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A neo-classical demand model for higher education in Belgium

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ABSTRACT

In this paper we derive a higher education demand model that integrates consumption and investment aspects. We emprically test the model for HOBU (short-run) and university (long-run) educational demand based on time-series data for Belgium between 1953 and 1992.
Different estimation procedures (including cointegration techniques) are compared on their predicitve and explanatory power. The cointegration method finds plausible evidence for a stable long-run relationship but the corresponding Error Correction Model finds little significant structure on short-run dynamics. The superior estimation technique appears to be a three-stage-least squares procedure, estimating HOBU and university demand as a simultaneous system of equations.
Income and foregone earnings seem to be driving enrollments, thus suggesting the importance of consumption aspects or imperfect access to capital. We notice significant differences between demand for HOBU and university education and consistently find that income and costs matter significantly more for HOBU than for university candidates.

INTRODUCTION

Since 1950 the number of students in Belgium continuing their education after high school has been on a dramatic increase. In 1953 about 35 000 students enrolled for a Higher Education degree. In 1991 this figure has reached 253 000. While in 1953 around 7 out of 100 youngsters continued studying after high school, this rate is at present near to 47 out of 100.

What were the reasons for this spectacular surge in demand for higher education and can we expect these trends to continue? In recent years the concern is voiced whether the economy has the capacity to keep on absorbing this growing number of highly educated people. Unemployment of the highly educated and underpayment are already observable in the labour market.

Neo-classical theory suggests that the market for educated labour is self-regulatory. Demand and supply will converge due to their reaction to market signals; i.e. wages, unemployment. The most explicit examples of market-driven models are in FREEMAN (1975) and DRESCH (1975).
One could argue, however, that this market automatism is not applicable to education. Demand for education may not so much be driven by the labour market for educated workers but may be supply driven through controlled government policy (e.g. policies of heavy subsidizing and student grants, compulsory education, supply rationing, etc.) (BISHOP, 1977) (CRAIG, 1981)(LOTT, 1990) (see also LESLIE & BRINKMAN, 1988 for an overview of studies that assess the impact of government programs on enrollments). The general postwar rises in enrollment rates are then due to trend improvements in the income and education of the population (resulting in public educational programs) and to reduction in the real cost of attendance.
Another impediment to market clearing is the fact that competition among candidate educated workers occurs through job competition and not so much through wage competition (THUROW, 1975). The best place in the 'labour queue' is not for the person who asks the lowest wage but for the person who will require least on-the-job training (for which the educational level gives an indication).
With this discussion in mind, we can formulate our working hypotheses. The paper will empirically test the opposing views by investigating sensitivity of demand for education to market signals. Moreover, a continuing issue in the educational policy debate in Belgium remains the (budgetary) emphasis that should be given to university versus non-university higher education. Can we detect substantial differences in the demand for the two educational systems that can contribute to the core of this debate?

The proceeding of the paper will look as follows. The analysis starts with a detailed description of recent trends in the demand for higher education in Belgium. Section two explores competing models that try to explain the demand for education, providing the theoretical basis upon which an estimable model for Belgium is selected in section three. An overview of empirical results is summarized in section four. This is followed by the presentation and discussion of our estimates for Belgium based on a time series data set. The appropriateness of competing time series modeling techniques is investigated, including OLS, 2SLS, 3SLS and ECM using cointegration.

1. TRENDS IN THE DEMAND FOR HIGHER EDUCATION IN BELGIUM

Participation at higher education in Belgium is very high compared to other OECD countries. At present nearly 47 out of 100 high school graduates continue their education. This is markedly higher than is the case in neighbouring countries such as The Netherlands (30%), Germany (29%) or France (36%). Higher education in Belgium is entirely publicly provided. Tuition is very low and access to higher education is open. There are no selection procedures; graduation from the broad high school types that prepare for higher education is sufficient to gain entrance to the institute of choice. Higher education institutions are fully subsidized and are not subject to any supply constraints, thus ensuring that supply follows demand. Higher education in Belgium consists of university education (UNIV) and non-university higher education (HOBU). The main differences are duration and program content. University education is longer (minimum 4 years vs. minimum 3 years) and offers a more academic (vs. professional) program.

1.1 General participation trends in higher education

The number of students continuing education after high school increased dramatically from about 35 000 in 1953 to over 253 000 in 1992[2]. The growth in sheer student numbers was continuous over that time period, as illustrated in figure one. Figure two shows the yearly growth rates of student numbers. It pictures clearly that growth occurred more uneven over the 1953-1992 time span, with a clear peak in the sixties, early seventies. In the fifties average growth was 5.3% per year. This figure soared during the sixties to 9.4%. After that growth fell back to 4.9% in the seventies, 2.7% in the eighties and on average a mere 1.7% in the last few years.

The spectacular growth rates of the sixties are undoubtedly linked to demographic forces. The postwar baby-boom generation reached the age group of 18-21 during the sixties, widening the age group eligible for higher education, which is clearly noticeable from figure one. It is, however, clear from this figure that demographics alone can not explain the increased demand for higher education. Growth of the 18-21 age group slowed down during the seventies and eighties and even became negative after 1983.

To exclude the impact of demographics, it is useful to look at the evolution of the participation rate in higher education. This is defined as the ratio of the number of students enrolled in higher education to the relevant age group (18-21 year olds). Figure 1 illustrates that, even after

[2] see also table 1

Fig 1 : Participation at higher education in Belgium 1953 - 1992

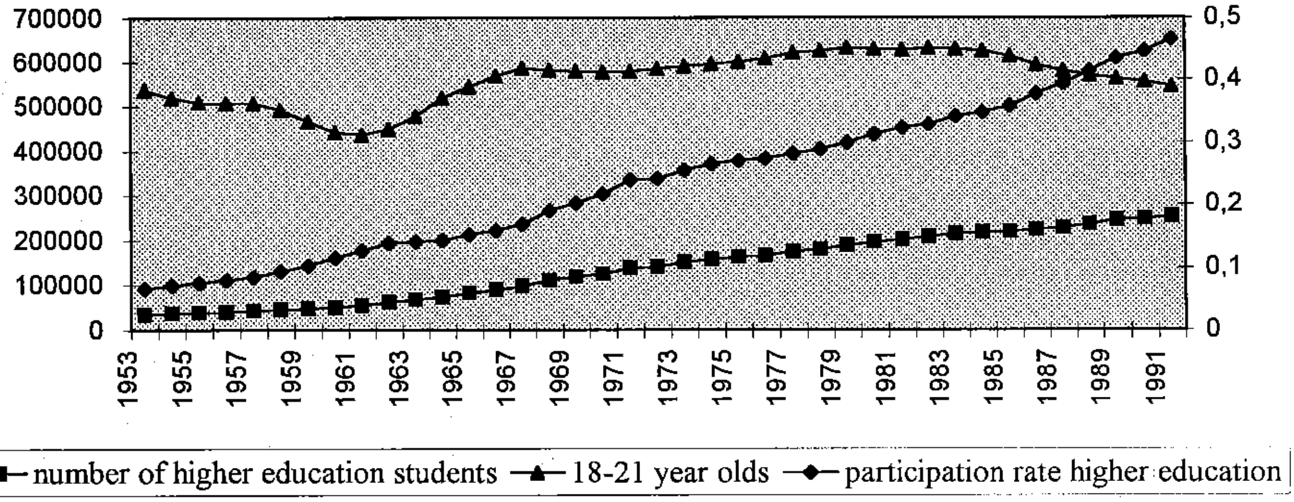


Fig 2 : Growth student population in higher education Belgium 1953 - 1992

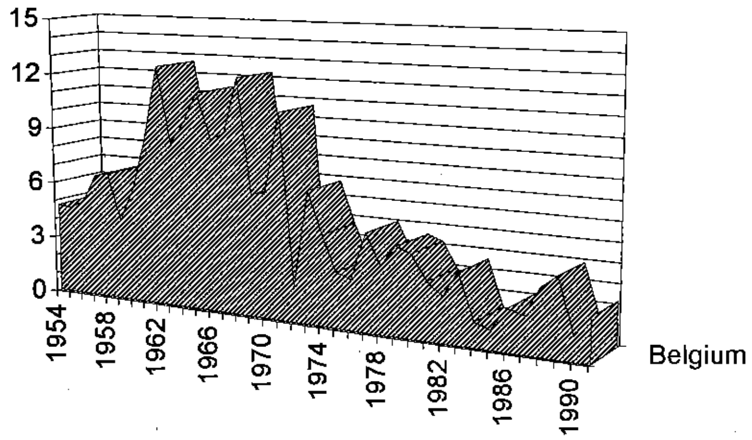
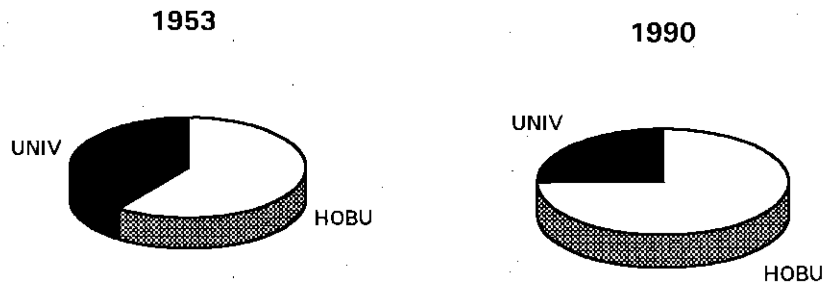


Fig 3 : Market shares in higher education - Belgium



correcting for demographics, the participation rate has also known a continuous increase since 1953. In 1953 around 7 out of 100 youngsters continued their education. This rate is at present near to 47 out of 100.

1.2 Demand for HOBU versus UNIV education

The differences between the evolution of the student population in the two higher education systems becomes apparent from table one.

table 1 : number of students enrolled in higher education - Belgium						
year	HOBU		UNIV		total	
1953	12542	100	22491	100	35033	100
1955	13931	111	24462	109	38393	110
1960	19928	159	30692	136	50620	144
1965	33611	268	48800	217	82411	235
1970	49751	397	75106	334	124857	356
1975	78405	625	83360	371	161765	462
1980	100907	805	95246	423	196153	560
1985	115215	919	103598	461	218813	625
1990	135661	1082	111845	497	247506	706
1991	136831	1091	116250	517	253081	722

While the expansion of higher education is felt in both systems, the HOBU student population grew much faster than the UNIV population. The index shows that, compared to the situation in 1953, the population in HOBU is now ten times larger. This increase is twice as large as the increase in the UNIV population. Universities have a longer history than HOBU institutions and traditionally attracted more students. Since 1978, however, this situation has been reversed. At present HOBU attracts over 136 000 pupils, more than the university population of around 116000.

Part of the HOBU success is due to the fact that the duration of many study programs has been prolonged. While historically concentrated on 2 year programs, now 3 to 4 year programs get more emphasis.

The differences in study duration make it difficult to compare the HOBU and UNIV system. For this reason table 2 presents data on freshmen enrollments, being those students enrolled for the first time in the first year of study.

table 2 : freshmen enrollments in higher education - Belgium						
year	HOBU[3]		UNIV		total	
1953	7332	100	4862	100	12194	100
1955	8144	111	5497	113	13641	112
1960	11464	156	7134	147	18598	153
1965	19689	269	12272	252	31961	262
1970	28872	394	15514	319	44386	364
1975	39208	535	16948	349	56156	461
1980	52201	712	18432	379	70633	579
1985	60070	819	20506	422	80576	661
1990	64288	877	21131	435	85419	700
1991	64461	879	22344	460	86805	712

Evaluation of the number of generation students draws the same picture as table 1 showed. Growth has still been much larger for the HOBU system than for the UNIV system. Compared to 1953, HOBU has nearly eight times more first year students attending. Universities attracted 22 000 students in 1991, nearly five times more than in 1953.

Using this table, and thus excluding the effect of program duration, provides a more correct benchmark to calculate the respective market shares of each system[4]. Figure 3 illustrates the evolution of the market shares for HOBU and UNIV from 1953 to 1990. It clearly shows how HOBU has been able to gradually conquer a larger chunk of the higher education market. It increased its market share from 60% in 1953 to 74% in 1980 to remain fairly constant after that[5].

We stress the differences between the two educational systems because they have important policy implications. Empirical research (PSACHAROPOULOS, 1973) (AASCU, 1977) (SULOCK, 1982) (MANSKI & WISE, 1983) typically finds students in short-term educational programs to be more sensitive to income, price and wage evolution. Our empirical

[3]First year students are used instead of freshmen enrollments. For HOBU, data on freshmen enrollments are only available for the last decade.
[4]Fall-out is comparable in the two systems, i.e. an average success rate of 52% à 58% in first year.
[5]As already mentioned, these market shares are slightly exaggerated to the advantage of HOBU since first year students instead of generation students are used. For the last decade, data on generation students in HOBU has become available and suggests that the true market share is 70% for HOBU and 30% for UNIV (1990).

evidence for Belgium consistently points in this same direction. The reason might be twofold. First, short-run programs will attract more lower-income students, who are known to be more price and income responsive (KOHN et. al., 1976) (BISHOP, 1977) (MANSKI & WISE, 1983). Besides these financial aspects, lower income students are probably also more prone to non-price (i.e. sociological) barriers to enter universities. The second conjecture is that substitution possibilities between HOBU (short-run) for university (long-run) are not symmetric and exhibit 'cascade' properties, such that university education will only be substituted with HOBU education when study results force students to do so. This result has important equity issues. If the policy aim is to make the use of higher education more equitable, i.e. also reaching lower income groups in society, a low cost and open access HOBU system combined with income stabilization policy remain important.

2. THEORIES OF DEMAND FOR HIGHER EDUCATION

2.1 Single demand for education in a neo-classical framework

Viewing education as a *consumption good*, a demand specification can be derived using standard neo-classical theory of consumer behaviour. The consumer chooses that bundle of goods and services that gives him the highest possible utility given certain (budget) constraints. As for any consumption good or service, demand for higher education will vary with income and prices. Income can take the form of disposable household income, own income and student loans. Demand should vary positively with income. The price of education must be viewed broadly and consists of two components, direct and indirect cost. Direct cost refers to tuition and other out-of-pocket costs such as books and differential living costs. The indirect cost component in the price of education entails the opportunity cost, i.e. the loss of income while going to school. Demand for education should vary negatively with these cost components. The responsiveness of potential students to price and income variations can be investigated using the concept of elasticities. Empirical work based on this approach was frequently encountered in the early literature, for example CAMPBELL & SIEGEL (1967), SPIES (1973), FELDMAN & HOENACK (1969), HOENACK & WEILER (1975), HIGHT (1975) and KNUDSEN & SERVELLE (1978).

With the development of human capital theory (SCHULTZ, 1960, 1961), (BECKER, 1975), (MINCER, 1974), education was viewed upon as an *investment good*. Students invest time and money now in return for future rewards. The underlying assumption is that education enables students to become more productive workers. This will be translated into a higher life-time earnings potential. Introducing this rationale, the human capital approach contributed a great deal in explaining the demand for education. Costs (direct and indirect) and discounted future earnings determine the optimal level of demand for education.

Two arguments further extended the human capital theory. First it was argued that consumption aspects also do play an important role in educational choice (BLAUG, 1976) (KODDE & RITZEN, 1984). When this motive is present, family income too determines the level of education demanded. The second argument concerns the introduction of capital market imperfections. When individuals have different access to funds, again family income or wealth positively affects demand for education (WALLACE & IHNEN, 1975) (KODDE & RITZEN, 1985). When income is introduced in this way, the effect of direct and indirect cost will no longer be identical, since, apart from the price effect, indirect cost (opportunity cost / foregone earnings) will have an additional wealth effect.

The important human capital argument was introduced into standard neo-classical consumer theory by adding the investment motive to the consumption arguments. The investment motive was included by making the consumer's decision an inter-temporal problem (PSACHAROPOULOS, 1973) (KODDE & RITZEN, 1984).
In fact, empirically it has become impossible to distinguish between the integrated neo-classical consumption/investment approach and the extended human capital approach (enriched with consumption aspects and imperfect capital markets). Numerous empirical studies confirm the combined approach and support the particular theoretical implications; i.e. positive wealth effect and different direct versus indirect cost effect (GALPER & DUNN 1969, PSACHAROPOULOS 1973, HOPKINS 1974, HANDA & SKOLNIK 1975, TANNEN 1978, LEHR & NEWTON 1978, PISSARIDES 1981, MATTILA 1981). More recent studies include SCHWARTZ (1985) and PAULSEN & POGUE (1988) for the USA, NAKATA & MOSK (1986) for Japan, HUYSMAN et al (1986) for The Netherlands and KING (1993) for Puerto Rico.

With the development of the Economics of Information a rivaling hypothesis to the human capital hypothesis was developed (ARROW, 1973), (SPENCE, 1973), (STIGLITZ, 1975). The *screening* hypothesis states that there is asymmetry of information about potential productivity between employers and candidate-employees. Therefore, a signal is wanted (i.e. educational qualifications) that provides information about this productivity. Wages that are offered will depend on the level of education attained. In turn, the level of education individuals will attain depends on the wages offered for that degree. In the screening case too, therefore, a positive correlation exists between education and future wages. In contrast with the human capital hypothesis, however, the higher wage reflects productivity differences that were already existent before education took place (education is not productivity enhancing).
For empirical demand estimates, the distinction between human capital models and screening models is not obvious since both theories relate higher earnings differentials to an increase of demand for education. RILEY (1979) points out that the screening argument will be more important in a sector where it is difficult to measure productivity. Thus signaling would be less important for students intending to become self-employed and more important for those intending to work in less competitive sectors such as the public sector (WOLPIN, 1977) (PSACHAROPOULOS, 1979) (COHN et al, 1987) (CORTENS & NONNEMAN, 1993).

This suggests that as the public sector and other 'screened' sectors grow in the economy, the demand for credentials (or educational degrees) will grow accordingly.

2.2 Modeling interaction of the education and labour market

Still within the same framework of an integrated consumption - investment neo-classical theory, FREEMAN (1971) developed a dynamic model, highlighting the interaction between demand for a certain field and the labour market. He applied this type of cobweb model on the field of engineering. Enrollments depend on expected wages, while wage adjustment in the labour market depends on the number of graduates, in turn defined by enrollments.
Other examples of FREEMAN's dynamic cobweb model were done by O'CONNEL (1972) for engineers and by NONNEMAN (1982) for Belgian medical students.
In this same line of thought is a study by DRESCH (1975). It is an example of a dynamic model that integrates adaptation on the educational and the labour market on an aggregate level. Thus, changes in demographics, technology and economy drive educational adaptation of the population.

2.3 Demand for education in a complete demand system

An important assumption underlying neo-classical demand analysis is that the utility function is separable between education and other goods. In other words education demand is independent of the demand for other commodities.
Relaxing this assumption in view of existing substitution possibilities between education and other goods, implies that demand for education needs to be estimated within a complete demand system such as the Linear Expenditure System (LES) (STONE, 1954), or the Almost Ideal Demand System (AIDS) (DEATON & MUELLBAUER, 1980).

An attempt at this approach was done by KIM (1987) who uses a translog LES specification. However, the author assumes education is a consumption good only. In practice, the investment aspect of education appears to be almost impossible to model within the complete consumer demand framework (KODDE & RITZEN, 1984).

2.4 Incorporating the Sociological Literature in Demand Studies

In the sociological literature alternative variables were highlighted for influencing demand for higher education, such as educational level obtained by the parents, proximity of schools, sex, race, language, etc. While these factors might not explain long run trends in enrollments, they could well be important in explaining variation between different individuals' decision to go to school or not. In a review article, LESLIE AND BRINKMAN (1987) conclude that where studies have considered more than just economic effects on enrollment rates, sociological variables turn out to be most potent.

Empirical economic studies have incorporated these factors into the traditional framework, usually in a cross section framework. Examples are in FELDMAN & HOENACK (1969), CHRISTENSEN, MELDER & WEISBROD (1975), ALVIN & THORNTON (1984), BEHRMAN & TAUBMAN (1985, 1986), KODDE & RITZEN (1988), COHN & HUGHES (1994) and CORTENS & NONNEMAN (1995).
Whereas the empirical studies provide interesting findings, the theoretical implications of incorporating these factors have not been elaborated on in the literature.

2.5 The Public Choice Literature

This far we have regarded the demand for education as a private good. In most countries, however, education is (partly) publicly provided or subsidized. Society considers education to be a *merit good*, i.e. a good with positive externalities to society (in terms of human capital formation, health, equity etc.) which would be under-consumed when left to the private sector. Thus, although not inherently a public good (education is an excludable and rival good), the 'merit' characteristics of education form the argumentation for government interference. Given this, the demand for education can be analyzed within the theory of collective decision making. How much does a community want to spend on education? Different approaches are possible to obtain an estimate of social demand functions. The main difficulty is obtaining a reasonable measure of preferences.

Relying on the median voter theory, several studies have used actual government expenditure levels and assume they represent the preferences of the median voter. They then relate these to economic (income, taxes) and demographic characteristics of the population. For an example of this approach, see BORCHERDING & DEACON (1972), LOVELL (1978) or PERKINS (1984).

Another interesting alternative are studies that estimate demand functions from survey data. Using logit or probit analysis, they obtain estimates of willingness-to-pay thus providing revealed preferences of the respondents. They then estimate demand functions by relating these revealed preferences to the respondent's socio-economic characteristics, such as the tax rate and income. Interesting illustrations of this approach were done by BERGSTROM, RUBINFELD & SHAPIRO (1982) and by HEWITT (1985).

3. A NEO-CLASSICAL DEMAND MODEL, INTEGRATING CONSUMPTION AND INVESTMENT MOTIVES

To select the most appropriate model for estimation, we need to recall the starting hypothesis. We want to explore long-run trends in higher education and investigate whether the expansion of demand for tertiary education was more policy driven or market driven. Therefore, we are interested in the responsiveness of demand to market signals (cost, wages, return on investment,..). Furthermore, we want to empirically test whether potential HOBU and UNIV students demonstrate differences in their choice behaviour. Caution is needed in order not to result in an ad-hoc specification of different relevant variables. We opt for the neo-classical integrated consumption-investment approach. This will force us to start from solid theory while the concept of elasticities provides an ideal framework to analyze the hypotheses.

The investment motive makes the standard consumption decision an *inter-temporal problem*. The consumer faces two distinct time periods and will choose that bundle of current and future consumption that gives her the highest possible utility.
In each period our consumer faces a time constraint and a budget constraint. In general notation the problem can be expressed as follows:

$$MAX \quad U(x, e)$$

$$s.\,t. \quad T = e + h$$

$$x + c * e = w * h + A$$

$$e < T$$

$$\begin{aligned} where\quad x &= composite\ good\ (price = 1) \\ e &= education \\ T &= available\ time\ (time - leisure) \\ h &= hours\ worked \\ c &= direct\ cost\ of\ education \\ w &= hourly\ wage \\ A &= non - wage\ income \end{aligned}$$

We assume that education can only occur in period 1. Therefore, available time in period 1 can be used either for studying or for working. The consumer has a non-wage income (A; identical for the two periods), complemented with a wage income (w * h) if she spends some of her time working . With this income she can buy goods and services, including education if not all of her available time is spent working. If the consumer spends all her time studying, she will only have her non-wage income to consume. If she doesn't study at all there are of course no education costs and she can spend her total potential income on consumption of other goods and services.

In period 2 no more education can be purchased and the consumer will spend all of her available time working ($T_2 = h_2$). The wage she receives in period 2 will depend on her choice in period 1. More education will result in higher future earnings ; $w_2 = w_1 (1 + \rho)$ where ρ is the schooling 'mark-up'.

Combining the constraints, both time and budget constraints, over the two periods, we can summarize the choice problem the consumer faces at the start of period 1 as :

$$\text{Max } U(x_1 , e_1, x_2)$$

$$s.t. \quad x_1 + e_1 c_1 + e_1 w_1 + \frac{x_2}{(1+r)} \leq (w_1 + \frac{w_1(1+\rho)}{(1+r)}) T + (1+\frac{1}{(1+r)}) A$$

Solving this choice problem will reveal the demand equations for the three 'goods' in the choice bundle.

The interpretation of this last set of equations leads directly to the specification that is estimated in the following section. We can interpret $e_1 c_1$ as the *direct out-of-pocket cost* of education while $e_1 w_1$ is the *opportunity cost in the form of foregone earnings*. The full price of education is then ($c_1 + w_1$). The right hand term is total potential income consisting of an *initial wealth* term (A) and a wage earnings term. This wage term will be larger when the individual has studied since a *wage differential* can be expected.

In general notation the demand for education can be expressed as :

$$e_1 = f(c_1 , w_1 , \rho , A, r)$$

$$and \quad \rho = \frac{w_2}{w_1} - 1 = relative\ wage\ ratio$$

From theory, the following qualitative effects can be derived. Initial wealth or income (A) will have a positive effect on demand for higher education, driven through consumption motives or imperfect capital markets. The relative wage ratio reflects the investment motive and its impact must be positive; the higher the wage differential between schooled and unschooled labour, the more attractive schooling becomes. The comparative statics of the price variables are less clear. The full price of education consists of a direct and an indirect (foregone earnings) component. Their impact will not be identical. When education is a normal good, the substitution and income effect of the direct cost of education will both be negative and thus the effect of direct costs on the equation must be negative. The effect of foregone earnings, however, must be determined empirically since the negative substitution and income effects might be offset by the additional positive income effect (wages also affect full wealth).

4. SURVEY OF EMPIRICAL RESULTS

4.1 An overview of empirical results of single equation demand estimates using time-series

The overview of empirical results in table 3 illustrates the wide variation that is found in time series estimates of demand for higher education. Theoretically, one expects the effect of income to be positive, that of direct cost to be negative and the wage differential to have a positive impact on demand. The impact of foregone earnings might be ambiguous. These a priori beliefs are generally being confirmed, although HANDA & SKOLNIK (1975) and NAKATA & MOSK (1986) report some perverse results (negative income and positive price effects). The magnitude of the effects differs widely, which of course is difficult to compare given differences in specified functional form, explanatory variables and units used. Important to note is that in the few studies that do report evidence on diagnostic test statistics, auto-correlation seems to be an important and recurring problem[6]. Elasticity estimates are compared with those of non time series studies in table 4.

[6]Galper & Dunn (1969), Psacharopoulos (1973), Handa & Skolnik (1975), Lehr & Newton (1978), Mattila (1981), Huijsman et al (1986), Nakata & Mosk (1986), King (1993).

table 3 : overview of single equation demand estimates using time series

Authors	Method	dependent var	independent variable reflecting		OLS estimates				elasticities	
			Consumption motive	Investment motive	dir cost	indir cost	income	relative earn	income	price
Campbell & Siegel (1969)	OLS time series 1950-1965 USA	enrollment rate (log)	- disp income per household - tuition (logs)		-0.44 (0.151)		1.2 (0.194)		1.2 (0.194)	-0.44 (0.15)
Galper & Dunn (1969)	OLS time series 1919-1965 USA distrib lags spec	enrollment	- real family income - size of the armed forces - high school graduates						0.692	
Psacharopoulos (1973)	OLS time series 1956-1968 USA	enrollment rate university college	- real disp income per household - tuition	-relative earnings college grads to high school grads	-0.349 (0.169) 0.051 (0.146)		0.025 (0.007) 0.029 (0.005)	16.5 (8.67) 31.09 (10.49)	3.4 10.12	-1.12 0.13
Handa & Skolnik (1975)	OLS time series 1950-1965 USA	enrollment undergraduates graduates	- income - dir cost (tuition, books, transport,- scholarship) - foregone earnings - eligible population group - number of unemployed	- returns from earning a degree (earnings of persons with postgrad degree)	-135.48 (-4.95) -24.9 (-3.61)	19.64 (2.17) -2.23 (-1.72)	-8.04 (-0.21) 16.08 (2.59)			
Hoenack & Weiler (1975)	OLS time series 1948-1972 USA	enrollment rate	- income - tuition - distance - draft		-0.047 (1.65)		0.121 (2.12)			
Mattila (1981)	OLS time series 1956-1979 USA	enrollment rate 18-21 Y 20-21 Y	- family income - unemployment rate - military draft rate - minimum wage - age control variable - employment trends indicator - high school graduates	- rate of return to investment in schooling			0.33 (0.54) 0.79 (1.73)	0.86 (2.02) 1.13 (3.59)	0.33 (0.54) 0.79 (1.73)	
Lehr & Newton (1978)	OLS time series + cross-section 1960-1974 USA	enrollment (log)	- per capita income - tuition - unemployment rate - number in armed forces - high school graduates (logs)		-0.659 (-3.77)		1.88 (8.76)		1.88	-0.659
Nakata & Mosk	OLS time series 1959-1980	application rate	- family disposable income - dir cost (fees, books, living	- internal rate of return			0.1 (6.2)	-87.7 (-1.4)		

table 3 : overview of single equation demand estimates using time series

Authors	Method	dependent var	independent variable reflecting		OLS estimates				elasticities	
			Consumption motive	Investment motive	dir cost	indir cost	income	relative earn	income	price
(1986)	Japan		expenses) - acceptance rate - employment indicator	- <u>ratio PV lifetime earnings college vs. high school graduates</u>	0.01 (3.14)		0.05 (2.09)	12.1 (2.4)		
Huijsman, Kloek, Kodde & Ritzen (1986)	OLS time series 1950-1982 The Netherlands	enrollment rate (1st diff)	- per capita income - tuition - high school graduates	- earnings after high school - earnings after university	-0.37 E-5 (-0.11)		0.99 E-4 (2.24)		1.02	-0.33
Shim (1990)	OLS time series 1965-1986 USA	enrollment rate	- per capita income - dir cost (tuition, living cost) - unemployment rate - dummy for qualitative factors		-0.013 (2.2)		0.031 (9.46)		1.122	-0.235
King (1993)	OLS time series 1962-1990 Puerto Rico	enrollments (log)	- tuition (credit fees) - high school graduates - dummy for grant scheme	- relative earnings degree vs. non degree holders	-0.41 (-1.7)					-0.41 (1.7)

4.2 Comparing estimates of income and price elasticities of demand for education

Elasticity estimates of various education demand studies (time-series and cross-section) can be compared from the summary in table 4.

table 4 : income and price elasticity estimates of demand for higher education

Authors	Method	dependent var	income elasticity	price elasticity
Campbell & Siegel (1969)	time series 1950-1965 consumer theory USA	enrollment rate	1.2 (0.194)	-0.44 (0.15)
Galper & Dunn (1969)	time series 1919-1965 consumer theory dist lags specification USA	enrollment	0.692	
Borcherding & Deacon (1972)	Cross section 1962 Public spending model median voter theory USA	public expenditure on education per pupil	0.295 (0.43)	-0.167 (0.78)
Psacharopoulos (1973)	time series 1956-1968 consumer theory USA	enrollment rate university	3.4	-1.12
		college	10.12	0.13
Feldstein (1975)	cross section 1970 public spending model median voter theory USA	public expenditure on education per pupil	0.475 (0.19)	-1.0 (0.07)
Perkins (1977)	cross section 1970 public spending model median voter theory USA	public expenditure on education per pupil	1.02 (0.23)	-0.29 (0.17)
Lovell (1978)	cross section 1970 public spending model median voter theory USA	public expenditure on education per pupil	0.65	
Knudsen & Servelle (1978)	cross section 1970 consumer theory USA	enrollment private institutions	1.21	-0.47
		private ins with public competitors	2.7	-1.23
Tannen (1978)	time series & cross section 1959-1969 consumer theory USA	enrollment rate	0.365	-0.427
Mattila (1981)	time series 1956-1979 consumer theory USA	enrollment rate 18-21 Y	0.33 (0.54)	
		20-21 Y	0.79 (1.73)	
Lehr & Newton (1978)	time series & cross-section 1960-1974 consumer theory USA	enrollment (log)	1.88	-0.659
Bergstrom, Rubinfeld &	survey data 1978	public expenditure on	0.83[7] to 0.38[8]	-0.57 to -0.43

[7]only price and income as explanatory variables

table 4 : income and price elasticity estimates of demand for higher education				
Authors	Method	dependent var	income elasticity	price elasticity
Shapiro (1982)	public spending model USA	education per pupil	(0.74) (0.34)	(0.54) (0.36)
Perkins (1984)	pooled cross-section & time series (70,73,75,76) public spending model median voter theory USA	public expenditure on education per pupil	0.464 (12.96)	-0.649 (6.96)
Hewitt (1985)	survey data 73-78,80,82 public spending model USA	public expenditure on education per pupil	2.1-0.1*(income) (13.4) (3.76)[9]	
Huijsman, Kloek, Kodde & Ritzen (1986)	time series 1950-1982 consumer theory The Netherlands	enrollment rate male	1.02	-0.33
		female	1.03	-0.52
Kim (1987)	time series 1958-1982 consumer theory LES - simultaneous equation system USA	consumer expenditure on education	1.34 (0.122 E-01)	-1.31 (0.202)
Shim (1990)	time series 1965-1986 consumer theory USA	enrollment rate	1.122	-0.235
King (1993)	time series 1962-1990 consumer theory Puerto Rico	enrollments (log)		-0.41 (1.7)
Nonneman & Cortens (1993)	cross-section 1992 consumer theory Belgium	educational attainment OLS	0.24	
		logit	0.32	

Elasticity estimates all have the expected sign. In other words, increase in income will make participation rates rise while the opposite is through for the price (or cost) effect.

Income elasticities are reported anywhere in the range from +0.3 to 1.8. One outlier is the study of Psacharopoulos, who finds higher education to be very elastic with respect to income and reports an income elasticity of 3.4 for university education and 10.12 for 2 year-degrees. Overall, time series studies find demand to be more income elastic than cross-section studies.

Demand for education seems to be more sensitive to relative changes in income than to relative changes in cost. Reported price elasticities are generally smaller in magnitude than the respective income elasticities. The range of estimates varies from -0.17 to -1.3.

In a review article, LESLIE AND BRINKMAN (1987) compared 30 empirical studies on the price responsiveness of demand for education and standardized results. They find a mean price response to a 100 US$ tuition increase of -0.7 percentage points. In other words, a 100 US$ increase in tuition fees will on average be associated with a 0.7 percentage point decline in participation rates.

[8] more (socio-economic) explanatory variables added

[9] concave function of income. Over the survey income range the elasticity is always positive and above one.

5 EMPIRICAL FINDINGS FOR BELGIUM

For the empirical estimation, we used the following approximation of the specification derived above [10]:

$$PR_t = a_{0t} + a_{1t} RY_t + a_{2t} RELW_t + a_{3t} FORE_t + a_{4t} D_t + a_{5t} T_t + \varepsilon_t$$

with $PR_t = N_t / E_t$ *and* N_t = *freshmen enrollments*

E = *'eligibles' or population of 18 year olds*

RY = *real per capita income*

$RELW$ = *relative wage rate of white versus blue collar workers*

$FORE$ = *foregone earnings*

D = *direct cost dummy* (<1965 $D=0$; $>=1965$ $D=1$)

T = *trend*

Some explanation about the variables used in the empirical specification is required.
To avoid interpretation difficulties arising from variation in study duration (both between the two systems and within one system over time), freshmen enrollment was used instead of total enrollments. To account for demographic factors, the dependent variable used is not mere enrollment but freshmen enrollment as a *ratio* of the eligible population group, i.e. the 18 year olds.
In comparison to other countries and other costs of education , enrollment fees are negligible, merely a symbolic contribution and show little variation over time. The biggest component of the direct out-of-pocket cost, therefore, is the extra expense of living away from home. In this regard the policy of regional spreading of the universities which was implemented in 1965 significantly reduced the direct cost of higher education. Thus, rather than using enrollment fees, the direct cost of education is accounted for by introducing a dummy variable with breakpoint in 1965.
Foregone earnings for potential higher education students are approximated by real average yearly earnings per worker for blue collar workers, corrected by the unemployment rate. Since unemployment amongst higher education degree holders is a rather recent phenomenon, the

[10] The most serious modification was due to the fact that we were not able to separate wage and non-wage income. Thus, RY includes both wage and non-wage income (instead of A; non-wage income) and might interfere with the other wage income variables. Also somewhat crude is the approximation of the relative wage of schooled vs. unschooled by the relative wage of white vs. blue collar workers.

national unemployment figures can be seen to reflect the chances of unemployment for blue collar workers. It is assumed that the unemployed receive 60% of their potential income in unemployment benefits. The exact calculation of foregone earnings is given in the appendix. The other variables used are quite standard and are also explained in detail in the appendix. The appendix equally contains standard descriptive statistics for all variables.

The equation was estimated using time series data for Belgium between 1953 and 1992, for higher education as a whole and also separately for the two higher education systems, university and HOBU. When estimating the equations for HOBU and UNIV separately, one extra variable was added to account for the competition effect of the other system. Addressing statistical methodological issues, different estimation approaches were used and compared on explanatory and predictive power. We start with standard OLS estimates, thus providing benchmark results. In second instance, the issue of endogeneity of some variables made us turn to 2SLS (single equations) and 3SLS (simultaneous model) estimation. In third instance, we explicitly addressed the issue of spurious regression and tackled the dynamics in the specification by using an error correction model and cointegration techniques.

5.1 OLS estimates

Table 5 presents the OLS estimates for the three equations. The results stress the importance of consumption or imperfect capital market aspects in determining demand for higher education. Confirming findings in the literature, family wealth consistently has a positive and significant influence on demand. Interpreting income as initial endowment or family wealth, it has a much larger impact on the demand for HOBU education than for UNIV education. This result is also found in PSACHAROPOULOS (1973), who found that income mattered more for freshmen entering 2-year institutions than for those entering higher education in general. This finding is equally confirmed in AASCU (1977), a study based on experimental data, SULOCK (1982) and MANSKI AND WISE (1983).

For UNIV education, foregone earnings (or indirect costs) have a negative impact on the regression, suggesting that the price effect (composed of a negative substitution and income effect) dominates the additional positive income effect. The direct cost dummy shows the expected sign, as the lowering of direct costs from regional spreading of the universities has a positive influence on the demand for university education. Although being significant, the impact of the regional spreading policy seems rather low.

table 5 : OLS estimation of demand for education (t-values in parenthesis)			
PARTICIPATION RATE PR	University education (UNIV) PRU	Non University Education (HOBU) PRH	total higher education PRT
C constant	-0.04439 (-1.045)	-0.1988 * (-2.092)	-0.0962 (-0.9599)
RY income	0.2390 ** (2.494)	0.8819 ** (4.08)	0.8019 ** (4.008)
RELW wage differential	0.0265 (1.091)	0.0628 (1.2013)	-0.0057 (-0.099)
FORE indirect cost foregone earnings	-0.1540 ** (-3.85)	-0.4739 ** (-5.287)	-0.3941 ** (-4.752)
D direct cost dummy reg spreading univ	0.01225 * (2.39)		-0.0258 ** (-2.652)
SUBST enrollment ratio other educ system	-0.164 ** (-2.433)	-1.465 ** (-4.516)	
T trend	0.0036 ** (3.759)	0.01196 ** (5.8455)	0.01114 ** (6.263)
adjusted R^2	0.976	0.991	0.995
D-W	1.004	1.245	1.334
income elasticity	0.854 ** (2.49)	1.31 ** (4.1)	0.842 ** (4.01)
price elasticity	-0.566 ** (3.9)	-0.724 ** (5.27)	-0.425 ** (4.7)
** significant at a 1% s.l * significant at a 5% s.l			

Since the 1965 regional spreading policy only applied to universities, the direct cost dummy was omitted in the estimation for the HOBU system. Foregone earnings have a negative effect on HOBU enrollments and again its effect is much larger than for the UNIV system. This seems to imply that opportunity costs are harder to bear for potential HOBU students than for university candidates.

The investment motive (RELW) finds hesitant support in the data, its effect being consistently positive as expected, though only at a significance level of around 10% for the HOBU equation and 15% for the UNIV equation. However, given the somewhat crude data approximation of this variable, we want to be careful with strong interpretation of this variable. Surprisingly the wage differential has negative impact on total higher education but the coefficient is not significant. The differences between the HOBU and UNIV system are again being confirmed. Potential HOBU students seem more influenced by return-to-investment considerations than UNIV students.

Competition from the other educational system is a significant and negative influence on total enrollments for both universities and HOBU institutions. Competition matters more for HOBU enrollment, which can be explained intuitively by the fact that many students see the organization of higher education as a 'cascade system'. Thus the conjecture of asymmetric substitution possibilities between the two educational systems appears to be confirmed. Students will preferably start at the highest possible level (university education) and will only go down when their study results force them to.

Income and price elasticities have the expected sign. Note that elasticities are calculated for the enrollment rate and not for enrollments as such, which makes interpretation somewhat different from the usual demand elasticities. Overall, the enrollment rate of higher education is more elastic with respect to income than with respect to price[11]. This confirms earlier reported findings in the literature. Again, the results indicate that HOBU candidates are more sensitive to income and price changes than individuals considering university education.

Potential HOBU students seem to regard education as a luxury good (income elasticity of 1.31) whereas demand for university education is inelastic with respect to income (elasticity of 0.85).

[11]the price elasticity is defined in terms of opportunity costs.

Price elasticity is defined in terms of the indirect cost aspect of the price of education, i.e. foregone earnings. Demand for higher education is inelastic with respect to foregone earnings, with a price elasticity of -0.57 for UNIV demand and -0.72 for HOBU demand. Once again, we find evidence that opportunity costs matter more to HOBU students than to university students. The reported elasticity estimates are in the range of other OLS time series estimates in the literature. Of particular reference are the quite similar estimates for the Netherlands (Huijsman et al, 1986) with a reported income elasticity of + 1.02 and a price elasticity (also in terms of foregone earnings) of - 0.33 for male enrollments. The respective elasticities for female enrollments are + 1.03 and - 0.52. The evidence on differences in income and price elasticities between HOBU and university students have important policy consequences. It suggests that in making the use of tertiary education more equitable, an accessible and low cost HOBU higher education system is important. Income stabilizing policies seem essential to stimulate participation of lower income groups (typically at HOBU institutions).

The OLS estimates were subjected to diagnostic tests for well-behaviour of the disturbances (KMENTA, 1986). Normality was visually checked by means of histograms and formally by means of the Jarque-Bera test. We accepted normality for all three equations. The White test reported no heteroskedasticity problems. The evidence for non auto-correlated residuals is less convincing. Durbin-Watson values are very low, although they are in the inconclusive range. The Breusch-Godfrey test rejects the hypothesis of non auto-correlation for the UNIV equation, but not for the other equations. The same test provides no evidence for higher order auto-correlation.

5.2 2SLS estimates

When looking at the OLS estimation output, we notice that the incorporation of the substitution variable in the HOBU and UNIV equations, in fact makes them a simultaneous equations model since the endogenous variable of one equation appears as explanatory variable in the other equation. The SUBST variable will therefore be correlated with the residual of the equation. In this case, a general method of obtaining a consistent estimate of the parameters is the instrumental variable method. In general IV estimation uses an instrumental variable that is uncorrelated with the error term to find an estimate of the endogenous variable. This estimate will then replace the endogenous variable in the original regression. In first instance we estimated the model equation by equation using 2SLS and thus taking into account the endogeneity of the substitution variable (table 6).

Overall, the 2SLS estimates remain in line with OLS results. The auto-correlation concern apparent from the OLS results, appears to be better dealt with given the improvement of Durbin-Watson values.The effect of income and the wage differential remains positive, while direct and indirect cost and competition from the other educational system influence enrollments negatively. The effect of the policy of regional spreading of universities on the demand for university education is not picked up anymore. Although being positive, the coefficient on the direct cost dummy is not significantly different from zero. Again, there is little significant response noticeable to the wage differential and demand seems driven by consumption or imperfect capital market aspects. Income and indirect cost matter considerably more to HOBU students than to university students, thus confirming previously found differences between the two systems. Remarkable is the substantial increase in elasticity estimates for the UNIV equation, such that UNIV elasticity values are now slightly above HOBU values. This is because, as already pointed out, elatsticities are defined in terms of the enrollment *rate* and not in terms of enrollment (as a standard demand elasticity). Since the mean enrollment rate is higher for HOBU education, an identical demand elasticity in terms of enrollments for both systems, would make the demand elasticity in terms of enrollment rates higher for UNIV than for HOBU. Conversely, near to identical enrollment rate elasticities imply higher enrollment elasticities for HOBU than for UNIV.

table 6 : 2SLS estimation of demand for education
(t-values in parenthesis)

PARTICIPATION RATE PR	University education (UNIV) PRU	Non University Education (HOBU) PRH
C constant	-0.0929 (-1.555)	-0.2199 * (-2.118)
RYB income	0.365 ** (2.891)	0.7798 ** (3.258)
RELW wage differential	0.0349 (1.085)	0.0802 (1.404)
FORE indirect cost foregone earnings	-0.2195 ** (-4.084)	-0.4664 ** (-4.833)
D direct cost dummy reg spreading univ	0.0018 (0.244)	
SUBST enrollment ratio other educ system	-0.4372 ** (-3.336)	-1.947 ** (-4.861)
T trend	0.0066 ** (3.834)	0.0146 ** (6.711)
adjusted R^2	0.963	0.990
D-W	1.42	1.45
income elasticity	1.312 ** (2.891)	1.158 ** (3.258)
price elasticity	-0.8096 ** (-4.084)	-0.711 ** (-4.833)

** significant at a 1% s.l.
* significant at a 5% s.l.
instruments used : c, ry, relw, fore, d, t, pru(-1), prh(-1)

5.3 3SLS estimates

Given that we should view the HOBU and UNIV equations as a simultaneous model, we investigated the pattern of residuals between equations and found a significant relationship. The correlation coefficient between the OLS residuals of the HOBU and UNIV regression was found to be 0.57 (t-value 4.219). This suggests that both UNIV and HOBU enrollment rates are reacting similarly to one or more factors that are not included in the model. This is known as contemporaneous correlation. This finding is important since it suggests that efficiency in estimation can be gained by estimating the two equations simultaneously using 3SLS. This method applies 2SLS (thus addressing endogeneity) together with a full treatment of the cross-equation correlations of residuals. The results of the 3SLS estimation are presented in table 7.

The efficiency gain from the simultaneous estimation 3SLS is considerable. Compared to the equation by equation treatment (2SLS) t - values increase substantially for all variables except for the direct cost dummy. The Durbin-Watson value still improved for the UNIV equation, while slightly decreasing in the HOBU specification. The hypothesis of autocorrelation can not be rejected for either specification.

The interpretation of results does not differ much from the 2SLS findings. All variables show the expected sign and are in the same order of magnitude of 2SLS coefficients. Again the difference in price and income responsiveness of HOBU and UNIV students has become small, but given the somewhat unusual definition of elasticity (in terms of enrollment rates) we can argue that the responsiveness to income and indirect cost of enrollments would still be larger for HOBU than for UNIV. The coefficient values on income, indirect cost and relative wages, confirm the notion that these variables have more impact on demand for HOBU education. We find hesitantly more support that the investment motive positively influences enrollment rates; the RELW coefficient is positive and significant at a 10% significant level for both HOBU and UNIV demand.

table 7 : 3SLS estimation of demand for education (t-values in parenthesis)		
PARTICIPATION RATE PR	University education (UNIV) PRU	Non University Education (HOBU) PRH
C constant	-0.0964 * (-2.208)	-0.2041 * (-2.271)
RYB income	0.382 ** (3.825)	0.8091 ** (3.825)
RELW wage differential	0.0343 (1.428)	0.0726 (1.448)
FORE indirect cost foregone earnings	-0.2274 ** (-5.736)	-0.4817 ** (-5.801)
D direct cost dummy reg spreading univ	2.17 E-05 (0.026)	
SUBST enrollment ratio other educ system	-0.4719 ** (-15.153)	-2.1172 ** (-15.755)
T trend	0.007 ** (7.345)	0.0149 ** (7.802)
adjusted R^2	0.96	0.989
D-W	1.44	1.44
income elasticity	1.373 ** (3.825)	1.202 ** (3.825)
price elasticity	-0.839 ** (-5.736)	-0.734 ** (-5.801)
** significant at a 1% s.l. * significant at a 5% s.l. instruments used : c, ry, relw, fore, d, t, pru(-1), prh(-1)		

5.4 Estimates using cointegration and an error correction model

Despite the plausible and fairly satisfactory OLS and IV estimation results, extra attention was paid to the dynamic specification of the model. As is the case with most macro-economic time series, all of our variables but one (relative wage) show an upward. The common trend will give way to high significance of the coefficients and a high determination coefficient (R^2) even if the variables would be independent. This is known as spurious regression, where you could find a systematic relationship between variables that are independent but do have a common trend (GRANGER & NEWBOLD, 1974).

This methodological problem is apparent from the typical spurious regression signals (highly significant coefficients, high R^2, low Durbin-Watson) in most time series studies reviewed, but has not explicitly been dealt with (GALPER & DUNN 1969, PSACHAROPOULOS 1973, HANDA & SKOLNIK 1975, LEHR & NEWTON 1978, MATTILA 1981, NAKATA & MOSK 1986 AND KING 1993). In their study, Huijsman et al (1986) point the problem out and explicitly try to deal with the dynamics by analyzing the model in first differences. They obtain reasonable results although the large and significant auto-regressive parameters suggest trend developments that have not been dealt with.

In the remainder of the paper we suggest an alternative to the approach of Huysman et al (1986) and tackle the dynamics in the specification by using cointegration and estimating an error correction model (ECM). HENDRY (1993) advocates this method for dealing with 'spurious regression' criticism above using differenced data models. "ECM ... circumvent the most basic spurious regressions problem without losing the long run information from using differenced data only"[12]. "ECM models, in an interesting way, nest 'levels' and 'differences' formulations. They mimic 'rational' behaviour for disequilibrium states around an otherwise constant steady-state growth path, and highlight features that seem worth incorporating in empirical time-series equations.."[13].

Before investigating the relationship between the variables, we will address stationarity of the variables separately. Estimation and hypothesis testing, using the least squares method, is justified only when the variables being used are stationary (HOLDEN AND PERMAN, 1994).

[12]Hendry, 1993, p 99.
[13]Hendry, 1993, p 26.

After that an error correction model is proposed and estimated with a cointegrating vector as the error correction term.

5.4.1 Stationarity and order of integration of the variables

A time series is stationary if its mean, variance and auto-covariances are independent of time (HOLDEN AND PERMAN, 1994). As mentioned above, OLS estimation and hypothesis testing is justifiable only if the variables in the regression are stationary.
The trend in most macroeconomic time series suggests that they are non-stationary. The central theme of cointegration is to investigate whether some relationship exists between the variables that is not caused by the common trend. In other words, cointegration will try to find some steady and stationary combination between non-stationary variables.

A time plot of the variables already suggests the presence of a trend, and thus of non-stationarity in all the variables but relative wage. Plots of the variables in first differences, however, show no sign of changing means or variances anymore. A formal test on stationarity by means of the Augmented Dickey-Fuller (ADF) unit root tests supports this intuitive conjecture. Table 8 reports the ADF-statistics for all variables in levels and first differences format. A trend and drift component were added wherever the specification pointed them out as being significant in the regression. The null hypothesis of non-stationarity can not be rejected for any of the variables (also relative wage) in levels format. For all variables in first difference format, the ADF test statistic convincingly rejects the hypothesis of non-stationarity.

table 8 : Augmented Dickey Fuller unit root test statistic values						
variable	levels		differences			
PRU	-1.329	d, t	-4.351	**	d	
PRH	-1.228	d, t	-7.768	**	d, t	
RY	-2.235	d, t	-5.919	**	d	
RELW	-1.832	d, t	-7.259	**		
FORE	-1.27	d	-3.439	*	d	

** rejection of non-stationarity at a 1% significance level
* rejection of non-stationarity at a 5% significance level
d the constant term is significant in the regression
t the time trend is significant in the regression

We conclude that all our variables are integrated of order 1, i.e. I(1), or in other words they need to be differenced only once in order to achieve stationarity. We summarize :

PRU ~ I(1) with drift
PRH ~ I(1) with drift and trend
RY ~ I(1) with drift
RELW ~ I(1)
FORE ~ I(1) with drift

5.4.2 ECM and cointegration

An error correction representation considers regressions in which both the levels of variables and their first differences are included :

$$\Delta y_t = \beta (\Delta x_t) + \alpha (EC_{t-1}) + \varepsilon_t$$

$$EC_{t-1} = y_{t-1} - f(x_{t-1}) = \text{error correction term}$$

where

$$y = \text{dependant variable}$$
$$x = \text{independant variable}$$
$$f(x) = y^* = \text{equilibrium value of } y$$

The economic rationale is that agents adjust their behaviour (δy) in response to changes in x (where β is the short-run effect) and to the previous disequilibrium (where α is the feedback coefficient).

A model in differences only, $\Delta y_t = \beta (\Delta x_t) + \varepsilon_t$, disregards any long-run relationship that might exist between the variables. A simple example will illustrate the problem. Say y is spending and x is income. If β is 0.5, then a rise in income of 1$ will always increase spending by 50 cents, disregarding whether the current absolute level of spending is too high or too low given the current level of income. In fact, the model in differences does not have an equilibrium solution since in equilibrium $y_t = y_{t-1} = y_{t-2} = \ldots$ and $x_t = x_{t-1} = x_{t-2} = \ldots$ which makes the differences model 0 = 0 and not an expression of y in terms of x.

The ECM now, postulates that y^* is the equilibrium value of y and can be written in terms of x such that $y^* = f(x)$. The model improves the model in differences by introducing a variable that takes into account how far off y was from its equilibrium value *y-axes* or $f(x)$ in the previous period t-1. This variable is the error correction term, or disequilibrium in the previous period, and α is the feedback coefficient.

It is immediately clear that α needs to be negative for the adjustment process to be sensible. When y is higher than y-axes in period t-1, the EC term will be positive and we expect agents to lower y so α is expected to be negative. When y is below its equilibrium value in t-1, the EC term is negative and we expect agents to push up y, so again α is expected to be negative.

In order to estimate an ECM using the OLS technique, all variables in the equation need to be stationary. Since we established that all our variables are integrated of order 1, the differenced terms are stationary or I(0). The variables in the error correction term, however, are specified in levels and thus are I(1) and not stationary.
The concept of cointegration resolves this tension. The idea of cointegration is to investigate whether some combination exists between non-stationary variables that is stationary. Thus, we will look for some combination between y and x that is I(0). The link with ECM is the argument that the (also stationary) error term of this cointegrating relationship coincides with the economic notion of 'long run disequilibrium' or error correction term. This argument was proven by Engle and Granger (1987) and resulted in the Granger Representation Theorem : cointegrated series can always be represented by an ECM and the variables in an ECM are always cointegrated.
Using the stationary error term of the cointegrated relationship as the EC term, will make all the variables in the ECM stationary or I(0), so we can go ahead with the OLS estimation procedure. In the remainder we will first investigate the existence of a cointegrated relationship between the variables and then use the findings to estimate an error correction model.

5.4.3 Cointegrated vector

We follow the Johansen procedure (using E-views) for investigating the existence of a cointegrated relationship between the variables PRU, PRH, RY, RELW, FORE, D. The procedure consists of several steps[14]. The cointegration relationship is not necessarily unique so first we will test how many possible cointegrating relationships might exist between the variables. For these tests, we need to specify the number of lags required. Given the optimal lag structure, we can then perform the tests that specify the number of possible cointegrating relationships. The last step is the determination of the cointegrated vector or relationship itself.

1. Optimal lag length

For the set of variables (PRU, PRH, RY, FORE, RELW, D) we estimated a VAR specification in which we started the lag length at 4 and reduced it by one when the LR-test

[14]For a good step-by-step description, see HOLDEN AND PERMAN, 1994, p106.

statistic accepted the hypothesis that the coefficients on the fourth lag coefficients are zero[15]. The optimal lag length was found to be equal to 1.

2. Number of possible cointegrated relationships

Using lag length one, the Johansen test (LR test) was performed to specify the possible number of cointegrating vectors[16]. The results are summarized in table 9 and point in the direction of two possible cointegrating relationships between the variables.

table 9 : LR test for the possible number of cointegrating vectors (NCV) (lag interval = 1)		
hypothesized	vector : PRU, PRH, RY, FORE, RELW, D (including intercept)	
NCV	LR statistic	5% cv
none	114.68 **	94.15 **
at most 1	78.61 **	68.52 **
at most 2	47.19	47.21
at most 3	25.97	29.68
* rejection of the hypothesis at a 5% significance level		

[15]LR test statistic = -2 (LLF_r - LLF_u) ~ X_2(# restrictions), where LLF is the value of the log likelihood function, r = restricted and u = unrestricted.
[16]For a description of the tests, see HOLDEN AND PERMAN, 1994, p 82.

3. Cointegrated vector

The LR test suggests the existence of two possible cointegration vectors between our variables. The normalized Johansen coefficient estimates of the two cointegrating equations look as follows :

PRU	PRH	RY	FORE	RELW	DX	C
1.000	0.000	-0.878	0.724	-0.13	-0.058	0.192
0.000	1.000	-3.115	2.202	-1.015	-0.258	1.847

This formulation of results suggests interpreting the two vectors as the long-run relationship between the exogenous variables and UNIV and HOBU enrollments respectively. Rearranging, the two long-run cointegrating relationships are summarized in table 10.

table 10 : Johansen cointegration results (normalized coefficients)		
PARTICIPATION RATE PR	UNIV -1.000	HOBU -1.000
C constant	-0.192	-1.847
RYB income	0.878	3.115
RELW wage differential	0.13	1.015
FORE indirect cost foregone earnings	-0.724	-2.202
DX direct cost dummy	0.058	0.257
long-run income elasticity	3.155	4.627
long-run price elasticity	-2.672	-3.357

As is normal practice, the t-statistics are not reported as they are liable to severe bias. The residuals from the cointegrated vectors were satisfactorily checked for normality. ADF-unit root tests on the residuals give evidence of stationarity at a 10% significance level, i.e. the error terms are I(0), supporting the acceptance of cointegration between the variables. The normalized coefficients in the cointegrated vector all show the expected sign. Income, price and the wage differential matter more for HOBU students than for those considering university education. Long-run elasticity estimates are quite high and significantly higher for HOBU demand than for UNIV demand, thus supporting earlier results and general findings in the literature.

In the next section , these cointegration results are consequently used to estimate an ECM specification.

5.4.3 Error Correction Model

As previously explained, the errors from the cointegrated vectors can be used as the error correction term in the following ECM :

$$\Delta PR_t = \alpha_0 + \alpha_1 * \Delta RY_t + \alpha_2 * \Delta RELW_t + \alpha_3 * \Delta FORE_t + \alpha_4 * EC1_{t-1} + \alpha_5 * EC2_{t-1} + \varepsilon_t$$

Since all variables are now I(0), the ECM specification can be estimated by OLS. Table 11 presents the results for both the UNIV and HOBU error correction specification.

As was shown on the previous page, the cointegration vectors were normalised such that the first vector can be interpreted as representing the UNIV long-run relationship, while the second one describes the HOBU relationship.The coefficient of the 'own' error correction term is significant and negative as expected a priori, an important finding again supporting the acceptance of cointegration. The coefficient of the 'cross' error correction term is positive (significant at a 5% and 10% s.l. respectively), indicating substitution between the two educational systems. When, for example, UNIV enrollments are above the expected long-run equilibrium value, the adjustment process is such that UNIV enrollments decrease in the next period (negative 'own' ECT coefficient in the UNIV equation) and are substituted by an increase in HOBU enrollments (positive 'cross' ECT coefficient in the HOBU equation). The adjustment process occurs at a faster speed in the HOBU sector than in the UNIV sector.

The short-run responses are very small in magnitude and not significantly different from zero, except for one variable (foregone earnings) but only in the HOBU equation. However, the direction of the effect is always as expected except for relative wage in the HOBU equation.

Congruent with theoretical expectations, short-run elasticities are much smaller than their long-run equivalents.

Overall, the EC specification using cointegration finds satisfactory and plausible evidence for a stable long-run relationship between the variables but little significance on the short-run structure.

table 10 : Error Correction Model estimates (OLS)

CHANGE IN PARTICIPATION RATE ΔPR	University education (UNIV) ΔPRU	Non University Education (HOBU) ΔPRH
C constant	0.0025 * (1.885)	0.0151 ** (4.146)
Δ(RYB) change in income	0.0992 (0.871)	0.0810 (0.262)
Δ(RELW) change in wage differential	0.0119 (0.529)	-0.0109 (-0.179)
Δ(FORE) change in indirect cost change in foregone earnings	-0.0053 (-0.059)	-0.5516 ** (-2.285)
$EC1_{t-1}$ Error Correction Term from UNIV vector	-0.166 ** (-2.438)	0.2413 (1.307)
$EC2_{t-1}$ Error Correction Term from HOBU vector	0.0308 * (1.712)	-0.1062 ** (-2.181)
R^2	0.230	0.181
D-W	1.683	2.817
short-run income elasticity	0.356 (0.871)	0.120 (0.262)
short-run price elasticity	-0.02 (-0.06)	-0.841 ** (-2.285)

** significant at a 1% s.l.
* significant at a 5% s.l.

5.5 Comparing prediction accuracy

The three 'traditional' model specifications (OLS, 2SLS and 3SLS) provided plausible estimates in terms of expected signs and magnitudes of the coefficients. The ECM model finds adequate evidence for a cointegrated long-run relationship between the variables, but the short-run dynamics do not seem to be significant. Figures 4 and 5 confront the four models in terms of their predictive power by plotting actual versus predicted evolution of enrollment rates. The plots show that OLS and 3SLS give a very close description of the evolution of enrollment rates, with 3SLS providing the closest prediction fit. The predictive performance of 2SLS and especially the ECM seems less convincing, with ECM showing remainders of systematic error in prediction especially for HOBU enrollments. These conclusions are enforced when we look table 11, where selected forecast evaluation criteria are tabulated. In general, HOBU enrollments were forecasted better than university enrollments. The three-stage-least-squares model consistently provides the most accurate forecast. The forecast error is very small, especially in predicting HOBU enrollments.

table 11 : Mean Square Error (MSE), Theil's inequality coefficient (THEIL) and Bias Proportion (PB) for measuring forecast accuracy

		OLS	2SLS	3SLS	ECM
UNIV	MSE	0.00347	0.00696	0.00215	0.00646
	THEIL	0.55543	0.78652	0.43725	0.75792
	BP	4.75 E-03	9.64 E-04	1.23 E-06	1.52E-04
HOBU	MSE	0.00659	0.00917	0.00109	0.00869
	THEIL	0.29117	0.34344	0.11832	0.3344
	BP	1.76 E-03	3.60 E-03	2.27 E-03	1.56 E-02

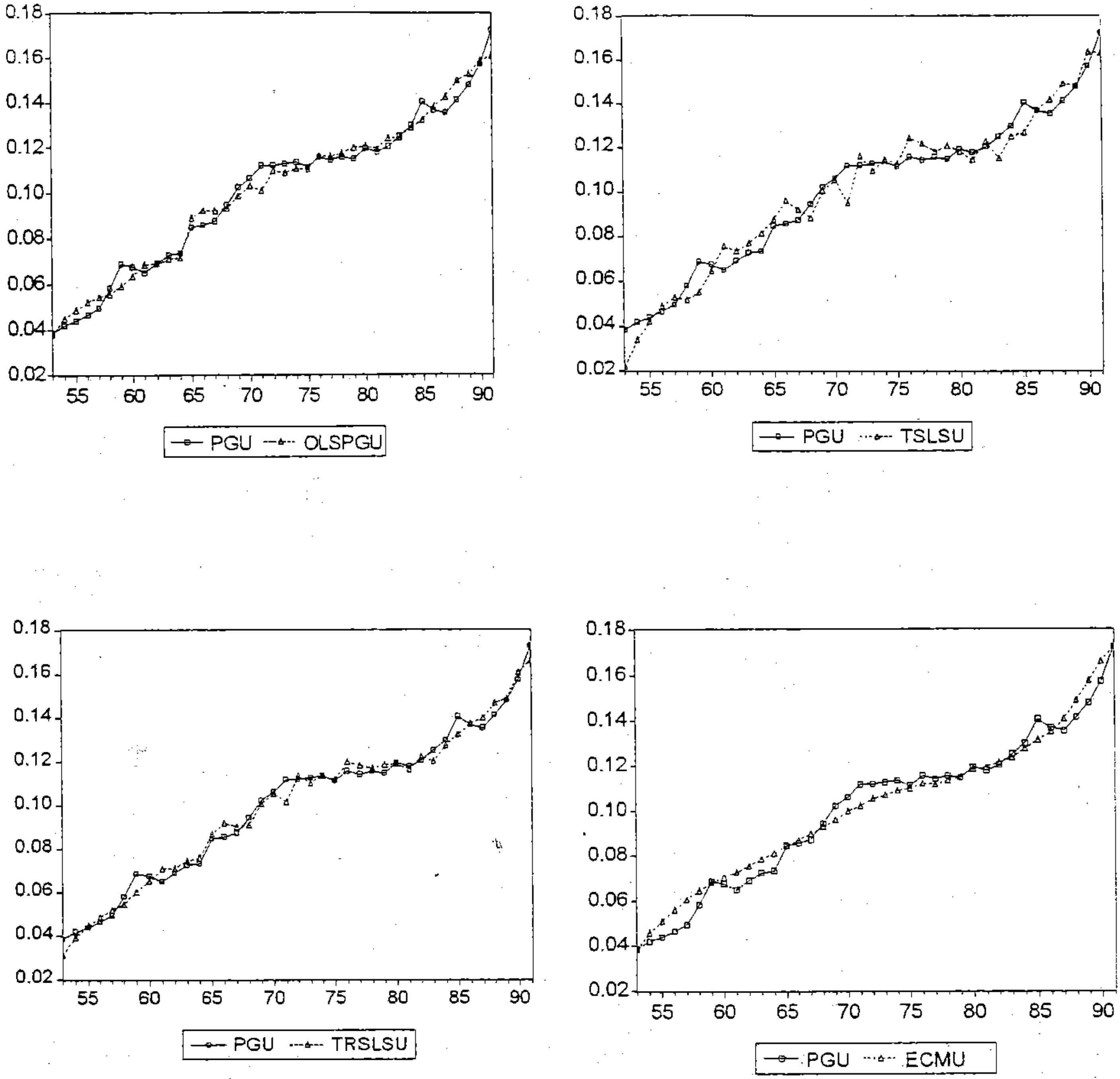
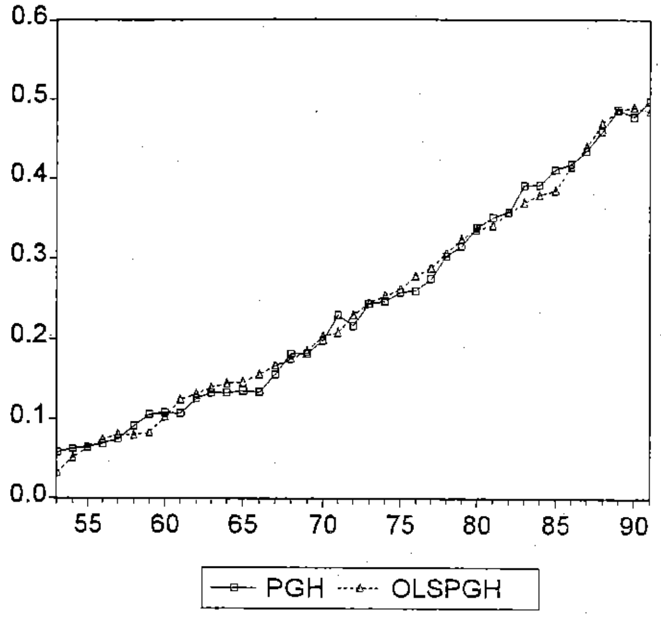
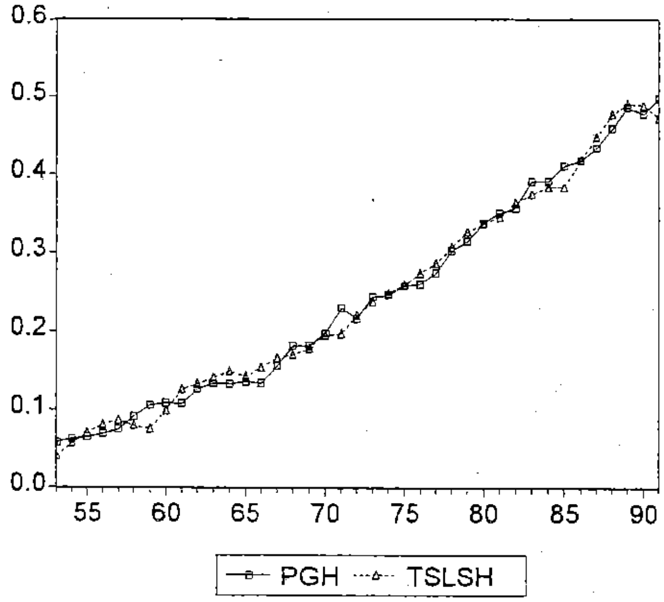
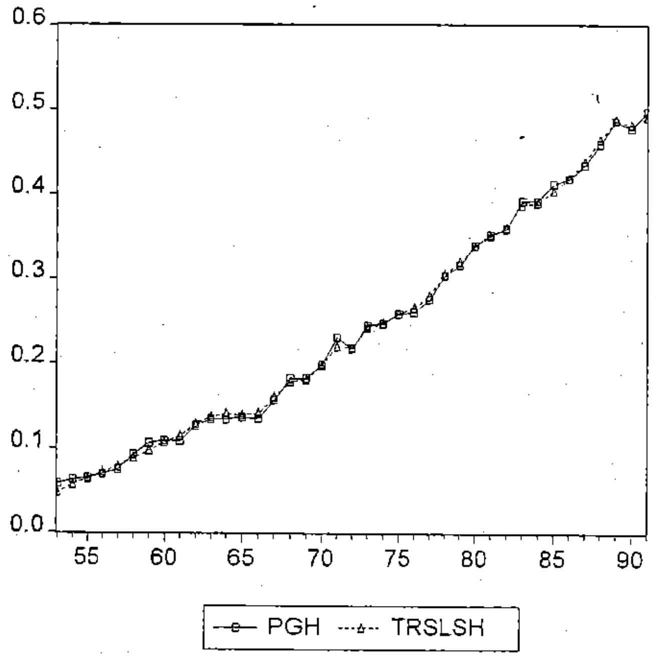


Fig 4 : Actual (PGU) versus predicted UNIV enrollment rates







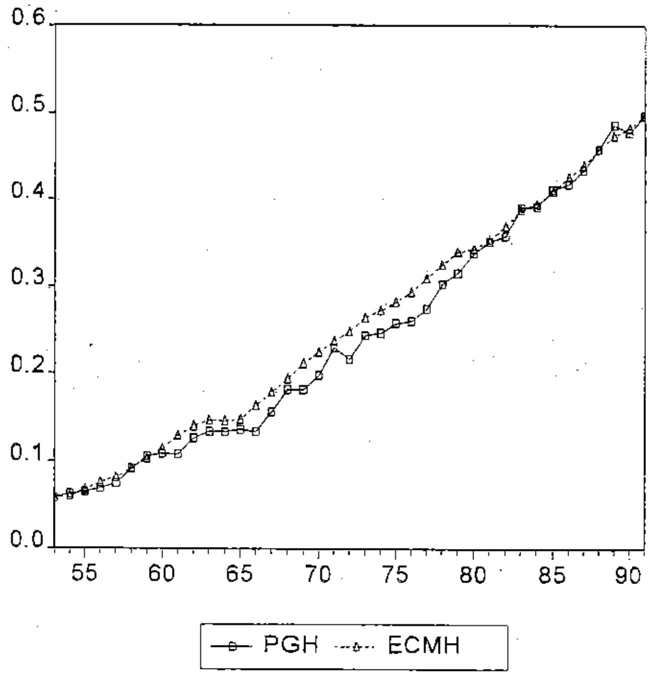


Fig 5 : Actual (PGH) versus predicted HOBU enrollment rates

6. CONCLUSIONS

We compared various estimation techniques to estimate demand for higher education based on time-series data. An error correction specification using cointegration, could find satisfactory evidence for a stable long-run cointegrated relationship between the variables, but the short-run dynamics do not correspond well with the data. The superior estimation technique, both in terms of predictive and explanatory power, appeared to consist of a three-stage-least-squares approach in which the demand for short-run educational programmes (HOBU education) and the demand for long-run programmes (university education) is estimated simultaneously as a system of equations.

The empirical model agrees fairly accurately with theortical implications; income and relative wage differences influence enrollment decisions positively, while direct costs have a negative impact on demand for higher education. The impact of indirect costs (foregone earnings) is negative, indicating that the negative price effect dominates the additional positive income effect.

Income and foregone earnings seem to be the driving variables in the demand model, thus emphasizing the importance to student's demand decisions of consumption aspects or imperfect access to capital. Consistently we find evidence that income and prices matter more to potential HOBU students than to university candidates, probably due to the fact that HOBU education attracts more students out of lower-income groups. Higher education appears to be a luxury good (elasticities around 1.2 and 1.3) and price elasticities range around -0.7 and -0.8. Substitution possibilities are asymmetric and exhibit 'cascade' properties, with HOBU experiencing high competition from universities but not vice versa.

DATA APPENDIX

1. Enrollment data

University freshmen enrollment data are provided in detail by *The Yearbook of the University Foundation*. Freshman enrollment is defined as those students registering for the first time in the first year of study.
Enrollment data for Non-University Higher Education are presented in *The Statistical Yearbook of Education* (Ministry of Education). Since freshman enrollment is not provided, first year enrollment was taken instead. A more serious problem is the federalization of the publication in 1972. As of that year each region (Flanders, Wallonia[17]) publishes its own yearbook, discontinuing some of the series available before and providing new series. The following procedure was followed to obtain a continuous series. For the period 1956 to 1971 first year enrollments are not reported, but we do have details about the age structure of the total student population. Per year of age (-18,18,19,20,..,25,+25) the total number of students is reported. From 1972 onwards first year enrollments are provided in detail for each region and simply added. There are some missing observations (Flanders 1972-1975 and Wallonia 1988-1989). In these case the figures were calculated using total enrollment figures for that region and the observable trend in the other region. For this same period (1972-1992) the Wallonia data show in detail the proportion of each age group (also -18,18,..25,+25) in first year enrollments. These proportions are very stable and show no statistical evidence at all of a time trend being present. It therefore seemed a defensible strategy to use the average value of these proportions and apply them to the available 1956-1971 data, to obtain a reasonable estimate of first year enrollment per age group in that period. These estimates were than simply added over all the age groups. The continuity of the series over the whole period 1956-1992, showing no major breaks, also supports the followed approach.

2. Eligible Population

The population of 18 year olds in Belgium was calculated from birth figures, corrected by mortality rates, provided by *The Statistical Yearbook of Belgium* (National Institute of Statistics - NIS).

3. Real Per Capita GNP

Real per Capita GNP is based upon data for Belgium from the National Accounts as published by the National Institute of Statistics (NIS) and made available through the electronic Bulletin Board System (*Plannet*) of the central Planning Bureau. GNP at market prices was deflated by a GNP deflator index (using 1985 as the base year). This figure was then divided by total Belgian population (also provided by the NIS).

[17] The German speaking region is included in the Wallonia figures.

4. Foregone Earnings

Foregone earnings are defined as real average yearly earnings per worker (also in prices of 1985) of blue collar workers in Belgium (NIS), corrected by the unemployment rate in order to reflect the higher chance of unemployment for blue collar workers.
Average yearly earnings are calculated by dividing real total earnings of blue collar workers (subject to the social security system) by the total number of blue collar workers (also subject to the social security system). Data on these two series are provided by the BBS *Plannet* of the central Planning Bureau.
The data series on the number of blue collar workers shows a break in 1970. This is due to the implementation of the 1969 law on the social security system that broadened the definition of those obliged to be included in the system. We made a new forecast of the 1970 figure, based on the estimates about the trend relationship for 1953-1969. The 1971-1992 figures were then transformed to the old definition by multiplying the figure by the ratio of the new versus the old figure for 1970.
As stated in the text, earnings are corrected by the unemployment rate (also provided by *Plannet*). It is assumed the unemployed receive 60% of their potential income in benefits. This way foregone earnings amount to :

$$FORE = YE * (1-U) + 60\% * YE * U$$

FORE = foregone earnings
YE = average yearly earnings
U = unemployment rate

5. Relative Wage Ratio

This consists of the ratio of real average yearly earnings (prices of 1985) of white-collar workers versus blue-collar workers as provided by *Plannet*. The calculation of average yearly earnings of white collar workers is analogous to that of blue collar workers as described above. There was no problem with definition change for this series.

6. Some descriptive statistics of the data

	PRU	PRT	PRH	RYB	RELW	FORE
Mean	0.100486	0.343651	0.243165	0.370701	1.580916	0.361223
Median	0.111833	0.341288	0.229454	0.381932	1.555902	0.370506
Maximum	0.172641	0.670697	0.498057	0.510582	1.753491	0.561280
Minimum	0.038494	0.096548	0.058053	0.210786	1.461664	0.188962
Std. Dev	0.034405	0.171322	0.138134	0.108060	0.080745	0.116532
Skewness	-0.143562	0.258732	0.350325	-0.203625	0.724444	0.017307
Kurtosis	2.150498	1.839716	1.795137	1.395977	2.308592	1.604247
Jarque-Bera	1.306653	2.622796	3.156732	4.450457	4.188148	3.167651
Probability	0.520312	0.269443	0.206312	0.108043	0.123184	0.205189
Observations	39	39	39	39	39	39

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