rule of seventy.

The primary sources of productivity are physical capital, human capital and technology. Physical capital is the man-made factor of production, including buildings and equipment. Human capital includes the skills and knowledge embodied in the workforce. Technology refers to the methods for combining resources into goods and services—i.e. the blueprints for production. As an economy accumulates these resources, productivity and standard of living rise.

The positive relationship between capital and productivity can be plotted as the production function. Because of diminishing marginal returns, the upward-sloping production function gets flatter as physical capital per worker is increased. Growth is represented by higher levels on the vertical axis. This can occur through capital accumulation—i.e. a movement along the curve—or investment in education or research and development of new technologies—i.e. upward shift of the curve.

Countries grow at different rates because they vary in the rates of accumulation of physical capital, human capital and technology. They can also grow at different rates due to differences in saving rates, level of foreign investment and institutions. Essentially, each country must be looked at individually to see why they are or are not growing, but economic theory does offer some suggestions.

And the theory can be tested. Because of diminishing marginal returns to capital combined with the public-good characteristic of technology, poor countries should grow faster than rich ones—i.e. the convergence hypothesis. Unfortunately, the data only weakly support this conclusion. China and the East Asian Miracle corroborate the theory, but Latin America and Africa refute it. Near the end of the chapter, institutions and spill-overs appear as afterthoughts used in an ad hoc way to make simplistic models fit the data of conditional convergence. The students just completed a chapter without clear benefit due to its awkward explanation of the world.

How well does this treatment address student learning? We probably have not changed their understanding of the world, since the students can learn this theory in parallel to their own. They simply need to memorise a short list of sources of growth and then learn the relationships of the production function. However, they likely cannot apply what they have learned because not only has it not changed their own beliefs, but the economists developing it appear to struggle in applying it.

Whatever beliefs brought by the students about the morality behind profit seeking most likely have not changed. They can easily conclude that Latin America and Africa remain poor because of exploitation or conclude that Asia is becoming rich because of free markets. The emotionally leaning socialists still have faith in generosity and the emotionally leaning libertarians still have faith in greed. The apathetic still think an opinion is a waste of time. Completing the chapter has not modified the students' world outlook.

The students are required to learn an ad hoc list of a few sources of growth. It is not clear which are more important than others. On the one hand, physical capital seems to be the most important because there is a graph based on it. On the other hand, human capital and technology are described as very important. But then why are so many countries not converging? Many reasons are offered. It is not clear what is really significant.

The chapter portrays an uncertain theory instead of a nuanced view of a complex world. Instead of describing the quantitative interplay between just a few forces, it introduces variables, one by one, adding more as necessary until all of the world's regions are explained. This seems to suggest that different regions follow different theories instead of a unified theory. Endogenous growth seems to be a competing view from diminishing returns instead of a concurrent force. Capital accumulation seems to lead to institutions instead of the other way. The students are struggling with ideas we did not mean to imply.

Of course, in the economics literature, just as in science, there is little certainty as new evidence either challenges or supports prior evidence. It is a slowly morphing body of knowledge. Eventually students should learn to confront this uncertainty and be comfortable enough to challenge it with new knowledge. However at the principles level, students should learn the basic body of knowledge that is almost certainly true, and they should learn it as if it is almost certainly true. They should come away from the course feeling that they have learned something valuable and that economics is a discipline with valuable things to say. Most of the students in an Introductory Macroeconomics course will likely not take another one, other than business majors required to take microeconomics. An effective presentation of the content will leave knowledge with the students, preferably for the rest of their lives.

4. A Unified Approach to Growth Theory

Rent Seeking and Creative Destruction

A good place to start in teaching the course content is with general themes that have broad applicability and are generally accepted by students. Two such economic themes are the rationality postulate and the model of supply and demand. Although rational self-interest has recently been coming under more scrutiny in the literature and media, nevertheless students seem to generally

accept it and view the exceptions as either, an intermediate tactic, moral high ground, or personal obstacle. In other words, generosity can have karmic benefits, compassion is socially idealistic and socially contrived, and impulsiveness is a poor strategy of long-run practical hedonism. All the while, self-interest is the basic behaviour.

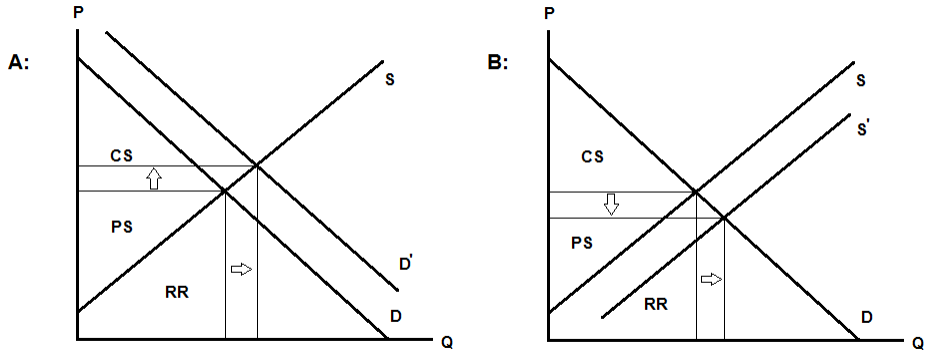
The model of supply and demand is so ingrained in students that it often becomes their default answer under uncertainty. They seem to have no trouble understanding and using it.

These two economic themes can be the starting point for teaching economic growth. The producer surplus indicates the profit to firms. Firms want to maximise their producer surplus. The students now have a foundation by applying the rationality postulate to the model of supply and demand.

The economics immediately gets interesting by realising that profit seeking leads to various moral outcomes for society. Firms can create rent by increasing either the supply or demand curve, or they can appropriate rent by capturing either the consumer surplus or resource rents. Two popular terms for these activities are *creative destruction* and *rent seeking*.

Creative destruction generates welfare by increasing the size of consumer and producer surpluses combined (see Figure 1). Although motivated by producers' profits, it can even have a disproportionate benefit for consumers following an increase in supply. This is the capitalism that generates the BMW M3, Apple iPhone, Avatar in 3-D, Nintendo Wii and countless other products so loved by students.

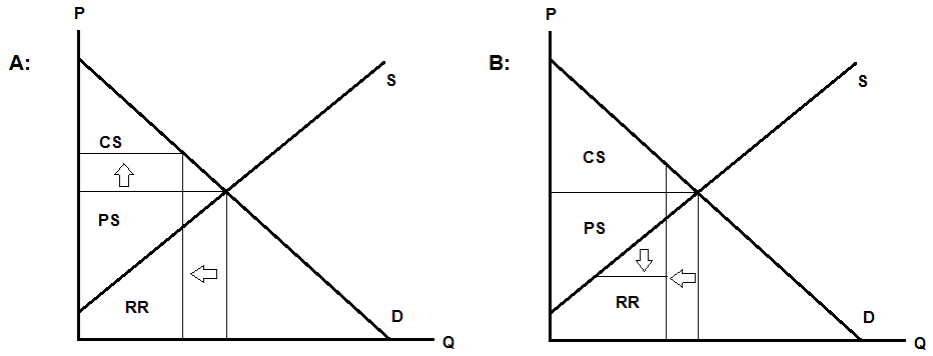
Figure 1



Creative Destruction increases total welfare. Panel A: following an increase in demand (D), producer surplus (PS) and resource rents (RR) grow, but the net change in consumer surplus (CS) is ambiguous. Panel B: following an increase in supply (S), consumer surplus grows, but the net changes in producer surplus and resource rents are ambiguous.

On the other hand, rent seeking decreases total welfare in society by generating a deadweight loss and opportunity costs from investing in unproductive activities (see Figure 2). Economics' most commonly cited example is the monopolist and a monopolist must reduce output in order to increase price and spend to maintain market power, possibly through lobbying or bribery, depending on the country and economy.

Figure 2



Rent seeking decreases total welfare. Panel A: a monopolist using market power to capture consumer surplus (CS) by charging a higher price for output. Panel B: a monopsonist using market power to capture resource rents (RR) by paying a lower price for inputs. Notice that this is in contrast to lowering costs by needing fewer resources (i.e. increasing productivity through creative destruction).

Rent seeking is the form of capitalism that generates NINJA loans (principal-agent problems as brokers and credit-rating agencies set values according to their interests instead of the interests of their principals), hand-crank windows and cacophonous seat-belt buzzers on entry-level cars (price/quality discrimination through product differentiation when buyers show brand loyalty (Kwoka, 1992)), and NCAA rules for amateur athletics (monopsonies as buyers form cartels, set near zero prices and impose penalties for violators), among other business practices. At a national scale, rent seeking can lead to thievery, slavery and war.

A profit maximising firm will pursue both strategies depending on the incentives imposed by society and balance the two strategies depending on the relative rates of return. Walmart provides familiar and emotionally-charged examples. Walmart attracts customers on Black Friday by offering a few products at extremely low prices. Most of the hopeful customers will buy from Walmart without obtaining one of the advertised discounts, thereby allowing Walmart to capture more revenue than consumers expected to pay. The use of loss leaders has occasionally even had fatal results (McFadden and Macropoulos, 2008).

In addition to seeking consumer surplus, Walmart seeks resource rents. Walmart is notorious for its efforts to limit unionisation and for its negotiation tactics with suppliers. Typically Walmart is able to prevent unionisation, but a rare success by union organisers resulted in Walmart closing the store (Fishman, 2006, p. 48). Walmart negotiates fiercely with its product suppliers as well. In Spartan cubicles at its Bentonville headquarters, suppliers face demands of lower costs if they want a chance to sell to the largest retailer in the world. Few reject Walmart's terms despite shrinking margins (ibid, chpt 5).

Besides rent seeking, Walmart pursues creative destruction. Recently, Walmart initiated Project Impact with the intent to improve the customers' shopping experience with "cleaner, less cluttered stores" and "friendlier customer service" (Gregory, 2009). Walmart.com lists "more than half a million items" for sale, providing customers with a large variety from one source (Walmart, 2009). These features increase the demand for Walmart's retail services.

Walmart is most famous for its innovations in logistical efficiency which lowered production costs and increased supply. Walmart "became a model of a vertically integrated supply chain, complete with automatic replenishment of our stores' inventories as well as co-managed inventories with many of our suppliers" (Soderquist, 2005, p. 153). Walmart incorporated management information systems and

brought just-in-time to retailing. This contribution is so significant that some research credits Walmart for much of the relative increase in U.S. productivity growth in the 1990s (Johnson, 2002 attrib. Krugman and Wells, 2009 and attrib. Soderquist, 2005). Although discussing Walmart can be quite emotional, it is the world's largest corporation ("Global 500", 2010) and should be understandable to students. Nonetheless, I am confident that a review of any large corporation would also yield multiple examples of each type of profit seeking, whether creative destruction or rent seeking.

Now that students have had the opportunity for their own observations to be confirmed and broadened, we can assess the social costs and benefits of profit seeking. Creative destruction generates growth. Monopolistically-competitive firms continually introduce new products and production methods in order to stay in business. Society benefits from the innovation while the old technologies and the firms hanging on to them are wiped out (Schumpeter, 1942). Graphically, either increasing the supply or demand curve increases total welfare in the economy.

Rent seeking slows growth. Monopolies and monopsonies force market prices away from welfare-maximising values resulting in deadweight losses (Harberger, 1954). Other deadweight losses result when potential buyers do not participate in markets due to asymmetric information (Akerlof, 1970). Potentially larger are the opportunity costs that arise from investments made in pursuit of rent seeking instead of creative destruction (Krueger, 1974). Beyond merely wasting resources that could have gone to output, rent seeking wastes resources that could have generated growth. Every dollar spent on the appropriation or protection of wealth and resources could have been invested in capital accumulation, education, health or research and development, but is not when firms decide that rent seeking is more profitable. One manifestation at the national scale is the resource curse in which resource-rich countries exhibit below-average growth rates (Sachs and Warner, 2001).

How do we balance rent seeking and creative destruction? Institutions "are the underlying determinant of the long-run performance of economies" (North, 1990, p. 107). A society's rules and values will decide the incentives for stealing, colluding, learning and researching. Good institutions will discourage rent seeking and encourage creative destruction, in all of their manifestations.

More specifically, "institutions are decisive for the resource curse" and influence whether natural resources become an asset or an economic distraction (Mehlum *et al*., 2006, p. 1). Corruption signals rent seeking and lower levels of it are associated with dynamic efficiency and the realisation of potential growth (Kauper, 2010). Institutions alter Walmart's incentives between rent-seeking and creative destruction. Consumer protection laws regarding truth in advertising and the provision of rain checks influence the benefits of promoting loss leaders. Labour laws regarding employer rights to union opposition and rules of organising alter the calculus of effort for both sides. When institutions can channel self-interest into creative destruction, free-market capitalism is socially beneficial.

From Creative Destruction to Increasing Supply

At this point in the lecture(s), the students should have the sense that they and their dissenters both have valid observations regarding individual self-interest and social welfare. Society's challenge lies in knowing which incentives will best exploit self-interest for society's gain. The next task in the classroom is for the students to understand the mechanisms for growth through creative destruction, and again the place to begin is with what the students already know.

Long before taking a macroeconomics course, students have already seen various manifestations of firms increasing supply. Many businesses provide a wide range of examples of economic investment. Either the students or the instructor can begin by providing specific examples and then the instructor can classify those by economic terminology. See Table 1 for possible examples from a hypothetical McDonald's restaurant.

Table 1: Ways to Increase Supply

How could a McDonald's increase the quantity supplied?	Economy-wide economic term—i.e. source of growth	Returns*
Use more ingredients: e.g. more potatoes	Increase in natural resources	
Hire more workers: e.g. more cashiers	Increase in labour	
Use more equipment: e.g. more cash registers	Increase in physical capital	—
Train workers: e.g. send managers to Hamburger University	Increase human capital—education	—
Reduce sick days: e.g. offer bonuses to non-smokers	Increase human capital—health	—
Use better ingredients: e.g. train suppliers in developing countries to produce more uniform potatoes	Better soil, climate etc.	
Use more effective capital: e.g. use cash registers with pictograms for keys	Better technology embodied in capital	—
Use better procedures: e.g. have cashiers fill sodas while waiting for order fillers to bring hamburgers and fries	Better technology—imitation	—
	Better technology—innovation	+
Use better advertising: e.g. promote the reintroduction of the McRib® sandwich	Reduce transaction costs—search	
Provide uniform products: e.g. same hamburger by look and taste throughout the United States	Reduce transaction costs—contract negotiation	
Provide quality guarantee: e.g. replace the hamburger of any dissatisfied customer, no questions asked	Reduce transaction costs—contract enforcement	
Find better location: e.g. closer to more traffic	Reduce transaction costs--transportation	
Build better road to store: e.g. driveways with better ingress and egress to a busy street	Build infrastructure (reduce transportation costs)	—

* "-" indicates a source of decreasing returns to development and "+" indicates a source of increasing returns to development.

Each of these sources of growth requires investment. Therefore, an indirect source of growth is to lower the cost of investment. Since the interest rate is the price of loanable funds and either an actual cost or opportunity cost of economic investment, then a lower interest rate can increase economic investment and growth. This lower interest rate can be attained through an increase in total savings or through more efficient financial markets.

As previously described, since creative destruction is an opportunity cost of rent seeking, institutions that reduce rent seeking will increase creative destruction and economic growth. With this we can make a summary list including the most typical sources of growth from Table 1:

- Accumulation of physical capital
- Investment in human capital
- Building infrastructure
- Imitating and adapting existing technologies
- Innovation
- Higher saving rates, whether domestic or from (financial) capital inflow
- Better institutions

Building and Testing the Theory: Divergence and Convergence

How can this information be used to explain observed economic growth rates, predict trajectories of growth, and improve country performance? A good place to start is with the idea that the returns—increasing or decreasing—to each source of growth will likely change depending on the level of development of the economy. In other words, as an economy grows its opportunities for growth will likely change. If there are increasing returns to development, then as a country develops, rates of return on additional investment should increase with the result that economic growth should accelerate and rich countries diverge from poor ones left in a poverty trap. On the other hand, if there are decreasing returns to development, then investment and growth should yield lower subsequent returns and poor countries should initially experience rapid growth which slows down as they converge to rich countries.

When should there be decreasing returns? If they can choose among specific alternatives within a source of growth, then rational agents will first choose options with the highest rates of return, followed by options with lower rates of return. For example, if a McDonald's manager can choose between the purchase of another cash register, oven, fryer, refrigerator, table or computer, then the rational manager will spend available funds on items that will increase profits by the largest amount. Likewise, if a franchisee is deciding where to open a new store, she will first choose the most profitable locations. Applying the principle of the lowest-hanging fruit implies that investment in physical capital yields diminishing marginal returns. This concept can be extrapolated to the national level, as the instructor would have likely shown in the chapter on aggregate supply and aggregate demand.

The principle of the lowest-hanging fruit should also apply to investment in human capital, infrastructure and the imitation of technologies. Elementary schools choose to teach reading and writing before macroeconomics. Efficient governments build bridges connecting large populations before they build a bridge to nowhere. Firms can choose among state-of-the-art and defunct technologies when copying others. The more outdated the firm's current technology, the larger the potential jump in productivity and hence the larger potential growth.

Of course, keeping one factor of production constant, for our purposes labour, more investment in another factor of production should yield diminishing returns as the balance of inputs shifts away from labour leading to crowding etc.

In some instances, returns can increase with economic development. When a firm is developing a new technology, then it cannot apply the principle of the lowest-hanging fruit. Since the firm does not know which method will yield the best results, it cannot select it before selecting technologies with lower returns, suggesting that innovation should not be characterised by decreasing returns. Due to spill-overs, technological and scientific progress should feed off of each other, generating an increasing rate of progress (Romer, 1986). This describes the history of the developed nations (Warsh, 2006).

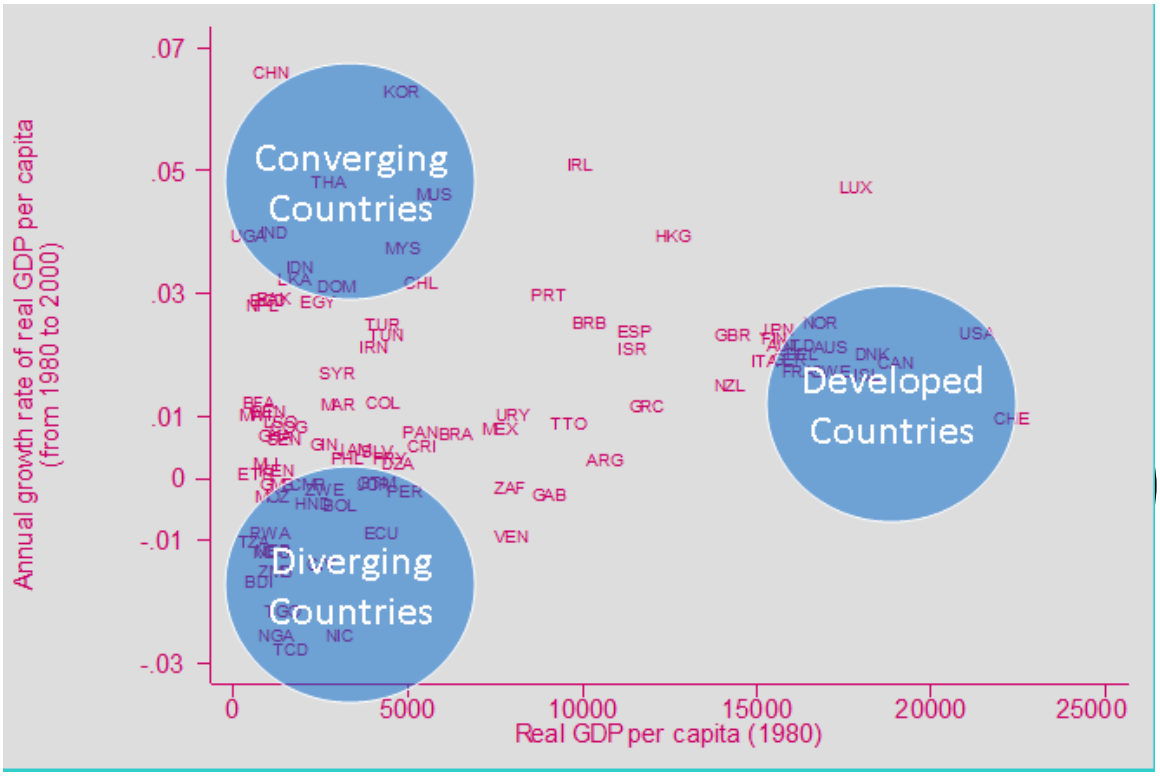
Other societal features should exhibit increasing returns to development. If individuals are characterised by diminishing marginal utility, then it should be easier for them to save as their wealth increases. The greater savings combined with increasing efficiency in financial markets allow more economic investment in growth. Development should facilitate further development. Similarly, if economic justice is a normal good that also improves economic efficiency, development should build momentum. The Progressive Era brought rights and economic participation to women and minorities, and arrived with the growth of the middle-class. The Progressive Era also led to less corruption, which suggests less rent seeking and more creative destruction. This suggests that institutions exhibit increasing returns to development; the more developed the country, the easier it is for the country to pursue growth through better institutions, analogous to Rostow's precondition-to-takeoff stage of growth (Rostow, 1960).

In a static view, we can show sources of growth with decreasing returns with the standard, upward-sloping and concave production function. We could create a production function with an independent variable with increasing returns and get an upward-sloping, convex curve. By convention, the independent variable is physical capital, the curve is concave and investment in any other source of growth shifts the frontier upward.

What would a dynamic view to illustrate predicted patterns of growth look like? In this case, the growth rate is on the vertical axis and our independent variable is initial GDP per capita. If the sources of growth with decreasing returns dominate, then the frontier would be downward-sloping, indicating convergence. If the sources of growth with increasing returns dominate, then the frontier would be upward-sloping. At this point, simple theory alone cannot predict the slope of the frontier, so empirical evidence can help.

The data show that some countries are converging, while others are diverging, thereby suggesting that countries are investing in the various sources of growth in many different combinations with varying degrees of success (see Figure 3). The most efficient countries are in fact converging and are likely investing in sources of growth with decreasing returns, such as physical capital, human capital and imitation of technologies. Research on the East Asian Miracle confirms this (Young, 1995).

Figure 3: Three Types of Countries



Average growth rates are from the PWT 6.1 (Heston *et al.*, 2002). GDP is expressed in 1996 PPP dollars. Data points are represented by the International Organization for Standard's (ISO) three-letter country codes.

Diverging countries, on the other hand, do not seem to be taking advantage of opportunities for growth. This suggests that they are stuck in a poverty trap of low saving rates and institutions that favour rent seeking—in other words, the sources of growth with increasing returns. This is consistent with the many economists that argue the importance of institutions for development (Olson, 1996; Knack, 2003; Rodrik *et al.*, 2004; and Kauper, 2010).

Although each country is unique, we can summarise the global situation for Intro students. Diverging countries, also known as developing or less-developed nations, need to improve their institutions so that the private incentives for profit seeking will generate creative destruction and not rent seeking. And they should increase their saving rates (or liberalise their capital inflows or devalue their currency). Converging countries, also known as emerging markets, are on the path to economic development by investing in physical capital, human capital and borrowing technologies from other countries. Developed countries are investing in capital and better institutions, but their key source of growth is the research and development of new technologies. Over time, the frontier should slowly shift out due to increasing returns to innovation; (see Figure 3).

5. Conclusion

My proposed presentation begins with profit-seeking options of rent seeking or creative destruction. Creative destruction leads to growth and a variety of sources are considered. Depending on the sources pursued and the nature of the returns, poor countries might show convergence, divergence, or something in between. The ideas are not new, but the presentation is unusual.

Another option is to begin with textbooks specialising in economic growth, and then simplify them for introductory students. Barro and Sala-i-Martin have an extremely thorough textbook, *Economic Growth* (1995), but this advanced book is part of the preparation of professionals that will be reading from and contributing to journals that advance formal models to be used in empirical studies. Their objectives are different and consequently the authors skim intuition to leave space for derivations and data.

Many authors of upper-division textbooks on growth (see Jones, 2002 and Weil, 2005) do a wonderful job of building the intuition with lucid prose and vivid examples. However, they require an entire textbook with about a dozen chapters to do so. In order to leave time for business cycles and inflation in an Introductory Macroeconomics course, their textbooks would have to be condensed into a chapter or two. Because they go through the typical sequence of importance of growth, role of capital, Solow model, and so forth, this would leave us with the same limitations of a typical introductory textbook and our students with the same incredulity.

Some introductory textbook authors have seen a need to change the typical approach, one example being Cowen and Tabarrok with their textbook *Modern Principles: Macroeconomics* (2010). Before their treatment of the aggregate production function, they have an entire chapter on the basic intuition of economic growth, complete with the overview that institutions determine the incentives for investment in factors of production which generate GDP per capita (ibid, p. 98). That institutions matter is a key part of my proposed treatment. Nevertheless, my proposal goes even further by providing the context of rent seeking versus creative destruction leading to diverging, converging and developed countries.

Not all economists will accept my emphasis on institutions, my partition of country performance, or some other specific feature, and rightly so since many of our past quests have proved elusive (Easterly, 2001) and consequences unintended (Lal, 1998). When Lucas (1988) thinks about the causes of poverty and hardly anything else, he wonders whether it is the Indian government or its “nature” that is to blame, and economists are still debating that question. However, I have tried to be broad in encompassing many sources of growth and many possible outcomes, while limited in measuring and ranking them, thereby avoiding as much debate as possible.

I have tried to present a summary of the basic features of economic growth. Since this is likely the only time our students will hear our economic descriptions, we should prepare them with our best collective effort for years later when they need to vote amidst political rancour and have managerial plans despite planning to change them. Our students already face plenty of uncertainty and we can reduce it and add value with a presentation of the economic forces that we largely agree upon.

Unfortunately despite my empathy with them, many students resist my approach. Even though it is intended to confirm and build upon students’ views, by expanding those views, it still challenges them and makes many students uncomfortable. Many are bothered by the notion that free markets are not a panacea. Others take umbrage in the suggestion that poor countries need to reform themselves and improve their own institutions. Some ridicule the thought that Walmart with its “always low prices” contributes to economic growth and well-being.

And many students still avoid the effort needed to understand the economic world. They know that they want a good grade, but are not so certain that the offered economic knowledge will actually be useful later in their lives. Given that calculus, they become cost-minimisers facing the fixed output of

passing the exam. Consequently, they want study guides and lectures that stick to the textbook as closely as possible. Time spent on real-world applications seems wasted to them and deviations from the textbook merely confusing.

Nevertheless, I think that deviating from the textbook is worthwhile and that my proposed content accurately coalesces the cumulative work on economic growth to help students leave the course with lessons for a lifetime.

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Bringing the 'Dismal Science' to Life: Teaching Economics Through Multimedia

Wayne Geerling

Abstract

This article examines the pedagogical benefits of using multimedia in the teaching of economics at undergraduate level. It also provides an example from my own teaching to serve as a reference for lecturers interested in creating an interactive learning environment, which prompts genuine two-way discussion in the classroom and produces better learning outcomes for students. The final section ties in the use of multimedia with broader debates among economists about the appropriate level of government intervention in the economy. The paper concludes by arguing that the use of multimedia has strong pedagogical advantages in stimulating greater student engagement and helping to rectify the image of economics in the wider community. Lecturers interested in using multimedia in their teaching will find an extensive list of web resources at the end of this paper.

JEL classification: A22

1. Introduction

Starting Point: Teaching and Learning Economics, an online website designed to assist economists in developing innovative teaching strategies, illustrates the benefits of using multimedia to reinvigorate the way we teach economics: 'The use of media to enhance teaching and learning complements traditional approaches to learning. Effective instruction builds bridges between students' knowledge and the learning objectives of the course. Using media engages students, aids student retention of knowledge, motivates interest in the subject matter, and illustrates the relevance of many concepts' (Mateer, 2011)[1]. Historians debate the origins of the term 'Dismal Science', but Thomas Carlyle's antipathy towards the discipline of economics continues to resonate in the community[2]. Bad teaching practice reinforces the notion of an abstract science out of touch with the modern world.

This paper will evaluate the different forms of, and benefits in, using multimedia in the classroom, then by drawing on an example from my own teaching, provide a practical illustration of how multimedia—in this case a film clip made by my students—can be used to liven up the economics curriculum and create an interactive learning environment, which is student-led and produces better learning outcomes. The caveats of using this technology in a lecture—mainly the questions of when and how—are dealt with. Next, I provide a brief overview of the film competition, before moving on to discuss the themes of the clip, in both a narrow and broader context. This section contains several sample questions which could be used to prompt discussion or be set for homework and links to further (interactive) resources.

[1] All hyperlinks are given in web resources used, at the end of this paper.

[2] One view is that it was a reference to the gloomy predictions of Thomas Malthus. Another traces the comment back to Carlyle's attack on economists for opposing the reintroduction of slavery.

Media can be used in almost any discipline to improve student learning in a variety of forms, both in-class (lectures and tutorials) and out-of-class (homework, offline/online assignments, essays and projects). Research shows that the use of multimedia or popular culture can stimulate discussion in introductory classes (Becker, 2004), illustrate basic concepts (Hall, 2005; Hall and Lawson, 2008) and explain abstract concepts like game theory (Dixit, 2005) or option value (Dixit, 2011) at an advanced level.

I have always used a variety of multimedia resources in my teaching: from commercials, film, music, television and YouTube clips in lectures to interactive-based homework, which requires students to read newspaper articles, report on economic trends or listen to/watch Podcasts/Webcasts. This illustrates how the theory they have been taught relates to the real world and promotes independent learning. Students are then tested on this material in the following week's tutorials through class debates, presentations and written tests. Topics are always contemporary and relevant, e.g. '$26 boost to minimum wage' (unemployment), 'Man drought hits Central Australia' (personal relationships) or 'Generation Y drowning in debt' (higher education and debt).

Students have different learning preferences. While those with a background in science or maths may have a comparative advantage in understanding the quantitative aspects of economics, research shows that people learn abstract, new and novel concepts more easily when they are presented in both verbal and visual form (Salomon, 1979). Visual media also make concepts more accessible to a person than text alone, promote deep learning rather than rote learning, and help with later recall (Cowen, 1984; Willingham, 2009).

The use of media is beneficial for teachers and students alike. Technology plays an important role in creating an interactive learning environment, which prompts two-way discussion in the form of student-created content (Bransford *et al*., 2000). Media sources are ideal for illustrating complex ideas in a short period of time, connecting learners with events that are culturally relevant and theories taught in the classroom with real-world events and policies (Mateer, 2011).

Using media of popular culture familiar to students is likely to: (i) maintain attention and student interest in the theories and concepts being taught; (ii) develop better analytical skills by analysing media using the theories and concepts they are studying; (iii) break down the barrier between formal learning and understanding, enabling students to see concepts and new examples when they use these same media in their private life (Mateer, 2011).

Before using audiovisual materials in teaching, one should have an understanding of copyright, which, by default applies to materials found on the web. The Economics Network's *The Handbook for Economics Lecturers* provides useful instructions on this issue[3]. Permission to use these materials might be requested directly, or granted in advance using a licence such as Creative Commons (Poulter, 2010). The biggest hurdle in using audiovisual materials—aside from a willingness to do so—is the workload involved and the skill in recognising content that will enhance learning, instead of becoming a distraction (Mateer, 2011). The good news is: help is readily available.

- The *Mathematics for Economics: enhancing Teaching and Learning* (METAL) site has a series of short clips which can easily be embedded into any lesson plan.

- *TED-talks* are well-produced video lectures of 15-20 minutes on themes as diverse as business climate, developmental economics, environmental issues and globalisation.

[3] The hyperlink is provided in the references section.

- Dirk Mateer, an academic from Penn State University, created *Teaching Economics with YouTube* to showcase in-class videos and provide links to economic content provided by other YouTube users.

- Mateer, along with other North American academics, pioneered or helped pioneer websites which provide economics lecturers with access to short clips from films, television shows and music. The clips usually include a synopsis, relevant concepts and, occasionally, sample questions which can be used in open-ended, student-led assignments. Examples include: *Economics in the Movies*, *TV for Economics*, *From Abba to Zeppelin, Led* and *Flash Music for Economics*.

The use of YouTube throws up one interesting extension of this medium: filming classroom experiments and/or getting students to make their own clips. After all, most of them belong to Generation Y. This can be used to give students 'ownership' of their own learning and extend the two-way discussion highlighted above.

2. Background

The Economics Network launched a student film competition in 2005–06 on its website for school students considering studying economics at university: *Why Study Economics?* (WSE). The aim was to encourage students from around the United Kingdom (and beyond) to make videos about their experiences. These videos are available on YouTube and most can be downloaded for offline use from the student films section of the WSE site.

My favourite clip is 'Captain Economics', in which a mysterious masked super hero helps university students solve everyday dilemmas: time preference (the impact of budgetary tax increases on the price of cigarettes, alcohol and going out); how the laws of supply and demand affect finding a partner at a nightclub; using comparative advantage and specialisation to decide who does the cooking in a shared house. Student-generated content can be used to enrich the learning experience by illustrating themes which are relevant and interesting to the lives of most young people.

I trialled this form of assessment in 'Economics of Everyday Life', a new 2nd year elective I introduced at La Trobe University in Melbourne, Australia, in 2010. The aims of the subject were to encourage students to:

1. Think like an economist;

2. Explain the intuitive logic of economics;

3. Apply economic reasoning to comprehend and solve problems in everyday life;

4. Better understand the complexities of human behaviour.

'Economics of Everyday Life' was aimed at different streams of students: those undertaking a degree or considering a major in economics, as well as non-specialists from different faculties opting for an elective.

The film project was optional and one video was submitted. One of the students has a background in media studies and was able to use his expertise in production and editing to ensure a high quality end product. Even the acting was believable! Their project will be discussed in more detail in the next section of the paper. In future years, I intend to make the film project compulsory, but as a concession will allow students to form their own groups to try to minimise the incidence of free riding. This has the

potential to create a lot of administrative work for the academic. SWoRD, a web-based peer review system, can help. It randomly assigns students within groups and creates the correct incentives for serious peer review of film projects (Cho *et al.*, 2006; Cho and Schunn, 2007).

Instructions in the subject outline were as follows: 'Each group will choose their own topic, which should be based on an aspect of how economics is relevant to everyday life. The clip should be no longer than 5 minutes in length. Students will be given practical demonstrations of how to use the audiovisual equipment (if necessary) but most of the work will take place outside the traditional classroom. The best clips will be uploaded onto YouTube' (ECO2EEL subject outline: semester 2, 2010, p. 10). Aside from approving the topic, students worked independently.

3. Film clip

A group of four students tapped into a controversial issue for staff and students alike at La Trobe University: car parking. The idea evolved accidentally from a theme I raised in a lecture on 'University Life'. Titled: 'Car Parking at La Trobe University: Is this a Case of Market Failure?', four self-described student economists set out to determine whether the shortage of car parking places is the symptom of market failure or a transitory adjustment in the market. It draws on themes taught at the beginning of Introductory Macroeconomics and Microeconomics (scarcity, opportunity cost, tradeoffs, thinking at the margin), plus more general microeconomics concepts: free riding, externalities, market failure and government remedies. The chosen topic is suitable for an introductory course in economics, a subject which requires students to apply theory to practical or real-life events, or to reinforce knowledge of previously taught material.

The student film project gave our group a chance to articulate what we had learned during the semester through a different medium. In many ways this was more challenging than a conventional assessment, as the logistical and collaborative issues associated with a group film project required higher developed time management skills (shooting the film, editing, brainstorming etc.) as well as teamwork. The fundamental difference between this project and writing an essay or doing an exam, is that it gave us great insight into working with technology and software and using such tools to convey the topics covered in a concise and entertaining way. If anything, this is what economics lacks! Although the formal areas of economics are necessary and fundamental to the discipline it does tend to make this school of thought quite inaccessible to those whom economics affects the most - the everyday person. Overall it was a great experience and I would like to do it again at some point... (subject evaluation, student 1)[4]

Audiovisual material can be used: (i) at the beginning of a lecture; (ii) after a brief introduction but before learning the concept; (iii) after learning the concept; (iv) before and after. Alternatively, it can be set as a homework assignment (Mateer, 2011). The 'Economics of Poker' is one such clip from Mateer's YouTube channel. Two students are sitting at a table playing poker. The game of poker has several principles taught in introductory Microeconomics: tradeoffs, opportunity cost, thinking at the margin, sunk costs, etc. The beauty of this clip is that it illustrates concepts which should resonate with students, many of whom play the game of poker (though may not necessarily understand the economics behind it). Furthermore, it provokes the viewer to think about more intermediate and advanced Microeconomics concepts: maximisation subject to constrained choices, prospect theory, time and adjustment process, etc., which make it suitable for introductory, intermediate and advanced classes.

A few questions to consider before using audiovisual material in teaching:

[4] Ethics approval to use student material was granted on the condition that students be anonymised.

1. Is there a clear link between the material shown and the learning objectives? The material should be embedded in the lesson plan, i.e. objectives, how you intend to use it and learning outcomes for students.

2. Will students understand the context, i.e. why the material is being shown? Are there concepts or background material which needs to be explained in advance? With respect to the car parking film clip, an audience would need figures on the following: (i) permit types and cost (daily, year, various zones) and the range of fines; (ii) average daily demand for car parking places v. available supply; (iii) student population: domestic v. international students; (iv) residential status: what percentage of students live on campus v. at home or in shared houses off campus.

3. Are the students expected to engage in activities while the material is being shown, or will follow-up activities be used instead? This could take the form of: (i) *think, pair, share* activities, where students discuss the question, prepare a written answer, then share it with their neighbour (Lyman, 1981; Lyman, 1987); (ii) lecturer/student-led classroom discussion; or (iii) homework assignments.

4. Will student learning outcomes be measured? If so, how?

5. How does this affect the amount of material covered in the course? It takes time to plan, set up and execute multimedia activities in the classroom and many lecturers are concerned that the opportunity cost of doing so is quite high, i.e. this time could be used to cover concepts in more depth and breadth. I would make three comments in response. First, if used effectively, technology actually allows a lecturer to cover more not less material. The car parking film clip cited in this paper could be used to teach concepts as diverse as: scarcity, opportunity cost, tradeoffs, thinking at the margin, externalities, market power, market failure, information asymmetry and the economics of crime. Second, lecturers should 'start small', that is, find a short film clip, song or newspaper source and introduce it into the class. Once you feel comfortable, slowly expand. Third, if the audiovisual clip is modelled briefly in class, then it can be set as a homework assignment. In this case, the material is a complement to traditional classroom teaching rather than a substitute.

6. Audiovisual materials can be used online (via the internet), downloaded and embedded into a PowerPoint presentation, run from a hard drive, USB stick or DVD. Knowing how to use equipment effectively and efficiently is important, as is knowing who to contact in an emergency!

I often use audiovisual clips as an 'ice breaker' at the beginning of the lecture. If I intend to assess the students directly, either in-class or as part of a group assignment or homework, I would initiate a general discussion to provide context. With respect to the car parking film clip, I would begin with the following questions: Who buys a car parking permit? Why? Does it offer value for money? Ever considered not paying? Have you ever had problems finding a spot? How do you react? Is this a problem for the university? If so, what should be done about it?

Then, I would tie this in with the economic concepts I wish to illustrate: (i) as a *think, pair, share* exercise, either during the clip or afterwards; or (ii) in a general class discussion. Students should be able to identify the concepts involved and to provide written/verbal examples from the material.

Once you have tested for general comprehension, you need to bring this back to the main theme of the film: is this a case of market failure? Depending on when you introduce this material in the subject, the definition of market failure might need to be explained, along with the three main causes: (i)

externalities; (ii) asymmetric information; (iii) market power. I find that students can usually provide examples in lay terms, i.e. understand how it works in reality but are not aware of the theoretical underpinnings or concepts involved. If the audiovisual material requires a level of understanding more advanced than the material already covered in the course, I would be tempted to briefly explain the theory behind market failure before showing the clip to help students make the link between theory and reality. If the material is reinforcing concepts learned earlier in the subject or from a previous subject, this would not be necessary.

4. Relevance in a broader sense

Market failure is an important concept in economics, yet one often misunderstood by many students. The central issues are: (i) the market fails to allocate resources efficiently; (ii) there is no market solution: in this case the market is the problem. Ask students to consider whether the car parking problem is self-correcting (transitory)? Are they able to identify instances of market failure in society?

Another crucial issue is: what is the appropriate role of the government (or in this case, the university) in dealing with market failure? This could be tied in with broader debates among economists about the appropriate level of government intervention in the economy. *EconStories.tv* has recently brought John Maynard Keynes and Friedrich Hayek back to life in a series of raps which trace the debate between government intervention and market forces over the 20th century, up to and including the recent Global Financial Crisis: *Fear the Boom and Bust* and *Fight of the Century*.

5. Final remarks

The benefits of using multimedia in the classroom are well established in the academic literature but, as a discipline, economics has been slow to adopt innovative approaches to teaching (Becker, 2001; Becker, 2003; Becker and Watts, 1996; Becker and Watts, 2001). This paper demonstrates the practical benefits of using multimedia, in particular, a film clip produced by students, to bring the 'Dismal Science' to life. On a micro level, students can tap into their own lives, hobbies and grievances to find a practical application of economic theory and develop an intuitive understanding of the core economic principles which shape our understanding of human behaviour: thinking at the margin, rationality, tradeoffs and opportunity cost. On a macro level, the recent global financial crisis is a wakeup call to economists: when economics loses touch with the real world, it ceases to provide insights into the social, economic and political behaviour of everyday life. The once 'Dismal Science' reverts back to its pejorative.

Web resources

'Captain Economics', Economics Network student film competition
URL: http://www.youtube.com/watch?v=ftBs8LBO8is&feature=player_embedded [last accessed 14 May 2011]

Our mysterious masked hero has practical advice for all sorts of people, based on concepts from economics. He also has nice, clean underpants.

'Car Parking at La Trobe University: Is this a Case of Market Failure?'
URL: http://www.youtube.com/watch?v=umUzJGNt8UM [last accessed 16 May 2011]

Film clip produced by my students in October 2010.

'Economics of Poker', Dirk Mateer's Econ Channel
URL: http://www.youtube.com/user/dmateer#p/f/28/V-t1V4WGcQ0 [last accessed 17 May 2011]

Two students discuss the application of playing poker to studying economics.

Ghent, L., Mateer, D.G. and Stone, M. 'TV for Economics'
URL: http://tvforecon.blogspot.com/ [last accessed 15 April 2011]

This website has a list of clips from TV shows that can be used to emphasise applications of economic concepts.

Hall, J.C, Lawson, R.A. and Mateer, D.G. 'From Abba to Zeppelin, Led'
URL: http://www.divisionoflabour.com/music/author_archives/dirk_mateer/ [last accessed 18 April 2011]

This website provides lyrics and follow-up questions that can be used to learn economics.

Mateer, D.G. 'Teaching Economics with YouTube'
URL: http://www.youtube.com/user/dmateer [last accessed 15 May 2011]

This channel showcases two teaching methods: (i) A series of short in-class videos that utilise interactive learning approaches to teach principles of economics; (ii) Links to economic content provided by other YouTube users.

Mateer, D.G. 'Economics in the Movies'
URL: http://economicsinthemovies.swlearning.com/ [last accessed 17 April 2011]

This website contains a database of film scenes that can be used to illustrate economic concepts.

'Mathematics for Economics: enhancing teaching and learning'
URL: http://www.metalproject.co.uk/METAL/Resources/Films/index.html [last accessed 19 April 2011]

This project provides lecturers and students with a selection of free learning resources designed to engage introductory level students more fully and enthusiastically in mathematics for economics.

Papola, J. and Roberts, R. 'EconStories.tv'
URL: http://econstories.tv/ [last accessed 30 May 2011]

This website brings John Maynard Keynes and Friedrich Hayek back to life in a series of raps: 'Fear the boom and bust' and 'Fight of the century'.

Schunn, C. 'SWoRd: Scaffolded Writing and Reviewing in the Discipline'
URL: http://www.lrdc.pitt.edu/schunn/sword/index.html [last accessed 15 April 2011]

This is a web-based review system which offers guidance on the topics of effective writing assignments, optimal feedback on writing, and the power of peer feedback.

'TED: Ideas worth spreading'
URL: http://www.ted.com/talks [last accessed 15 April 2011]
TED-talks are short video lectures of 15-20 minutes length on a variety of topics.

'Why Study Economics?'
URL: http://www.whystudyeconomics.ac.uk/ [last accessed 15 April 2011]
The Economics Network launched a student film competition in 2005-06. These videos are available on YouTube and most can be downloaded for offline use from this site.

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An Interactive Computer Model of Two-Country Trade

William Hamlen and Kevin Hamlen

Abstract

We introduce an interactive computer model of two-country trade that allows students to investigate the consequences of changing economic parameters. The model is self-contained and makes no assumption concerning the existence of social welfare functions or social indifference curves. The factors of production earn incomes that lead to the demand for two goods. Students can see who are the winners and losers when going from a closed economy to an open economy. The students are able to predict the consequences and then obtain immediate feedback.

JEL classification: A22, A23, F10, F11

1. Introduction

The purpose of this paper is to present an interactive computer model of two-country international trade that allows students to understand the gains and losses of going from a closed economy to an open economy with international trade. Although computer models tend to make specific and sometimes simplifying assumptions, many students learn better when they are able to experiment by making predictions on the effects of changing parameters and then obtaining immediate feedback on these changes.

The model proposed is in the spirit of those computer models by Murphy (1995), Mixon and Tohamy (1999 and 2003), and Hamlen and Hamlen (2006). The model by Murphy was one of the first efforts to produce a production possibility (PP) curve using the mathematical software DERIVE. The 2003 model by Tohamy and Mixon provides an excellent presentation of international trade possibilities using the specific factor model. Its complexity, along with several restrictive assumptions, make it reasonable for a specific course in international trade but not for a general intermediate microeconomics course where PP curves and the resulting two-country international trade outcomes are just a small portion of the course contents. Hamlen and Hamlen (2006) developed the self-contained model for a single country.

In the model proposed here the simple equations used by Hamlen and Hamlen for one country are extended to two countries. The primary goal of the proposed model is to enable the student to evaluate the gains and losses of two countries, and representative individuals in these countries, when the countries go from closed economies to open economies. By changing parameters in the model the students can predict the consequences and then quickly obtain feedback on the actual outcomes within the model structure.

The endowments of labour, $\bar{L}_i$, and capital stock, $\bar{K}_i$, in each country, i = 1,2 are to be given changeable parameters. Representative individuals of labour income earners and capital stock income earners in each country are given homogeneous utility functions (of degree 1) and the parameters of these can be changed. There are the same two goods produced in each country and the two production functions in both countries are Cobb–Douglas types but returns to scale need not be constant. Many interesting details can be examined by changing the parameters. The students can learn to predict which goods will increase and decrease in each country when trade is opened up. They can also learn to predict whether labour or capital stock owners will benefit in each country when free trade is made available. One of the most important learning lessons for the students is to dispel the notion that everyone is made happier by shifting from a closed economy to an open economy and that social welfare is always improved.

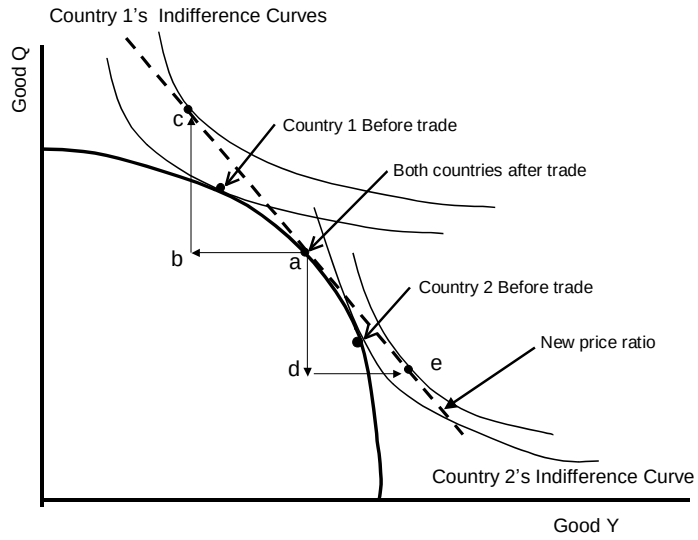
In section two the usual textbook presentation of the benefits of international trade are described along with the weaknesses in the presentation. In the third section, using the basic algebra of international trade, the simple two-country model is presented in a way that can be programmed in Excel, readily allowing student access for experimentation. In the fourth section the methodology for successfully using the model in the classroom is described. This is followed by the conclusion.

2. The textbook case

One of the current authors remembers attending a seminar in the early to mid 1970s when the speaker, Professor Ronald Jones, began by saying that while most professors who teach principles of economics claim that all countries are better off when they engage in international trade and, in fact, everyone benefits by having international trade, it is, in reality, not true. Since many of those in attendance were not international trade specialists there was a general sense of surprise and bewilderment. Most had been taught a simplistic untruth that everyone benefits by moving from a closed economy to one of free trade. This untruth is still frequently passed on in today's principles of economics textbooks.

Figure 1 illustrates an example of the familiar textbook presentation of the benefits of international trade. In the specific example given it is assumed that there are two countries with the same factor endowments but with different social welfare functions, i.e. different social indifference curves. Without international trade (Figure 1) each country maximises its social welfare and finds an optimal place on its own respective PP curve. The domestic price ratios for each country are shown and are different for different countries with good *Q* being relatively more valuable in country 1 and good *Y* relatively more valuable in country 2. Figure 1 also shows the result after international trade takes place. Each country can reach a higher social indifference curve. In this case, country 1 shifts to producing more of good *Y* and less of good *Q* while country 2 shifts production to more of good *Q* and less of good *Y*. A common international price ratio, such as the one shown, is established and it is required that imports and exports match for both countries. In Figure 1 this implies that $cb = ad$ and $ba = de$.

Figure 1: Trade with a Social Indifference Curve



The solution shown in Figure 1 depends on the existence of well-behaved social indifference curves such as those shown. Fortunately or unfortunately, as Kenneth Arrow (1951) pointed out long ago, social welfare functions with well-behaved social indifference curves such as in Figures 1 probably do not exist, except possibly in the case of one indicating the tastes and preferences of an absolute dictatorship.

Perhaps the closest thing to a known social welfare function (SWF) is that which was derived by Negishi (1960) for a perfectly competitive economy. Negishi proved that under the most common assumptions for a perfectly competitive economy the society "acts as if" it is maximising a specific SWF, subject to the standard supply and demand conditions and production technologies. The Negishi function is the weighted sum of the utility functions of the respective households with the weights equal to the reciprocals of their marginal utilities of income. This SWF cannot, of course, satisfy all of Arrow's (1951) desirable attributes for a social welfare function, e.g. transitivity and completeness. This is because Negishi's SWF is not independent of the PP curve. The weights placed on individual households in the SWF, i.e. the reciprocals of the marginal utilities of income, are directly dependent on the production processes. Nevertheless, when a society chooses a free enterprise, competitive economy, based possibly on its attributes of freedom and efficiency, it is implicitly acting "as if" it seeks to maximise the Negishi SWF. Thus, when comparing two states of the economy in a competitive model the changes in the Negishi SWF can be used as a measure of gain or loss for the entire country. The Negishi SWF, however, cannot be used to determine the optimal point on the production possibility curve. It can only be measured after the optimal point is obtained through other demand and supply conditions.

3. The equations of the two-country model

In 1971 both Ronald Jones (1971) and Paul Samuelson (1971) worked out the simple algebra of a closed two-good economy. Every point on a production possibility curve generates incomes to the factors of production. These, in turn, create demands for the goods produced. The point on a production possibility curve where supply and demand are equal for both goods is the economic equilibrium solution. No SWF or social indifference curves such as in Figure 1 are needed to determine the optimal point on the production possibility curve. When this closed algebraic system is applied to two countries with free trade the solution requires that the total demand equals total supply and that there be a single international relative price ratio. By making some specific assumptions on individual preferences the model can be closed and appropriate search procedures used to find the solutions for closed

economies and open economies. In fact, the equations necessary to solve a specific problem can be simulated in an available software package such as Excel.

In the current case some, but not all, of the equations related to deriving the PP curve for a single country are found in Hamlen and Hamlen (2006). These equations are combined and expanded here for a two-country trade model. The Excel model allows students to experiment and see for themselves the possible outcomes under different scenarios. The model does not require that there exists any particular "returns to scale" in production. It does require that there be no increasing "returns" to any factor of production but this is a standard assumption. Factors of production, i.e. labour and capital stock, are assumed to receive the value of the marginal physical product of the last unit hired but when the returns to scale are not unitary the difference, plus or negative, is assumed to go to the owners of the capital stock.

One immediate result is that going from a closed economy with no international trade to an open economy with international trade generally helps some factors of production but hurts others. This does not imply that those gaining could not potentially compensate the losers but, if so, such compensation rarely occurs. And if some policy of compensation for accepting international trade was added to the competitive model the new behaviour rules for the participants would have to be derived. The competitive results derived by Negishi would no longer hold.

The Production Equations

Each country is assumed to produce the same two goods, good Q_i and good Y_i, i = 1,2. These are produced using Cobb-Douglas production functions:

$$Q_i = A_i L_i^{\alpha_i} K_i^{\beta_i}, i = 1,2 \tag{1}$$

and:

$$Y_i = B_i(\bar{L}_i - L_i)^{a_i}(\bar{K}_i - K_i)^{b_i}, i = 1,2 \tag{2}$$

where $\bar{L}_i, and \bar{K}_i, i = 1,2$ are the endowments of labour and capital in each country.

To obtain the PP curve in each country, it is useful to make most other variables a function of one of the inputs, say L_i, i = 1,2. To obtain the Edgeworth–Bowley contract relationship in each country, the total differentials of (1) and (2) are taken and dQ_i and dY_i are set equal to zero. Then the slopes of the isoquants, dK_{ji}/dL_{ji}, j = 1,2 and i = 1,2 for both goods, j = 1,2 are obtained and set equal to each other for each country. From this we obtain the relationships:

$$(\alpha_i/\beta_i)(K_i^{1-\beta_i}/L_i^{1-\alpha_i}) = (a_i/b_i)[(\bar{K}_i - K_i)^{1-b_i}/(\bar{L}_i - L_i)^{1-a_i}], i = 1,2 \tag{3}$$

For any value of L_i, i = 1,2 and production parameters, α, β, a, b, A and B, a value of K_i I=1,2 can be obtained that solves equation (3). This provides the relationship $K_i = g_i(L_i)$, i=1,2. Therefore we can graph the following equations to obtain the PP curves in each country:

$$Q_i(L_i) = A_i L_i^{\alpha_i}[g_i(L_i)]^{\beta_i}, \ i = 1,2 \tag{4}$$

and:

$$Y_i(L_i) = B_i(\bar{L}_i - L_i)^{a_i}[\bar{K}_i - g_i(L_i)]^{b_i}, \ i = 1,2 \tag{5}$$

The slopes of the PP curves are needed to construct the price ratios and to find the final solution after the countries move from closed economies to open economies. Using equations (4) and (5) the increments along the PP curves can be obtained. These are given by:

$$-(P_{Yi}/P_{Qi}) = [\Delta Q_i(L_i)/\Delta Y_i(L_i)],\ i = 1,2 \tag{6}$$

Since only the relative prices are relevant P_{Qi}, i= 1,2 is set equal to 1.

Demand Equations

In each country there is assumed to be two groups of individuals, those who derive their income from labour and those who derive their income from owning the capital stock. We allow each group to have a single representative utility function. This assumption can be further relaxed to allow for subgroups, although there is not much to be gained for such an extension. For the utility functions we use simple homogeneous utility functions of degree 1. These are given by:

$$U_i(Labour_i) = D_i Q_i^{s_i} Y_i^{t_i},\ D_i, s_i, t_i > 0, s_i + t_i = 1, i = 1,2 \tag{7}$$

and:

$$V_i(Capital_i) = E_i Q_i^{w_i} Y_i^{x_i},\ E_i, w_i, x_i > 0, w_i + x_i = 1, i = 1,2 \tag{8}$$

The indirect utility functions are easily derived and are given by:

$$U_i(Labour_i) = M_{Li}^{s_i+t_i}[P_{Qi}^{-s_i} P_{Yi}^{-t_i} (s_i + t_i)^{-s_i-t_i} s_i^{s_i} t_i^{t_i}], i = 1,2 \tag{9}$$

and:

$$V_i(Capital_i) = M_{Ki}^{w_i+x_i}[P_{Qi}^{-w_i} P_{Yi}^{-x_i} (w_i + x_i)^{-w_i-x_i} w_i^{w_i} x_i^{x_i}], i = 1,2 \tag{10}$$

where M_{Li} and M_{Ki} are the incomes of the labour and capital stock owners in each country respectively.

The Negishi (competitive) SWF in each country is given by:

$$W_i = (1/\lambda_{Li})U_i(Labour_i) + (1/\lambda_{Ci})V_i(Capital_i),\ i = 1,2 \tag{11}$$

where λ_{Li} and λ_{Ci} are the marginal utilities of income for labour and capital stock owners in country i respectively. These can be calculated by the well-known first order condition that $\partial U_i(Labour)/\partial Q_i = \lambda_i P_{Qi}$ and $\partial V_i(Capital_i)/\partial Q_i = \lambda_i P_{Qi}$

Next we assume that there is a competitive market for labour and thus given the Cobb–Douglas production functions we obtain income to labour as:

$$M_{Li} = \alpha_i Q_i + a_i P_{Yi} Y_i,\ i = 1,2 \text{ and } P_{Qi} = 1 \tag{12}$$

The income to capital stock owners is assumed to be equal to the value of output not claimed by labour. When there are decreasing returns to scale in both goods this solution provides a surplus beyond the perfectly competitive value. Thus the income to capital stock owners in each country is:

$$M_{Ki} = (1 - \alpha_i)Q_i + (1 - a_i)P_{Yi} Y_i,\ i = 1,2 \tag{13}$$

The income equations (12) and (13) along with the first order conditions for the optimal product selection provide the demand equation for one of the goods, e.g. good Y_i, as a function of labour, L_i. This demand can be set equal to the supply Y_i to yield the following equilibrium condition for each closed country:

$$\frac{[\alpha_i Q_i(L_i) + a_i Y_i(L_i)(P_{Yi}/P_{Qi})]}{[(s_i/t_i)+1]} + \frac{[(1-\alpha_i)Q_i(L_i) + (1-a_i)Y_i(L_i)(P_{Yi}/P_{Qi})]}{[(w_i/x_i)+1} - Y_i(L_i) = 0 \qquad (14)$$
$$i = 1,2$$

By varying L_i from 0 to $\bar{L}_i$, $i = 1,2$ the location on the PP curve where the total supply equals the total demand for both goods can be obtained. At this point one can also evaluate the utility achieved by labour and capital stock owners using equation (9) and (10). This all accomplished for two closed economies.

The next problem requires obtaining the open economy solution. In this case the total demand must equal the total supply there must be a common price ration. This can be accomplished using equation (14) but combining the demands and supplies for both countries. Then using a search routine it is possible to find solution where the total demand for goods equals the total supply (equation 14) and there is a single price ratio between countries. Incomes for all factors of production in each country are re-calculated using the new international price ratio and equations (12) and (13). Next the utility for each representative in each country can be calculated. This is the open economy solution. We know from basic international trade theory, of course, that there can be situations where international trade between two counties has only a boundary solution or no unique solution. Most of the situations used in the model presented above do not run into that problem.

Comparing the autarky and open trade solution using the model allows not only the differences in production in each country to be examined but also the differences in happiness (utility) of the representative individuals in each country as well as the changes in the Negishi SWF.

4. Use of the model

The two-country trade model has been used extensively in an advanced (senior) undergraduate course as well as less extensively in required core MBA courses in economics. It was used along with many other similar models developed primarily in Excel. In fact, use of such models was the focus of the advanced undergraduate course. The answer to an important pedagogical question was sought: Does use of interactive computer models facilitate the learning experience? The computer models are not used alone without the basic theory related to the models.

The first time the course was taught, only average student evaluations were obtained (3.5 out of 5 with 5 being the top evaluation and the question being: “how much did you gain from this course?”) Since it was an experimental course the students seemed willing to share their views. It turned out that the particular method of using the interactive computer models was the primary fault. The models were initially presented to the students and then they were given lengthy assignments to complete using the models. They would change the parameters and then write down the resulting changes in the outcomes of the models. Students admitted that, given the demands on their time in other courses, they found it expedient and optimal to just change the parameters in the models and fill in the resulting answers. There was very little learning involved.

Subsequently, it was found that the models were more beneficial to the learning process when used primarily within the classroom and not for assignments. The successful approach was to briefly present an overview of the theory and then ask the class to predict the results if specific changes were made to the parameters of the models. Using this method, near perfect evaluations were obtained (close to 5

out of 5) and the students were very enthusiastic about developing a logical instinct about making economic predictions. Of the many models used the current two-country international trade model and one that modelled the Grossman and Stiglitz (1980) financial market with informed and uninformed investors were the most popular. Some of the students went beyond the course requirements working on the models at their leisure and then bringing interesting questions to the classroom. Though the interactive models have only been in use for several years it has become clear that they are most appreciated by students in an elective course rather than a required core course. An elective course with an enrolment of approximately twenty-five students is an ideal setting. This allows for approximately five teams of five individuals.

Two examples of in-class problems are described below. In working these examples two interesting questions are: (1) To which good would we expect each country to shift its production after going from a closed economy to an open economy and; (2) Which factor of production is likely to gain or lose in each country when going from no trade to free trade? Working extensively with the current model has led to some predictive rules. When going from a closed economy to an open economy, countries tend to produce more of (specialise in) the good that has the lower relative price before trade. In addition, a factor of production will tend to gain (lose) when free trade occurs if the good the country is going to increase (decrease) in production is that which more (less) abundantly rewards that factor of production.

Example One

Figures 2 and 3 show an initial solution for two countries when they are closed economies and then after trade takes place. Table 1, Example 1, provides the parameter values and outcomes. In using the Excel model the questions submitted to the students is not: what *will* certainly happen when two countries begin to trade? Nor is it: what *could* possibly happen when two countries begin to trade? The useful question is: what is *most likely* going to happen? It is important to remind the students that a simulation model cannot provide universal conclusions.

Figure 2: Country 1

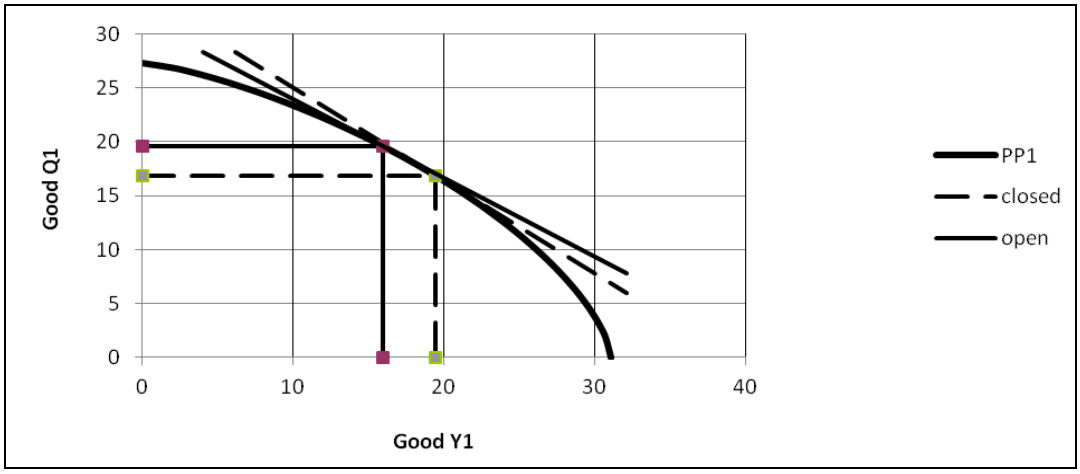


Figure 3: Country 2

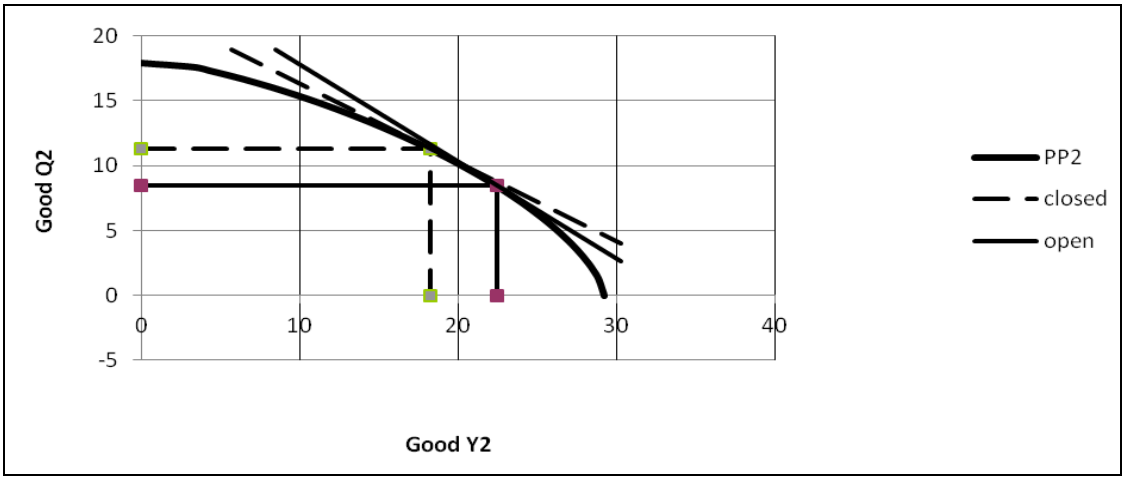


Table 1: Country 2

	Exercise 1			Exercise 2	
Parameters	**Country 1**	**Country 2**	**Parameters**	**Country 1**	**Country 2**
Lb	600	80	Lb	600	80
Kb	20	100	Kb	20	100
α	0.4	0.4	α	0.55	0.55
β	0.25	0.25	β	0.7	0.7
a	0.35	0.35	a	0.35	0.35
b	0.4	0.4	b	0.4	0.4
s	0.5	0.5	s	0.5	0.5
t	0.5	0.5	t	0.5	0.5
w	0.5	0.5	w	0.5	0.5
x	0.5	0.5	x	0.5	0.5
A	1	1	A	1	1
B	1	1	B	1	1
Changes	**Country 1**	**Country 2**	**Changes**	**Country 1**	**Country 2**
PY/PQ(bt)	0.86	0.61	PY/PQ(bt)	10.24	11.09
PY/PQ(at)	0.74	0.74	PY/PQ(at)	10.4	10.4
ΔU(L)	0.17	–0.02	ΔU(L)	–1.49	1.41
ΔU(C)	–0.01	0.28	ΔU(C)	1.52	–1.15
ΔQ	2.71	–2.51	ΔQ	–47.08	37.42
ΔY	-3.47	3.76	ΔY	4.55	–3.47
ΔSWF	-2.24	2.96	ΔSWF	2.5	–8.08

In Example 1 both countries have the same production functions and labour and capital stock owners have the same preferences in both countries. The difference is in the factor endowments. Country 1 has relatively abundant labour while country 2 has relatively abundant capital stock.

What can we predict when this two-country world shifts from closed economies to open economies? Before international trade the price ratio of good *Y* for good *Q*, in country 1, is $\Delta Q_1/\Delta Y_1 = -P_{Y1}/P_{Q1} = -0.8567$ or $P_{Y1}/P_{Q1} = 0.8567$. The ratio in country 2 is $\Delta Q_2/\Delta Y_2 = -P_{Y1}/P_{Q1} = -0.608$ or $P_{Y1}/P_{Q1} = 0.608$. Thus good *Q* is relatively cheaper in country 1 than in country 2, or equivalently, good *Y* is relatively more expensive in country 1 than in country 2. It is reasonable to assume that after international trade takes place each country will tend to produce more of the good that is relatively cheaper in their country, i.e. where it has a comparative advantage. So country 1 produces more of good *Q* and less of good *Y* and country 2 will produce more of good *Y* and less of good *Q*. This prediction is confirmed in the results shown in Table 1.

The parameters α and "a" in the production function also provide the relative shares of the value of outputs *Q* and *Y* respectively that go to labour. Thus $\alpha = 0.4$ and $a = 0.35$ tells us that labour tends to get a greater share of the value of the output of *Q* than of *Y*. Thus, in country 1 we would expect labour to benefit from the increase in production of *Q*. Simultaneously, labour will tend to be hurt in country 2 as it reduces its production of good *Q*. We find from Table 1 that this is the actual result. The change in utility for labour is positive in country 1 and negative in country 2. The opposite results occur for the owners of capital stock. As an added feature we find, using the Negishi measure of social welfare, that country 1 has a net decline and country 2 a net increase.

Example Two

The parameter values for the second situation are also shown in Table 1, Example 2. For the conservation of space the figures are not shown. Everything is the same as in Example 1 except now there are increasing returns to scale in the production of good *Q*.

Again, the important thing to look at is the relative price ratio of the two goods before free trade takes place since with free trade countries will tend to specialise in the good that is relatively cheaper. We see that in the closed economy situation good *Y* is the relatively cheaper good in country 1, $P_Y/P_Q = 10.24$ and good *Q* the relatively cheaper good in country 2, $P_Y/P_Q = 11.09$. Thus after free trade takes place country 1 would be expected to produce more of good *Y* and country 2 to produce more of good *Q*. This is exactly what we find in Table 1, Exercise 2. Country 1 increases its production of *Y* and country 2 increases its production of good *Q*.

Next, we look at the parameters α and "a". These represent the shares of the value of goods *Q* and *Y*, respectively that go to labour. The share of the value of good *Q* going to labour is $\alpha = 0.55$ and the share of the value of output of good *Y* going to labour is $a = 0.35$. Thus labour would prefer to see an increase in the production of good *Q* where it receives the relatively greater share. When free trade takes place country 1 increases its production of good *Y* and decreases its production of good *Q*. This, in essence, is expected to hurt labour in country 1. On the other hand, country 2, with free trade, will increase its production of good *Q* and labour will gain in this country. From table 2 we find that these predictive rules are confirmed in the analysis. Labour loses and capital stock owners gain in country 1 with the presence of free trade. The opposite holds true for country 2. Also in this example the net change in Negishi's measure of social welfare favours country 1 over country 2.

5. Conclusion

The above model was developed to show the students the outcomes of going from a closed economy to a free trade economy. Unlike the traditional model, which assumes the existence of social indifference

curves, the current applied model is based on the Samuelson/Jones (1971) theoretical models that present closed systems without the assumption of social indifference curves. At every point on the production possibility curve the combination of goods produced also generate incomes to the factors of production. Given preferences by representative labour and capital stock owners there is an associated demand for the goods produced. In a closed economy the solution in each country is one in which the total demand equals total supply. Where this occurs on the production possibility curve the relative price ratio of the two goods can be obtained by computing the slope of the production possibility curve. With free trade the solution changes to one in which the total demand by both countries equals total supply by both countries and the price ratio of the final goods (i.e. slopes of the production possibility curves) are identical in each country.

Using the interactive model the student finds that going from a closed economy to an open economy does not usually make everyone better off. The gains to trade results obtained in the traditional model usually depend on the assumption that there are social indifference curves. Yet no such social indifference curves are likely to exist unless they are imposed, such as those of the dictator's in Arrow's impossibility theorem.

Learning how to use interactive economic models in the classroom is as important as developing the model. First, the model has to closely conform to the microeconomic theories upon which it is built. The traditional model with its assumed social indifference curves does not remain honest to its microeconomic foundations.

In the course that used the above model the students were very familiar with the Cobb-Douglas production function and the similar homogeneous utility function. They had already learned about production possibility curves. Second, the models should be used in the classroom with student participation encouraged. Possibly the best way to do this is to allow students to make predictions without the fear of grade repercussions and then provide immediate feedback on the results. Third, the models should be made readily available to the students outside of class, especially for the more interested students, but assignments based on using the models is not likely to lead to successful learning experiences.

The two-country trade model is currently being extended to increase the complete interaction. A programme has been constructed that requires students to rank bundles of two goods. This then generates the parameter values of the utility functions used in the above two-country model. In the same course, the students generate the production function parameters by playing simple games in the classroom. These games involve labour (the students) and some form of capital stock. For example one, "paper-throw" game that has been successful requires adding students and crumbled papers (balls) and throwing these into a basket at ten feet. By varying the number of students and balls and then counting the number of baskets per minute, enough data is collected to estimate the Cobb-Douglas production function. The output is made representative of one of the goods in the PP curve. Other different games or separate experiments with the "paper throw" game can be used to generate the production parameters of the second good. When all is complete and tested the students will, in essence, have created enough data to solve a domestic PP curve. By dividing the class into two countries, or in some cases using two separate classes we are able to repeat this operation. Then we can show the final results of closed and open economies.

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Toward Teaching Markets as Complex Systems: A Web Based Simulation Assignment Implemented in Netlogo

Tim Kochanski

Abstract

This paper is based on a simulation model, programmed in NetLogo, that demonstrates changes in market structure that occur as marginal costs, demand, and barriers to entry change. Students predict and observe market structure changes in terms of number of firms, market concentration, market price and quantity, and average marginal costs, profits, and markups across the market as firms innovate. By adjusting the demand growth and barriers to entry, students can explore market changes in terms of the output variables mentioned above. The exercise allows students to synthesise information from several different chapters of the text that discuss differing market structures including perfect competition, monopoly, monopolistic competition, and oligopoly. Finally, the exercise exposes students to computational methods, simulation, and a dynamic perspective on the static models provided by the course text.

JEL classification: A22, C60, D40, D41, D42, D43

1. Introduction

While simulations can provide both a dynamic environment for static models of economics (Kochanski, 2007; Paetow, 1998; van Loo and Maks, 1996) and allow the implementation of agent based computational economic modelling, they also introduce students to the idea of building economic models and simulations themselves, leading them down a path toward programming proficiency. This paper describes how principles of economics students were introduced to a market simulation where they controlled two parameters (demand growth and barriers to entry) while firm innovation occurred via localised agent-environment interactions. The students were asked to make predictions, drawing from material introduced in their principles of economics text and after running the simulation, to reflect upon how the results compared to their predictions[1].

In the textbook, dynamic processes are reduced to simple static analyses where there are two points of interest, equilibrium before a supply or demand curve shifts and equilibrium after a shift. If the model is not in equilibrium then students are taught that the market mechanism will bring it to equilibrium. Unfortunately, today's textbooks do not explore models or explanations of how the dynamics of the market mechanism might play out as with zero intelligence traders for example (Gode and Sunder,

[1] Course textbook was Bradley R. Schiller, *The Economy Today* (Boston: McGraw-Hill Irwin, 2008).

1993). In most cases, the text can even leave students unable to imagine a world where supply and demand curves are bouncing around due to continual changes in determinants of supply and demand leading to an endless dance of equilibrium. It can be even more difficult for students to imagine how to begin sorting out the many competing effects a mass of changing determinants has on an equilibrium.

This paper demonstrates how simulations can allow students a view into both the dancing dynamics of equilibrium models, a Cournot model in this case (Cournot, 1838), and the generative models of agent based modelling. Students can observe market outcomes of price and quantity, profit, market concentration, market power, and number of firms. By adjusting parameters students can study the behaviour and rate at which the market transitions over time. They can also experiment with combinations of parameter settings such as low barriers with falling demand to see which effects appear to dominate, giving them an appreciation for the complexities that arise from an interconnected set of parameters. The assignment also demonstrates the process of agentising a model through the innovation process mentioned above and gives them an appreciation for the complexities that arise when introducing heterogeneity and localised interactions to models.

NetLogo is a well-known agent based simulation package with applications across the disciplines. It provides powerful modelling, graphical, and statistical components for both the novice and expert modeller. Saving the simulation as a java applet also provides students with an easily accessible web based program containing a user-friendly graphical interface (dashboard), the NetLogo code, and a text editor allowing a display of the assignment.

The NetLogo code for the assignment is provided to the students so for this exercise they are not required to do any programming though the code is visible for them to examine and revise. With NetLogo students gain a better understanding of how iteration can turn static models into dynamic ones. Students gain an understanding of how computational models can be built and can begin to ponder the differences between top down analytic models of today's mainstream economics texts and the bottom up generative models slowly emerging on the discipline's horizon (Colander, 2003).

In the following sections, I begin by providing some background on the computational modelling of markets and discussing implementation of the model within NetLogo. I then introduce the market simulation assignment, discuss the simulation results, and summarise student predictions and observations for the various questions. I end with a general discussion of the assignment, student responses to the assignment, and some concluding remarks.

2. Background: computational modelling of a market

There are several ways to simulate markets, from designing zero intelligence traders (Gode and Sunder, 1993)[2] to simply placing the equations of an analytic model from a mainstream textbook into a computer package such as Mathematica and changing parameters iteratively (Kochanski, 2007). The model implemented here is essentially a hybrid. It is based on a Cournot solution for the *n*-firm case (Sarkar *et al.*, 1998) where firms have heterogeneous cost structures (see Appendix A for derivation). The model is unique in that it produces exact monopoly and perfect competition solutions (at $n=1$ and as $n \to \infty$ respectively) and produces the intermediate equilibrium outcomes consistent with models of imperfect competition. That said it has characteristics of an agent-based model as well since firms follow a few simple rules as they interact locally with their environment in process innovations.

While students in the course learn the mathematical frameworks for perfect competitors and monopolists they were not exposed to the derivation of the Cournot solution. It was discussed during the section of the course covering imperfect competition. Several introductory texts, including the

[2] Mark McBride has implemented the model designed by Gode and Sunder in NetLogo. http://mcbridme.sba.muohio.edu/ace/labs/zitrade/zitradenetlogo.html

Schiller text used for the course, introduce students to the idea of firm interdependence with the oligopolist's kinked demand curve and the game theory payoff matrix. The Cournot model of firm interdependence dovetails nicely into this section of the course material.

In the context of imperfect competition, typical classroom discussions include oil cartels, collusion, the airline industry during deregulation, and how the interactions of a changing business environment with differing cost structures can drastically shift each firm's respective market share and affect market concentration.

When studying imperfect competition, students see the powerful price cutting incentives behind cartels such as OPEC and gain a deeper understanding of how firms, such as Pan Am in the 1980's can lose market share and ultimately exit a market. Finally, they can see how falling costs and changing demand affect market price and output and how changing barriers affect market entry. They also gain understanding of how all the above affect market concentration.

3. Implementing the model in NetLogo and running the simulation

Students are first introduced to the basic mechanics of the model and instructed on how it works. Then they are instructed on how to use the parameter adjustments on the NetLogo dashboard and how to interpret the simulation's graphical output. Finally they are asked to try several different parameter configurations, to make predictions based on theory from the textbook and course material, to comment on what they observe, and at the end of the assignment to comment on how market simulations might serve businesses and policy makers. The sections below outline the assignment as provided to the students.

What is it?

This is a Cournot model named after the French economist Antoine Augustin Cournot (1801-1877). It is commonly used to model imperfect competition in cases where firms have some market power and must choose a level of output to produce that considers the responses of their competitors as well. The resulting price and output end up somewhere between what perfect competition and monopoly markets would produce and is a Nash Equilibrium.

How it works:

The simulation begins with 20 firms when you click the [SETUP] button. When you click the [GO] button the simulation begins and runs for 1000 time periods (days). At each point in time we can see on the graphs: 1) the Cournot equilibrium market price and quantity, as well as average MC in the market, 2) the average profit of firms in the market, 3) the market concentration as measured with the HHI (Herfindal-Hirschman Index), 4) the number of firms in the market, and 5) the average price markup or (Price/Avg.MC).

In this simulation, firms are moving randomly across a business landscape. When they enter the green patch in the centre they spend some of their accumulated profits on productivity innovations, assuming they have accumulated such profits. This lowers their marginal costs and gives them an advantage over their competitors. For the innovating firm, this leads to more market share, higher profits, and increased market concentration.

How to use it:

There are two parameters that can be adjusted to affect how the simulation plays out.

1) Demand growth, setting this to a positive value means that the market demand curve gradually increases over time.

2) Barriers to entry, determine how costly it is for new firms to enter the market. At the lowest setting we have perfect competition conditions. At high setting we have oligopoly or even monopoly conditions.

Things to notice:

1) If HHI is increasing then either some firms are gaining market share from others, or, firms are exiting the market creating more market share for the remaining firms. It is likely that both affects are occurring simultaneously.

2) If number of firms is increasing then HHI should on average decrease (unless, due to the other affect discussed above some firms are gaining market share over the new entrants).

3) As the market becomes more concentrated market prices should increase.

4) As average profitability increases this creates the incentive for new firms to enter (depending on the level of barriers).

5) Chaotic events can happen in a dynamic setting with several interacting components. As new firms enter, innovate, increase profits, etc. the results may be quite predictable and smooth or in some cases may be chaotic with wild fluctuations.

Note: when the simulation stops before 1000 rounds it means that all firms have exited the market, even the last remaining firm, which was a monopolist.

After being introduced to the graphical display of the simulation, students are then asked to perform several different operations, to make predictions based on theory introduced in the course, and to describe how the simulation performed relative to their predictions.

Things to try:

Please provide answers to the following questions. I prefer typed responses but hand written responses that are clearly legible will suffice. Feel free to incorporate graphs, equations, or sketches in your responses.

1) When you click [SETUP] the first time conditions similar to perfect competition are generated (no barriers). Additionally demand is held constant. What do you expect to happen when you run the simulation for the following: Average profitability, HHI, number of firms, market price, and market quantity? Just say if you expect them to increase for decrease. Will market price be close to marginal cost (MC pricing) or above average marginal cost (markup pricing)?

Make sure the settings are at:
[DEMAND GROWTH] = 0
[BARRIER] = 0
Now run the simulation. It might not finish if an infinite number of firms flood the market. If so, what happened to the above mentioned measures as firms entered?

The simulation produces results consistent with mainstream theory under conditions of perfect competition, namely falling prices and increased market output (to a point), low market concentration, low profit, a large number of firms, and little or no markup.

From the mainstream perspective this example is characterised by the market supply curve shifting to the right over time as new firms enter the market. The effect is not as dramatic however since firms that exist in the market become smaller and smaller as the market saturates. Since firms cannot accumulate profit they are unable to reduce costs by investing in cost reducing R&D projects.

Most students made predictions consistent with a perfectly competitive market where firms are reducing costs through innovation, namely that, with low barriers to entry and constantly falling costs, a large number of firms enter the market, causing low market concentration, falling prices, increased output, minimal or no profit, and no markup.

Figure 1

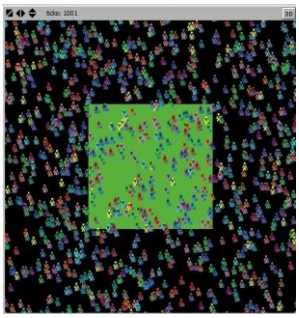
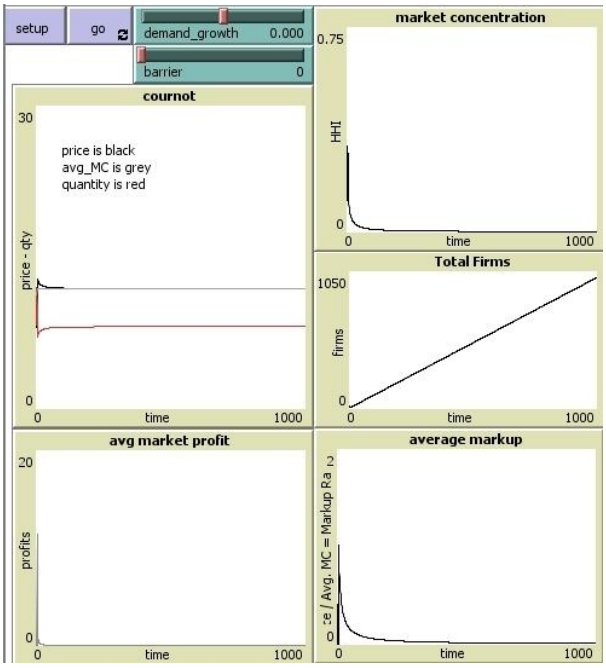


Figure 2



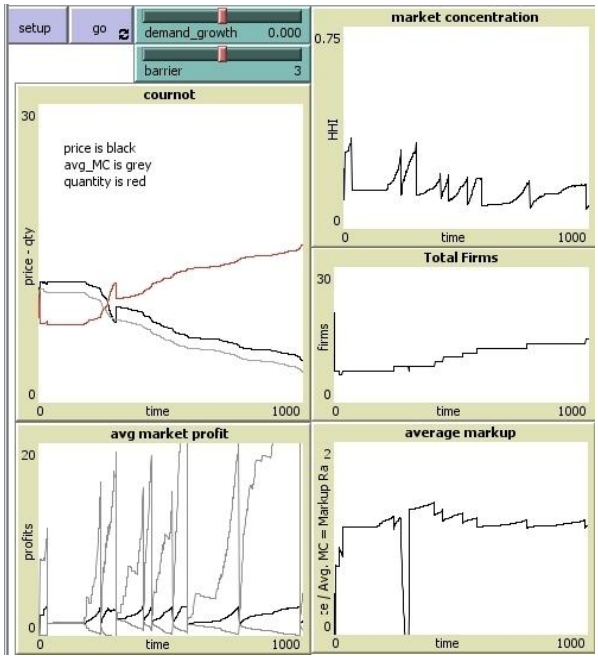
2) Next, we'll keep all settings as they were but we will increase [BARRIER] TO 3.
How do you expect the results to differ from question (1) in terms of: Average profitability, HHI, number of firms, market price, and market quantity and the price markup? Run the simulation. What happened? Were the results more chaotic or volatile?

The simulation produces results consistent with mainstream theory, a moderately concentrated market, moderate profit levels, a modest number of firms (about 30), and some degree of market power with price markups. With moderate barriers, profits are positive, allowing money for cost-reducing innovations, which cause falling prices and increased output. From the mainstream perspective this is characterised by the market supply curve shifting to the right over time as firms reduce marginal costs and a few new firms enter the market.

Most students predicted the higher barriers would lead to higher market concentration, fewer firms, and some degree of profit for firms in the market. They predicted increased output and falling prices and a few identified uncertainty due to the mix of effects on price resulting from falling costs, new entrants, and the markup associated with market power.

Figure 3

Figure 4



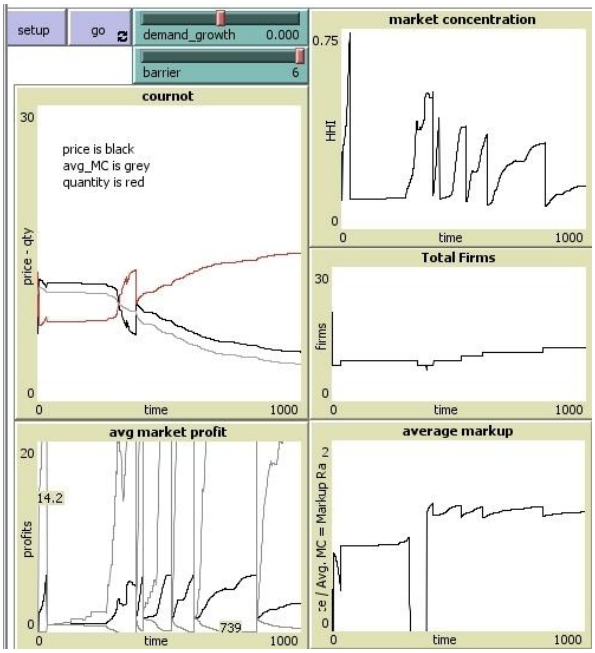
3) Keep the setting from question (2) but increase [BARRIER] TO 6 and run the simulation. What happened to: Average profitability, HHI, number of firms, market price, and market quantity and the price markup? Did the simulation run with more or less volatility?

In this question the results are similar to the previous case but with larger fluctuations in profit and market concentration. In general, the market experiences falling prices, increased market output, an even more concentrated market, moderate profit, fewer firms than in the previous question, and market power with some degree of markup.

Given the similarity between this question and the previous one, students generally predicted that the even higher barriers would lead to even fewer firms, a higher market concentration, and higher profits. Some also predicted longer delays between new firm entrants since the barriers to entry were higher.

Figure 5

Figure 6



4) Now set [BARRIER] TO 3 (moderate barriers) and increase [DEMAND GROWTH] TO .001. According to our text, what happens in a market when demand is increasing? Does equilibrium price increase or decrease? What about equilibrium quantity? Do you expect that the market would be able to accommodate more or fewer firms? Run the simulation. Do the results support your theory? Is price close to the average marginal cost for the industry? Try the simulation with [DEMAND GROWTH] set to –0.001. Does the opposite happen?

This is a two-part question identical to question (2) above but with the addition of shifting demand. Regarding the first part with increasing demand, firms in the industry have some markup power given the moderate barriers, yet profitability from increasing demand entices other firms to enter the market. While price reductions are comparable to above, the market quantity has increased dramatically and more firms (just over 30) are accommodated.

Many students predicted that increased demand would put upward pressure on price and increase market output while accommodating more firms in the market, lowering market concentration[3].

[3] Throughout the assignment, students occasionally made common errors regarding the direction of price and quantity changes associated with shifting curves.

Additionally many predicted the entrance of new firms would also increase output while placing downward pressure on price. Some commented on the indeterminate effect on price due to the competing pressures resulting from increased demand and increasing supply resulting from new entrants and cost reducing innovations.

Figure 7

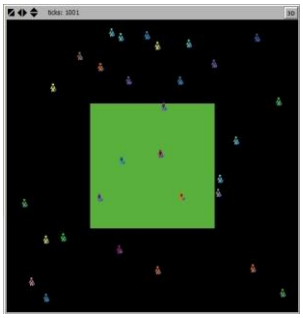
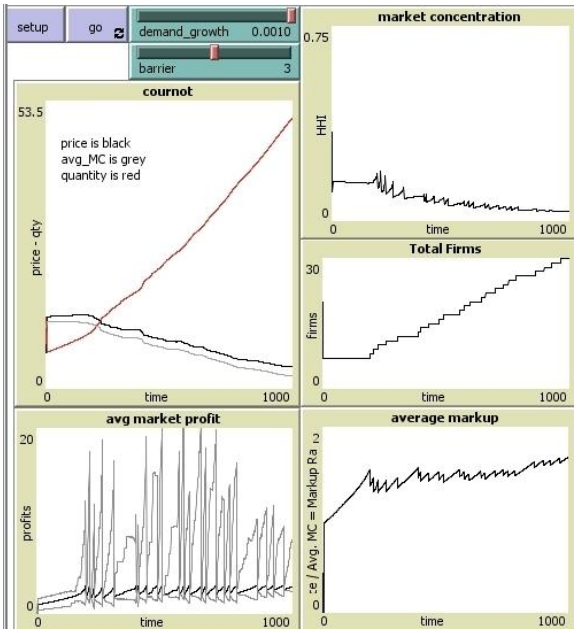


Figure 8



For part two of the question with moderate barriers and falling demand almost all firms are squeezed out of the market. The remaining firms are forced to lower prices as demand continues to fall and toward the end of the simulation price and profits approach zero. The result is a highly concentrated yet unsustainable market that ultimately collapses due to insufficient demand.

Most students simply predicted the opposite effect relative to part one (with increasing demand) though a few commented on the downward price pressure and decreased output that should result from falling demand. No students predicted market collapse due to insufficient demand.

Figure 9

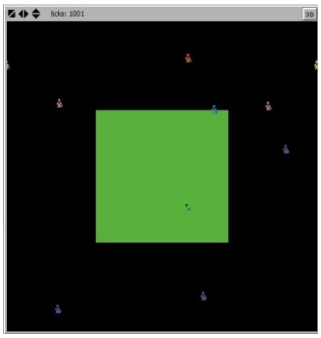
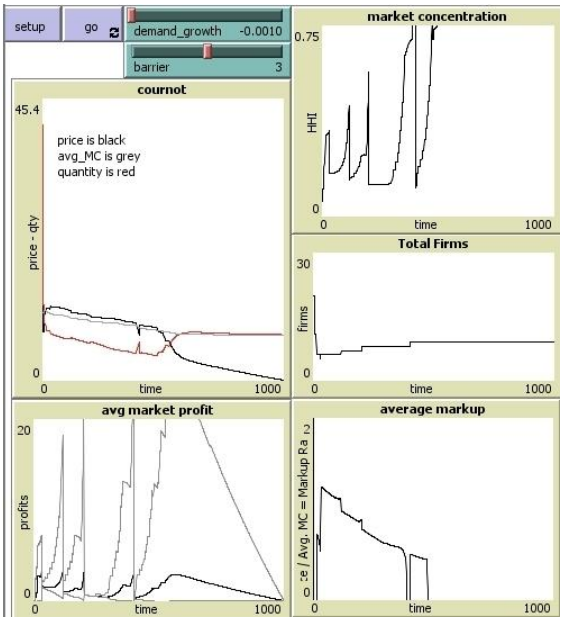


Figure 10



5) Write a few sentences about how market structure affects market performance. You might address the following: Do cost reducing innovations necessarily get passed on to consumers in the form of lower prices (do lower marginal costs mean lower prices necessarily)? Does it matter if innovations occur in a perfectly competitive market vs. a less competitive one? Why might regulators be concerned with industries that are characterised by high market concentrations?

For this question students drew from the theory in the text identifying cost reductions with lower prices and increased output but also noting that increased market power leads to pricing above marginal cost (whether costs are falling or not). Additionally, they tended to state that markets characterised by high market concentration needed to be regulated.

6) At the beginning of the term, I stated that economists make observations of economic participants and their behaviour. They then develop theories based on those observations. Next, they build economic models that are consistent with those theories. Finally, they use the economic models to forecast change under different conditions. How might simulations be useful as a policy tool for modelling a market (or the economy)?

For this question students generally pointed to well-constructed simulations as useful for both firms and policy makers interested in studying the effects of various policies. Firms, for example, could use simulations to study the effects of increased demand on profitability and the structure of the market the firm is operating in. Policy makers could study the effects on market structure of allowing mergers or promoting policies that increase market demand. Students also proposed an idea common in other simulation texts that running simulation scenarios would allow decision makers to study the effects of various policies before tinkering with their business or the economy.

4. Student response to the assignment

This exercise was conducted as an extra credit homework assignment in two of my Introductory Microeconomic Theory courses at Portland State University. The class size was roughly 60 students per class with 28 participants in total. With such a large class size it is typically not feasible to conduct assignments that require all students to be online at the same time interacting in real-time (Schmidt, 2003; Wolf and Portegys, 2007)[4] or even working on the simulation while in a classroom setting (Sayama, 2006). The benefit of implementing the simulation in NetLogo is that files can be saved as java applets and run in a web browser at the students' convenience, requiring no software downloads or complicated installations.

This exercise provided an opportunity for students to synthesise the various market structure frameworks proposed within their text and to gain experience augmenting classic microeconomic models. Throughout the course animations were provided to instil a sense of static vs. dynamic processes.

The assignment was distributed during the middle of the term and throughout the remainder of the course discussion time was allowed regarding the assignment. Initially students were not familiar with the dashboard or simulation output as it was quite different from the graphical representations in the text. After running through the simulation a number of times, students gained an appreciation for the simulation and a better understanding of the output produced.

One weakness of mainstream texts is that while they introduce students to the short run and long run outcomes of different market structures, namely, perfect competition, monopoly, oligopoly, and monopolistic competition, there is little or no discussion of how markets might change along this continuum from perfect competition through imperfect competition toward monopoly and vice a versa. This can be a difficult task since each market structure is based on characteristics (e.g. number of firms, barriers to entry, product type (homogeneous or differentiated), and market power) that do not necessarily vary continuously[5].

That said the Schiller Economy Today text has a chapter featuring a case study with extensive coverage of the evolution of the personal computer market, which went through several changes between 1976 and 1983 as firms entered and exited the market. As mentioned above, the Schiller text also covers changes in the airline industry during the era of deregulation. This also led to significant market structure changes. It is these types of processes that simulations serve so well: allowing demonstrations of the dynamics behind market change.

[4] In smaller courses I have scheduled lab time for students to play the web-based version of John Sterman's Beer Game. http://beergame.mit.edu/guide.htm. Other options for class simulations include turn based simulations such as the Greenland Game made available by the synthetic worlds initiative at Indiana University with the goal of providing large games as research environments.

[5] While it is possible to simulate a range of product types, the assignment for this course assumed homogeneous products and allowed for variation in the other characteristics.

In general, the students expressed enjoyment in the act of testing hypotheses (e.g. what happens if I increase demand in a market with high barriers to entry). They also accepted the idea that the simulation presented was one of many potential models of how a market might function and something to be improved upon. In addition to being able to identify likely simulation outcomes for problems 1 to 4 above, students also showed an appreciation for many of the complexities associated with the interrelatedness of market structure, falling costs, and price, namely, how falling costs might affect prices differently in perfectly competitive markets versus imperfectly competitive markets. Many of their responses demonstrated an appreciation for the relationship between market structure and market power and how regulators need to be diligent in monitoring markets where market failures are evident. Finally, they noted how simulations can be used to run scenarios and test potential policies before implementing them in the real world economy, whether as a firm or a regulating agency.

5. Conclusion

Agent based simulations are increasingly implemented across the disciplines and it is unfortunate that many students of the social sciences are not exposed to the methods or software in their undergraduate coursework. Programmes like NetLogo serve as an excellent platform for students to begin developing their own models. Exposure to such programmes early in their studies will acclimatise students to modelling software and provide them with transferable skills since programming experience in one package often makes them more adept at acquiring proficiency in other programming languages. NetLogo is available as a free download for students or instructors and the java applet feature allows students to run the simulations at their convenience from a web browser with java installed.

Though time constraints may make programming exercises a stretch in principles courses, exposing students to the software in principles courses by having them run the simulation serves as an excellent introduction to programming projects implemented in upper division and elective courses. Interactions with the NetLogo dashboard provide students with a sense of how they might be able to build models from the text into a simulation, how they might build economic models of their own, and how they might tweak parameters to study outcomes and inform better policies for stronger economies.

An extension to this project might be to have the students modify existing sliders or add extra sliders to gain more control of additional parameters such as the rate at which costs fall as firms innovate, the degree of heterogeneity in costs that firms start out with, the slope of the demand curve, or the costs of process innovations. Thus introducing them to programming aspects of NetLogo and moving them down the path toward building their own models.

Appendix : derivation of Cournot solution

The n-Firm Cournot Element of the Model

To derive the *n*-firm Cournot solution Sarkar, Gupta, and Pal begin with inverse demand $P(Q) - mc_i - bq_i = 0$, where $a > 0$ and $b > 0$. Each firm chooses q_i to maximise profit, $\pi_i = q_i[P(Q) - mc_i]$. In words, profit equals total revenue minus total cost, where mc_i is each firm's marginal cost. Firm *i's* first-order condition for profit maximisation is:

$$P(Q) - mc_i - bq_i = 0 \tag{1}$$

Summing first-order conditions for all firms gives $NP(Q) - bQ = \sum_{i=1}^{N} mc_i$. Dividing this by N produces $P(Q) - \frac{bQ}{N} = \overline{mc}$, where $\overline{mc} = (\sum_{i=1}^{N} mc_i)/N_i$, the average marginal cost in the market. Substituting $P(Q) = a - bQ$ into the previous equation produces:

$$a - \left(\frac{N+1}{N}\right) bQ = \overline{mc}\,. \tag{2}$$

In equilibrium Q^*, market equilibrium can be found by setting $\overline{mc}$ equal to the linear function with the same intercept as demand but with a slope of $-\left(\frac{N+1}{N}\right) b$. So, $Q^* = \frac{a - \overline{mc}}{b}\left(\frac{N}{N+1}\right)$. From here $P^* = a - bQ^*$. Substituting Q^* yields $P^* = a - b\left[\frac{(a - \overline{mc})}{b}\left(\frac{N}{N+1}\right)\right]$, which reduces to $P^* = a - (a - \overline{mc})\left(\frac{N}{N+1}\right)$. When $N = 1$ the monopoly Q^* and P^* are produced and, as N increases, the perfect competition Q^* and P^* are produced. Equation (1) above implies that for each individual firm $q_i^* = (P^* - mc_i) / b$. Plugging P^* into q_i^* yields the reaction function for the individual firm where each firm's output is dependent on its own marginal cost as well as the average marginal cost of the market.

$$q_i^* = \frac{a}{b} - \frac{a - \overline{mc}}{b}\left(\frac{N}{N+1}\right) - \frac{mc_i}{b} \tag{3}$$

Using the variables computed above I calculate among other things firm market share and market HHI where $HHI = \sum_{i=1}^{N}\left[\frac{q_i^*}{Q^*}\right]^2$ and ranges from 0.0 – 1.0.

NetLogo file is available for download at http://www.openabm.org/model/2313/version/2.

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The Heart of Teaching Economics: Lessons from Leading Minds

Simon W. Bowmaker. Edward Elgar Publishing, 2010; 392 pages
Reviewed by Sandra Odorzynski

Looking to discover or reaffirm the heart of teaching economics? Then turn the anatomically correct cover on Simon Bowmaker's volume, where twenty-one prominent economists share their thoughts on the matter. The book is organised into three parts: *Fundamentals* with interviews of Robert Frank, John B. Taylor, Steven Landsburg, and Robert J. Gordon; *Tools* with interviews of Benjamin Polak, William Greene, and David Laibson; and *Applications* with interviews of Steven Medema, Barry Eichengreen, Carolyn Hoxby, Daniel Hamermesh, Edward Glaeser, Luís Cabral, Shoshana Grossbard, David Cutler, Nancy Folbre, John List, David Friedman, Gene Grossman, William Easterly, and Frederic Mishkin. The interviews were conducted face-to-face over the period March to July 2009, and centered on seven lines of inquiry: background information, general thoughts on teaching, the learning process, teaching philosophy and technique, course content and design, textbooks, and teaching economics in the future. Interviews were digitally recorded and transcribed, then only lightly edited to preserve the essence and spirit of the conversations.

The author claims four motivations for this book: "first, to present economists with a unique and rare opportunity to talk about teaching; second, to discover how they interpret, understand and practice their role as teachers; third, to learn lessons that can inform other people's teaching; and fourth, to shatter the illusion that teaching and research are strictly independent and competing activities" (Introduction, pg. x). In successfully achieving these goals, Bowmaker offers teaching academics, be they freshly minted or highly seasoned, the opportunity to learn from the masters. As Robert M. Solow says in his Foreword, it is not just "….little hints or recipes about classroom technique, but rather about mind-sets and attitudes" (p. vii).

Due to the light use of editing, the spontaneity of the interviews shines through, giving the reader the sense that s/he is just at the next table, perhaps in a coffee shop, casually eavesdropping on intellectual conversations with leading minds in economics. Several themes unfold as the interviews are compared. For example, when asked what they like most about teaching, many said it was seeing the light bulb go on in their students' eyes, or the *aha* moment that students experience when they *get it*. Daniel Hamermesh adapts an old line he attributes to the Jesuits: "Give me your son when he is three and you can have him back when he is seven: he is mine for life. That's especially true in introductory economics" (p. 198). William Greene sums it up best: "When a student says, 'now I get it, now I understand', there is no feeling that beats that. That's opium, it really is" (p. 103).

Most of the interviewees confess they have little formal knowledge about how humans learn. Nancy Folbre says "I know from talking with Bob Frank, and from reading what he writes, that it's important to engage students' curiosity about the world around them" (p. 290). John List credits Gary Becker and Kevin Murphy with demonstrating to him the value of explaining economics at an intuitive level. The use of active learning techniques is frequently mentioned, with John List quoting Benjamin Franklin: "Tell me and I forget, teach me and I remember, involve me and I learn." Sometimes that involvement

might include a Razor Scooter and rap song, complete with drooping pants, or California raisins – see the chapters featuring Daniel Hamermesh and John Taylor for more information. Personal anecdotes and gems too numerous to mention are sprinkled throughout the book.

Responses to the question about research and teaching being competitive or complementary are wide-ranging and relevant, particularly for academics facing rising institutional expectations in both areas over time. Robert Solow points out that "… teaching and research are both drains on a common pool of time and energy, and it would be foolish not to recognize that fact." But he also argues that "Corner solutions are not the answer…" and "These interviews suggest that the scholars and institutions involved have arrived at a viable allocation" (Foreword, p. viii).

Looking to the teaching of economics in the future, several interviewees made the case that economics will (or should) play a stronger role in education and society. Benjamin Polak says: "We're seeing two phenomena at the same time: the social sciences are expanding enormously in university education and economics is expanding as a toolkit, as a technique, as a set of standards if you like, with the social sciences" (p. 99). Nancy Folbre argues that social science is not keeping pace with the problems being generated in the 21st century. She suggests that much can be learned from economists' studies of race and gender, and those insights are transferable to issues of environmental instability, extreme income inequality, and intensified military and ethnic conflicts across the globe.

This book is highly recommended for anyone who aspires to be or already is engaged in the art of teaching economics at the undergraduate or graduate level. Novice and veteran teachers will both come away with fresh perspectives on best practices in the field. It would be useful as well to high school teachers and trainers of teachers, although several questions from the interview script are not relevant to the work that those professionals perform. Three-fourths of the interviewees are associated with private universities, with the remaining at public institutions. Since all twenty-one teach at research universities, the insights they provide resonate most strongly for academics with similar affiliations. However, this reviewer, a lifelong academic at small, liberal arts institutions, found the volume to be highly engaging and applicable to that environment. Perhaps Bowmaker has a sequel in mind for those of us who toil in those trenches.

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