Reducing Product Diversity in Higher Education

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Abstract

Public systems of higher education have recently attempted to cut costs by providing financial incentives to institutions who reduce the diversity of their programs. We study the profit and welfare effects of reducing product diversity in higher education, against the background of a funding system reform in Flanders (Belgium). We find that dropping duplicated programs at individual institutions tends to be socially undesirable, due to the limited fixed cost and variable cost savings and the students' low willingness to travel to other institutions. Furthermore, we find that the financial incentives offered to drop programs may be very ineffective, leading to both undesirable reform and undesirable status quo. These findings emphasize the complexities in regulating product diversity in higher education, and serve as a word of caution towards the various decentralized financial incentive schemes that have recently been introduced.

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1 Introduction

The publicly financed systems of higher education in Europe have recently come under increased scrutiny to increase their efficiency (European Commission, 2006; Nadeau & McNicoll, 2006). Most European governments still show a reluctance to raise private contributions through tuition fees. They have instead taken various measures to reduce product diversity, i.e. to reduce the wide duplication of study programs across a large number of campuses. In particular, universities have been encouraged to merge or form associations, and new public funding systems have been designed to provide financial incentives to institutions to drop some of their study programs. These policies are based on a common belief that a reduced product diversity saves on the (duplicated) fixed costs, without generating too large losses to consumers (students).

This paper considers the effects of reducing product diversity in higher education, against the background of a recently proposed funding system reform in Flanders (Belgium). According to the 2005 proposals, institutions would receive public funding based on their achieved concentration index, i.e. the average number of students per study program. This therefore provides financial incentives to eliminate the smaller programs. We address two main questions. First, does reducing product diversity make sense from a welfare perspective? Second, does the concentration index provide the proper incentives to cut the right programs, i.e. if and only if this is socially desirable?

To address these questions we estimate a model of undergraduate educational choice, accounting for the determinants of the students' decisions where and what to study. The welfare effects from cutting programs consist of consumer surplus losses, variable cost savings (or losses) due to an output reallocation effect, and fixed cost savings. The profit effects consist of tuition fee revenue losses, fixed cost savings, and the incentive provided by the concentration index funding system.

Our first main finding is that the social desirability of cutting programs at individual institutions is limited to less than 10% of the cases. This follows from the students' low willingness to travel to other institutions. Reducing product diversity therefore results in large consumer surplus losses that typically outweigh any possible variable or fixed cost savings. Our second main finding is that a funding system that would make use of a concentration index may be very ineffective and often misses its purpose. It frequently creates incentives to cut programs when this would actually be socially undesirable. Furthermore, for the minority of cases where program cuts are actually desirable, the system may often not provide the proper incentives to do so. These findings of undesirable reform and undesirable status quo emphasize the complexities in regulating product diversity in publicly financed systems of higher education, and serve as a word of caution towards the various other measures that have recently been proposed. Policy makers often appear to be too pre-occupied with the fixed cost savings following program cuts: these may be too limited when traded off against the implied consumer surplus losses.

Our paper relates to the empirical industrial organization literature on product diversity. Several studies have estimated demand models to measure the effects of new product introductions or eliminations. They typically focus on consumer surplus and *gross* producer surplus effects, i.e. excluding the difficult to observe fixed costs.[1] A few studies have accounted for the role of fixed costs, by adding an entry model to the demand side. In particular, Berry and Waldfogel (1999) infer fixed costs from a model of free entry, where entry occurs if and only if this is profitable.[2] This approach is not possible in our application, since the decision to supply study programs is subject to an untransparant government approval process. We therefore make the weaker assumption that institutions offer programs if (but not only if) this is profitable. This provides simple upper bounds on the fixed costs per program, and actually brings us quite far in drawing unambiguous conclusions about the total welfare effects and profit incentives of reducing product diversity. Similar approaches may therefore be useful in other applications where there is no simple free entry process.

In the educational economics literature there has been a long-standing concern with the efficient use of resources.[3] Several papers identified the importance of scale economies in the provision of education, thereby providing arguments in favour of reducing product variety.[4] However, the demand side of higher education remains underexplored. A notable exception is Long's (2004) thorough analysis of the determinants of higher educational choice in the U.S., including the role of distance and college characteristics. Kelchtermans and Verboven (2006) extend her approach to study the choice determinants at the more detailed level of the study fields. Both papers do not, however, draw implications about reducing product diversity, an issue that is especially relevant in the regulated European systems. To accomplish this, we estimate a rich model of student choices at the most disaggregated level of the individual study program.

[1] Petrin (2002), Hausman and Leonard (2002) and Nevo (2003) look at the consumer effects of new product introduction. Perloff and Ward (2003) also look at product eliminations and consider both consumer surplus and gross profits, using assumptions about pricing behavior.

[2] For the large theoretical literature on free entry and optimal product diversity, see for example Spence (1976), Dixit and Stiglitz (1977), and Mankiw and Whinston (1986).

[3] For example, Bergstrom et al. (1988) devised an empirical test to determine whether governments spend too much on public education.

[4] Riew (1966) and Cohn et al. (1989) found evidence of scale economies at the secondary school and higher education level, respectively. These findings suggest that education institutions could reduce their unit costs of operation by growing relative to their current size.

The remainder of this paper is organized as follows. Section 2 discusses the relevant institutional aspects of the higher education system in Flanders (Belgium), in particular the current product diversity and the proposed funding system reform. Section 3 outlines the economic framework to analyze the effects of reducing product diversity. Section 4 presents the empirical model of educational choice and the empirical estimates. Section 5 uses the framework and empirical results to assess the profit and welfare effects. Finally, section 6 concludes.

2 Higher education in the region of Flanders

Our empirical analysis is based on Flanders (Belgium), but it is also relevant for several other European countries. We focus our discussion on the current product diversity and on the recent government policies aimed at reducing it. For a more detailed discussion of higher education in Flanders, we refer to Van Heffen and Lub's (2003) country report.

2.1 Institutions and study programs

There are two types of institutions offering higher education: colleges and universities. Colleges largely focus on teaching and offer one-cycle or two-cycle vocational study programs. Universities are active in both research and teaching and offer two-cycle academic programs. In recent years, there has been a convergence between the two-cycle vocational programs at colleges and their academic counterparts at universities. Several institutions have multiple campuses across the region.

There are ten main study fields: architecture, engineering, sciences, economics & business, education sciences, other social sciences, medicine & paramedics, bio-engineering, languages and cultural studies. These fields apply to both colleges and universities, except for sciences which are only offered at universities. Each field may consist of more than one "elemental" study program. For example, hotel management and marketing are study programs in the vocational economics & business field, while dentistry and medical sciences are programs in the academic medicine/paramedics field.

Table 1 provides an overview of product diversity in the academic year 2001-2002. The table shows the number of campuses, study programs, incoming students, and the average number of students per study program. The information is summarized for each of the ten study fields at colleges (upper panel) and universities (lower panel). Table 1 shows that there are 44 college campuses and 9 university campuses, amounting to a high density of one campus per 250 km^2. All fields are broadly available at many campuses throughout the region. This "duplication" of supply is especially large for vocational study fields at colleges, in particular for engineering, economics & business, education sciences and medicine & paramedics. The average scale per study program is relatively low, most notably for programs within the cultural studies field at colleges (where there are only 19 incoming students per program).

In sum, Table 1 illustrates the high product diversity in the market for higher education in Flanders. There is a broad geographical coverage of all study fields, and a correspondingly small average scale, especially at college campuses. These observations will be useful when interpreting and evaluating the effects of the government policy towards the large product diversity.

2.2 Government intervention and the 2005 reform proposals

As in most European countries the Flemish undergraduate higher education system is entirely public. The government intervenes in several ways. First, it regulates tuition fees, which are currently uniform at € 425 for colleges and € 445 for universities. Second, the government exercises some direct control over the quality and the diversity of supply. The quality is controlled through a system of self-assessments and external visiting committees. The diversity is regulated since institutions are not automatically eligible to offer all possible study programs. In practice, however, the institutions form a continuous pressure to be entitled to supply additional subsidized programs. Third, the government intervenes by granting subsidies. In the former funding system the subsidies consisted of a fixed and a variable component. The variable component represented a constant subsidy per student, varying across study programs on cost-based principles.

The 2005 reform proposals aimed to make the funding system more efficient. The constant subsidy per student has been made in line with recent and more accurate estimates of the variable cost per student, as obtained by Deen et al. (2005). Since the subsidies will be used as a measure for the variable costs in our analysis below, Table 2 summarizes the information for the ten different study fields (i.e. averaged over the individual study programs within each field). The subsidies tend to be lower for colleges than for universities, and show a wide variation across fields: the lowest levels are for humanities and social sciences and the highest levels for medical and exact sciences. These differences in subsidies per student clearly reflect the differences in the estimated variable costs per student.

The more crucial 2005 reform proposals, and the focus of our analysis, consisted of a series of financial incentives to induce institutions to limit the number of institutions and study programs. These incentives served as an alternative to the former approach which had unsuccessfully attempted to limit product diversity through direct regulation. First, institutions were required to reach a minimum size to be eligible for funding. Furthermore, financial bonuses through phase-out funding were provided for programs that an institution decided to cut and institutions could earn additional funding by jointly offering study programs. A final incentive proposed to reduce product diversity was the replacement of the fixed funding component by a variable scheme based on the institution's achieved concentration index. The concentration index of institution k, C_k, is the average number of students per offered study program:

$$C_k = \frac{Q_k}{J_k},$$

where Q_k is the total number of students and J_k is the total number of study programs at institution k. An institution would then receive a subsidy amount r per unit of the achieved concentration index.[5] We will refer to this system as the CI funding system. It provides an incentive to reduce the number of programs J_k, though at the risk that the number of students Q_k also goes down.

In the next section we provide a framework to analyze the incentives to cut programs taking into account the students' demand responses. We also will provide conditions under which reducing product diversity is desirable from a welfare perspective. We note, however, that the 2005 proposed CI funding system was not actually incorporated in the 2007 reforms for practical reasons.[6] Nevertheless, our analysis emphasizes the key importance of properly accounting for students' demand responses, and is therefore also relevant for other financial incentive schemes designed to reduce product diversity (such as the financial bonuses to eliminate or merge study options).

3 Economic framework

We now provide the economic framework for analyzing the demand, profit and welfare effects of reducing product diversity in higher education. This will serve as the basis for our empirical analysis in the next sections.

[5] In practice, the index is slightly more complicated (Vandenbroucke, 2005). It is normalized by the average index over all institutions. This normalized concentration index has to stay within bounds of 0.5 and 1.5. We account for this in our empirical analysis, but not in our discussion since it complicates the exposition and it only matters for a minority of the institutions. The lower bound is obtained for 5 and the upper bound for 4 out of the 53 institutions. The subsidy r per 0.01 units of the (normalized) concentration index was set at € 16,000.

[6] For example, it was argued by universities that it is common to pool students and 'share' them across study programs so that critical mass is achieved whilst the concentration index is not able to capture such initiatives.

3.1 Demand, profits and welfare

There are K institutions; each institution $k = 1 \cdots K$ offers J_k study programs, $j = 1 \cdots J_k$, so the total number of study alternatives is $J = \sum_{k=1}^{K} J_k$. There are I students, $i = 1 \cdots I$, each making the discrete choice of one among the J available study alternatives.[7] The discrete choice model is specified in section 4.1. The implied number of students or aggregate demand for program j at institution k is denoted by $q_{jk}(\mathbf{p})$, where $\mathbf{p}$ denotes the $J \times 1$ price vector $\mathbf{p}$ of all study alternatives (programs and institutions). The total demand of institution k is the sum of all its program demands, i.e. $Q_k(\mathbf{p}) = \sum_{j=1}^{J_k} q_{jk}(\mathbf{p})$. Since all students choose one of the available study alternative, total demand across all institutions is inelastic and simply equals the total number of students, i.e. $\sum_{k=1}^{K} \sum_{j=1}^{J_k} q_{jk}(\mathbf{p}) = I$.

The program-related profits of institution k consist of tuition fee revenues and subsidies minus variable and fixed costs over all its programs.[8] Each program j has a constant variable cost per student c_j (common across institutions k) and a fixed cost F_{jk}. The subsidies consist of two parts. First, there is a constant and program-specific variable subsidy per student s_j, which is cost-based so that $s_j = c_j$. Second, there is an additional subsidy at the level of the institution k. As discussed in section 2, the 2005 reform proposals replaced the traditional fixed subsidy by the CI funding system, i.e. a subsidy r per unit of institution k's achieved concentration index $C_k(\mathbf{p})$. This index is equal to the institution's average program size, i.e. the average number of students per program at a given price vector $\mathbf{p}$:

$$C_k(\mathbf{p}) = \frac{Q_k(\mathbf{p})}{J_k}.$$

The program-related profits of institution k are therefore:

$$\begin{aligned} \pi_k(\mathbf{p}) &= \sum_{j=1}^{J_k} (p_{jk} + s_j - c_j)\, q_{jk}(\mathbf{p}) + rC_k(\mathbf{p}) - \sum_{j=1}^{J_k} F_{jk} \\ &= \sum_{j=1}^{J_k} p_{jk} q_{jk}(\mathbf{p}) + rC_k(\mathbf{p}) - \sum_{j=1}^{J_k} F_{jk}, \end{aligned}$$

or simply the tuition fee revenues plus the revenues from the achieved concentration index minus the fixed costs.

Producer surplus is the sum of all institutions' program-related profits minus government subsidies. The subsidies cancel out since they are simply transfers from the government to

[7] There is thus no outside good. This is consistent with our earlier work with study options at the more aggregate field level (Kelchtermans and Verboven, 2006), where we found very limited substitution to the outside good in response to cost increases.

[8] Institutions may also obtain other benefits, such as benefits from research or from raising the students' productivity (as modeled by Del Rey, 2001), or "prestige" (De Fraja and Iossa, 2001). While we do not rule out the presence of such objectives, we assume them to be separable from the direct program-related profits.

the institutions, so that producer surplus reduces to tuition fee revenues minus variable costs and fixed costs:

$$PS(\mathbf{p}) = \sum_{k=1}^{K}\sum_{j=1}^{J_k}(p_{jk} - c_j)q_{jk}(\mathbf{p}) - \sum_{k=1}^{K}\sum_{j=1}^{J_k} F_{jk},$$

where c_j is observed since we observe $s_j = c_j$.

Consumer surplus at a given price vector $\mathbf{p}$ is the sum of each student i's individual consumer surplus, $CS(\mathbf{p}) = \sum_{i=1}^{I} CS_i(\mathbf{p})$. Total welfare is the sum of consumer and producer surplus, $W(\mathbf{p}) = CS(\mathbf{p}) + PS(\mathbf{p})$.

3.2 The effects of reducing product diversity

It is convenient to define the elimination of study alternatives (i.e. programs and/or institutions) in terms of prohibitive tuition fee increases. The initial price vector $\mathbf{p}^0$ consists of uniform tuition fees p^0 for all study alternatives. After the elimination of one or more study alternatives there is a new price vector $\mathbf{p}^1$, where the prices for the eliminated alternatives are replaced by infinitely high prices (so that their demands effectively become zero). We focus the exposition here on the unilateral elimination of one program j at one institution k, and denote this new price vector by $\mathbf{p}^1_{jk}$ (with the price for program j at institution k set equal to infinity and the other prices remaining at the initial level p^0). In our empirical analysis, we will also consider the joint elimination of one study program j at all institutions, as denoted by a price vector $\mathbf{p}^1_j$ (with infinite prices for program j at all institutions).

Demand effects First, consider the effects of a unilateral cut of program j at institution k on the total demand (number of students) of institution k. A common measure is the diversion ratio DR_{jk} of the eliminated program j with respect to the other programs offered at institution k:

$$DR_{jk} = \frac{\sum_{j' \neq j}^{J_k} \left(q_{j'k}(\mathbf{p}^1_{jk}) - q_{j'k}(\mathbf{p}^0)\right)}{q_{jk}(\mathbf{p}^0)}.$$

This ratio is between zero and one, and measures the fraction of the students lost from the eliminated program j that flows back to other programs offered by the same institution k.[9] A high diversion ratio means that students have a strong preference for the institution rather than for the specific program. This may reflect high mobility costs, but also simply the

[9] The diversion ratio is often used in merger analysis (e.g. Shapiro, 1995), where it refers to the fraction of sales lost by brand A (due to a price increase) that is captured by brand B, as a first indicator of the competitive effects of a merger of brands A and B. It also frequently appears in the theory of access price regulation, where it is known as the displacement ratio.

possibility that students perceive different study programs at the same institution as close substitutes.

Profit incentives Now consider the profit incentives for eliminating program j at institution k. After some rearrangements one can verify that the change in profits from such a unilateral program cut is:

$$\begin{aligned} \Delta\pi_{jk} &= \pi_k(\mathbf{p}^1_{jk}) - \pi_k(\mathbf{p}^0) \\ &= \underbrace{-(1-DR_{jk})p^0 q_{jk}(\mathbf{p}^0)}_{\text{tuition fee revenue loss}} + \underbrace{r\left(C_k(\mathbf{p}^1_{jk}) - C_k(\mathbf{p}^0)\right)}_{\text{change in concentration index}} + \underbrace{F_{jk}}_{\text{fixed cost saving}}. \end{aligned} \tag{1}$$

According to (1), the profit incentive from a diversity reduction consists of three terms. The first term is the tuition fee revenue loss, and is clearly negative. The loss is smaller than the initial fee revenues from the eliminated alternative $p^0 q_{jk}(\mathbf{p}^0)$, since it accounts for the fact that some of the lost students may remain within the same institution ($DR_{jk} > 0$). The third term is positive and refers to the fixed cost savings associated with eliminating study program j. The second term captures the change in the concentration index, and may be positive or negative. One can easily verify that the concentration index increases, i.e. $C_k(\mathbf{p}^1_{jk}) - C_k(\mathbf{p}^0) > 0$, if and only if

$$q_{jk}(\mathbf{p}^0) < \frac{C_k(\mathbf{p}^0)}{1 - DR_{jk}}.$$

Hence, the CI funding scheme provides a positive profit incentive for eliminating program j at institution k if it has a sufficiently low number of students. When $DR_{jk} = 0$, it provides a positive incentive if the number of students at program j is below the institution's average program size ($q_{jk}(\mathbf{p}^0) < C_k(\mathbf{p}^0)$). When $DR_{jk} > 0$, some of the lost students substitute to other programs within the institution, so that the system may provide a positive profit incentive to cut a program even if the number of students is above average. The general message is that the CI funding system creates positive incentives to drop programs with few students and with sufficient substitution possibilities to other programs within the institution.

Welfare effects Finally, consider the welfare effects of a unilateral cut of program j at institution k. The effect on consumers is

$$\Delta CS_{jk} = CS(\mathbf{p}^1_{jk}) - CS(\mathbf{p}^0),$$

which is clearly negative since the program drop involves a (prohibitive) tuition fee increase for the eliminated program. Note that one can interpret $-\Delta CS_{jk}$ as the students' net willingness to pay for program j at institution k, i.e. the students' willingness to pay on top of the current tuition fees.[10] The effect of dropping program j at institution k on producer surplus is

$$\begin{aligned}\Delta PS_{jk} &= p^0 \sum_{k=1}^{K}\sum_{j=1}^{J_k}\left((q_{jk}(\mathbf{p}_{jk}^1) - q_{jk}(\mathbf{p}^0)\right) - \sum_{k=1}^{K}\sum_{j=1}^{J_k}\left(c_j(q_{jk}(\mathbf{p}_{jk}^1) - q_{jk}(\mathbf{p}^0)\right) + F_{jk} \\ &= -\sum_{k=1}^{K}\sum_{j=1}^{J_k} c_j\left(q_{jk}(\mathbf{p}_{jk}^1) - q_{jk}(\mathbf{p}^0)\right) + F_{jk},\end{aligned}$$

where the second equality follows from the fact that total demand is inelastic. The first term is the variable cost saving from an output reallocation effect following the program drop. It may be positive or negative depending on whether the other programs to which the students substitute have a lower or a higher variable cost than the eliminated program. The second term is a positive fixed cost saving.

The effect of a program cut on total welfare then consists of the following components:

$$\begin{aligned}\Delta W_{jk} &= \Delta CS_{jk} + \Delta PS_{jk} \qquad (2)\\ &= \underbrace{CS(\mathbf{p}_{jk}^1) - CS(\mathbf{p}^0)}_{\text{consumer loss}} - \underbrace{\sum_{k=1}^{K}\sum_{j=1}^{J_k} c_j\left(q_{jk}(\mathbf{p}_{jk}^1) - q_{jk}(\mathbf{p}^0)\right)}_{\text{variable cost saving from output reallocation}} + \underbrace{F_{jk}}_{\text{fixed cost saving}}.\end{aligned}$$

Eliminating program j thus involves a negative effect on consumers, a positive or negative variable cost saving from output reallocation, and a positive fixed cost saving.

3.3 Inferences without observing fixed costs

A comparison of (1) and (2) clearly shows that the profit incentives and welfare effects of a program cut are not necessarily well-alligned. Our empirical analysis aims to assess this, but faces the following main challenge. While we can measure most profit and welfare components from our demand parameter estimates and our variable cost proxy $c_j = s_j$, we do not observe the fixed cost savings involved in a program cut. We therefore proceed as follows.

- In a first step, we focus on the observable components of the profit and welfare effects, i.e. tuition fee revenue losses, the change in the concentration index, consumer losses, and the output reallocation effect. This is in the spirit of other work on the effects of product diversity, such as Petrin (2002), Hausman and Leonard (2002) or Nevo (2003), which all abstracted from fixed cost considerations.

[10] In the empirical analysis we will compare this with the willingness to pay for program j across all institutions (by considering the new price vector $\mathbf{p}_j^1$).

- In the second step, we obtain reasonable bounds on the fixed cost savings, and thereby at least provide sufficient conditions under which unilateral program cuts raise or lower total profits or welfare. It turns out that, in our application, this approach gives us conclusive answers on the profit and welfare effects of the CI funding system for a large number of cases.

More specifically, in the second step we make the following assumptions about the fixed costs of any program j at any institution k. First, we assume that fixed costs are positive, i.e. $F_{jk} > 0$ for all j, k. Second, we assume that institutions did not find it profitable to cut any of the offered programs under the old funding system, where the concentration index was not yet at work.[11] Inspecting (1), but without the term for the change in the concentration index, this amounts to an upper bound on fixed costs of $F_{jk} < (1 - DR_{jk})p^0 q_{jk}(\mathbf{p}^0)$. Intuitively, the fixed costs at any program j at any institution k are assumed to be less than the tuition fee revenue losses that would result from a program cut in the old funding system. These revenue losses are simply the actual revenues $p^0 q_{jk}(\mathbf{p}^0)$, adjusted for the estimated diversion ratio.

In sum, we thus bound the fixed costs of program j at institution k between two levels:

$$0 < F_{jk} < (1 - DR_{jk})p^0 q_{jk}(\mathbf{p}^0). \tag{3}$$

Note that as the diversion ratio increases (becomes closer to 1), the upper bound on the fixed cost becomes tighter.

We can now combine the fixed cost bounds (3) with (1) and (2) to obtain the following *sufficient* conditions for the sign of the profit and welfare effects of unilateral program cuts:

Proposition 1 *Consider a unilateral cut of program j at institution k.*

(i) This is socially desirable if $\Delta CS_{jk} - \sum_{k=1}^{K} \sum_{j=1}^{J_k} c_j \left(q_{jk}(\mathbf{p}^1_{jk}) - q_{jk}(\mathbf{p}^0) \right) > 0$*, and undesirable if* $(1 - DR_{jk})p^0 q_{jk}(\mathbf{p}^0) + \Delta CS_{jk} - \sum_{k=1}^{K} \sum_{j=1}^{J_k} c_j \left(q_{jk}(\mathbf{p}^1_{jk}) - q_{jk}(\mathbf{p}^0) \right) < 0$.

(ii) The CI funding system provides a positive profit incentive for this program cut if $-(1 - DR_{jk})p^0 q_{jk}(\mathbf{p}^0) + r \left(C_k(\mathbf{p}^1_{jk}) - C_k(\mathbf{p}^0) \right) > 0$*, and it does not provide a profit incentive if* $r \left(C_k(\mathbf{p}^1_{jk}) - C_k(\mathbf{p}^0) \right) < 0$.

[11] This is in the spirit of the empirical IO literature on entry. From observing a certain program we can infer that it is profitable to supply it, implying an upper bound on the fixed cost level. The empirical IO literature on free entry would however go a step further. Under free entry, one could also infer that supplying additional programs would be unprofitable, implying a lower bound on fixed costs. This inference is not reasonable in our setting, since the entry of additional programs is regulated, implying that institutions cannot simple add more programs to their portfolio as long as that is profitable. We therefore set the lower bound on fixed costs to zero.

We will provide intuition for these inequalities at the beginning of Section 5.2 where we apply Proposition 1.

Proposition 1 implies that the effects of the CI funding system can be classified in four natural cases, summarized in Table 3. The top left cell shows the "desirable status quo" cases, under which a unilateral program cut is neither profitable nor socially desirable. The top right cell shows the "undesirable status quo" cases, under which a program cut is not profitable under the CI funding system although it would be socially desirable. The bottom left cell shows the "undesirable reform" cases, under which a program cut is profitable although it is not socially desirable. Finally, the bottom right cell shows the "desirable reform" cases, where a program cut is both profitable and socially desirable. Our empirical analysis will show that it is possible to unambiguously classify many of the unilateral program cuts into one these categories, even without observing the actual fixed cost savings F_{jk}.

4 Empirical framework

To estimate the effects of reducing product diversity, it is necessary to understand how students make their educational decisions. We have a rich data set of $36,602$ students choosing one out of 562 study alternatives (programs/institutions). We specify the students' choice process based on a conditional logit model. This model is well-suited to deal with the large data set, since the parameters can be consistently estimated by sampling over the large number of study alternatives. This is considerably more efficient than sampling over the individuals.[12]

Our logit model does not include an outside good or "no-study alternative". In a previous paper Kelchtermans and Verboven (2006) included an outside good in a nested logit framework (with study options aggregated to the field level). Since we found that students are extremely cost inelastic regarding the decision whether to study, we chose to adopt the computationally simpler logit model without an outside good here. Hence, we focus exclusively on the decision where and what to study. This is especially convenient since we

[12] Sampling over alternatives in non-logit discrete choie models does not generally give consistent maximum likelihood estimates. Bierlaire et al. (2006) show that it is still possible to obtain consistent maximum likelihood estimates in "block additive generalized extreme value models", which includes the logit but not the nested logit model. Kelchtermans and Verboven (2006) show how to sample over alternatives in a nested logit model using a sequential procedure. Most recently, Fox (2007) has proposed a maximum score estimator to obtain consistent estimates based on a subset of alternatives for a general class of discrete choice models including random coefficients (or mixed) logit models. However, given the richness of our data set, the need for controlling for additional unobserved student heterogeneity appears to be lower here than in other applications.

analyze the study alternatives at a considerably more disaggregate level than Kelchtermans and Verboven (2006).

4.1 Indirect utility

A student i's conditional indirect utility for study program j at institution k consists of a deterministic component V_{ijk} and a random component ε_{ijk}. The deterministic component V_{ijk} depends on the expected benefits from studying and on the expected costs, including the monetary costs in the form of tuition fees and travel costs. We take the following specification:

$$V_{ijk} = \beta_{jk} + w_i'\gamma_{jk} + w_i'\alpha(y_i - p_{jk} - g(x_{ik})), \tag{4}$$

where w_i is a vector of individual characteristics (sex, age, high school background, etc.), y_i is student i' s annual income, p_{jk} is the tuition fee for study program j at institution k, and $g(x_{ik})$ is an implicit price because of the annual travel costs x_{ik} of student i to institution k.

The first two terms in (4) may in principle include a full set of alternative-specific intercepts β_{jk} and slope vectors γ_{jk}. In practice, such flexibility would imply a very large number of parameters to be estimated, because of the large number of alternatives to be interacted with the individual characteristics in the vector w_i. We will therefore specify β_{jk} and γ_{jk} to depend on a more limited but still rich set of alternative characteristics (e.g. program type or field, institution's religious affiliation, etc.)

The third term in (4) refers to the utility from the consumption on goods other than the study alternative, after spending the tuition fee p_{jk} and an implicit price $g(x_{ik})$, which is an increasing function of the annual travel costs x_{ik} of student i to institution k. The parameter vector α captures the determinants of the marginal utility of income and is important to convert utility in monetary terms and conduct our welfare analysis. Each student either commutes or goes on residence. If she commutes, her implicit price for alternative j is simply the annual travel cost $g(x_{ik}) = x_{ik}$. If she goes on residence, she saves a fraction ϕ of the trips, but pays an extra annual cost on rent r_k, so that her implicit price becomes $g(x_{ik}) = (1-\phi)x_{ik} + r_k$. A cost-minimizing student thus commutes if and only if she is located sufficiently closely to institution k, i.e. $\phi x_{ik} \leq r_k$. The deterministic component of utility (4) can then be written as:

$$V_{ijk} = \beta_{jk} + w_i'\gamma_{jk} + w_i'\alpha\,(y_i - p_{jk} - x_{ik}) + w_i'\alpha(\phi x_{ik} - r_k)\, I(\phi x_{ik} - r_k), \tag{5}$$

where $I(\cdot)$ is an indicator function equal to 1 if its argument is positive, and equal to 0 otherwise. Utility therefore decreases in the annual travel costs x_{ik} in a piecewise linear way: at a steeper rate $w_i'\alpha$ for low values of x_{ik} (when the student commutes), and at a flatter rate $w_i'\alpha\phi$ for high values of x_{ik} (when the student goes on residence).

4.2 Estimation and data set

Each student i chooses the study program j at institution k that maximizes random utility $V_{ijk} + \varepsilon_{ijk}$, where ε_{ijk} takes the logit extreme value distribution. This results in the familiar logit choice probabilities for each student i for each progam j at institution k. It also gives the standard expressions for expected consumer surplus for each student i; see for example Train (2003) for details.

The choice probabilities can be used to construct the likelihood function. There are, however, practical difficulties due to the very large size of our data set:

- $36,602$ students, i.e. all incoming students in Flanders in 2001;
- 562 study alternatives, i.e. the various programs offered across 53 campuses;
- a large set of study characteristics, interacted with many student characteristics.

The logit model is well-suited to manage this data set, as it enables consistent maximum likelihood estimation by sampling over the study alternatives. This is considerably more efficient than sampling over individuals, in particular to identify the utility determinants of the infrequently chosen alternatives. Specifically, for each student we sample a choice set of 20 alternatives, including the chosen alternative plus a random sample of 19 other study alternatives.[13]

Our data set comes from the Flemish Ministry of Education, and has information on:

Student characteristics (w_i). This consists of demographic information, i.e. sex, nationality and religious affiliation of the high school; and information on scholastic ability, i.e. years of repetition in high school, the type of high school (general, technical or professional) and the study program followed at high school (e.g. mathematics, languages).

Travel costs (x_{ik}). From information on students' and institutions' locations, we compute the distance per trip d_{ik} (in km) and the travel time per trip t_{ik} (in min) for every student i to every institution k. We then set the annual travel costs x_{ik} (in Euro) to $x_{ik} = 75d_{ik} + 40t_{ik}$.[14]

[13] Furthermore, since we do not exploit observable variation across the study programs (e.g. nursing) within a study field/type (e.g. biomedical vocational), we can aggregate the 562 elemental program/institution alternatives to 226 field/type/institution alternatives. As shown in Ben-Akiva and Lerman (1985), in the logit model this simply requires including the log of the number of elemental program alternatives within each aggregate field alternative as an additional variable in the utility specification.

[14] This assumes that a commuter engages in 10 trips per week during 30 weeks of the year, at a transportation cost of 0.25 Euro/km and an opportunity cost of time of 8 Euro/hour. The latter amount corresponds to the typical wage for student jobs.

Study alternative characteristics (entering β_{jk} and γ_{jk}). This consists of the following variables: the institution's religious orientation, the study program type (one-cycle and two-cycle vocational programs at colleges, and two-cycle academic programs at universities) and the ten study fields discussed in section 2 (architecture, engineering, etc.).

Following the utility specification (5), we interact the student characteristics (w_i) with both the travel costs (x_{ik}) and the study alternative characteristics (in γ_{jk}). Table 4 provides summary statistics on the student characteristics and travel costs (rows), by a few main study characteristics (columns).

4.3 Parameter estimates

We now briefly discuss the parameter estimates of the logit model, as shown in Tables 5, 6a and 6b. It is however possible to directly move to section 5.1 where we show what these estimates imply for the demand, profit and welfare effects of reducing product diversity.

Table 5 gives a general overview of the estimated specification and highlights the role of travel costs in the study choice process ($w_i'\alpha$ and ϕ). Travel costs have a negative and highly significant effect on utility, but there are differences across individuals. For example, students from a catholic high school or with a classical languages background are less cost sensitive and consequently travel further. In contrast, students with several repetitions at high school or with a technical (non-product focused) high school background are more cost sensitive and therefore study more nearby their homes. Furthermore, the parameter $\phi = 0.49$ shows that the effect of travel costs decreases significantly in distance: more distant students go on residence and save 49% on the travel costs. Finally, Table 5 shows that the size factor parameter is close to 1, indicating that the study programs within a program field are relatively heterogeneous.

Tables 6a and 6b show how individuals value the various characteristics of the study alternatives ($w_i'\gamma_{jk}$).[15] The first column of Table 6a shows the preferences for catholic institutions. Most notably, students from a catholic high school tend to value catholic colleges and universities higher than other students, suggesting the continuing strong links between the catholic high school and higher education networks. The second and third columns of Table 6a show the impact of nationality and the specific high school background on the utility for academic or two-cycle vocational programs (with one-cycle vocational programs as the base). For example, foreign students tend to prefer the academic and two-cycle voca-

[15] These results extend Kelchtermans and Verboven (2006) by (1) considering more detailed study fields (Table 6a), and (2) adding richer interaction terms between the study fields/types and the student characteristics (Table 6b). Nevertheless, several parameters are imposed to zero because of a too low number of observations on some of the interactions.

tional programs over the one-cycle vocational programs. This is also true for students with a general high school background in classical languages and/or mathematics. The remaining columns of Table 6a show the impact of nationality and high school background on the utility for the specific study fields (cultural studies being the base category). Foreigners are more likely to opt for engineering or economics & business. Furthermore, the specific general high school background is closely related to the valuation for the study fields at higher education institutions. For example, students with a science of mathematics general high school background have a strong preference for science or engineering programs and not for programs in languages or culture (the base category). The reverse is true for students with a general high school background in classical languages.

Table 6b presents the role of the other student characteristics (sex, years of repetition and type of high school) on the study fields, broken down by the program type (one-cycle and two-cycle vocational, and academic). For example, male students have a higher preference for engineering and economics & business programs, regardless of the type of higher education. At the same time, they have a lower preference for medicine & paramedics but only if this is of the one-cycle vocational type (which primarily consists of nursing programs). As another example, students who experienced a year of repetition in high school have a lower utility from participating in architecture and engineering but only if this is of the academic type. Such students also prefer economics & business or medicine & paramedics of the one-cycle vocational type, rather than of the two-cycle vocational or academic types. Students with an intellectually more demanding general high school background tend to prefer the academic and two-cycle program fields over the counterparts of the one-cycle program fields.

5 The effects of reducing product diversity

Section 5.1 discusses the demand, profit and welfare effects from reducing product diversity, without accounting for the fixed cost savings. Section 5.2 then considers the total profit and welfare effects, based on our obtained bounds for the fixed cost savings (3), enabling us to draw policy implications regarding the CI funding system.

5.1 Demand, profit and welfare effects

The demand effects from unilateral program cuts at individual institutions are best summarized by the diversion ratios implied by our parameter estimates. As discussed, the diversion ratio measures the fraction of students that go to other programs in the same institution when a specific program is eliminated. Table 7 shows the diversion ratios from unilateral program cuts, summarized by study field. The diversion ratios clearly tend to be higher at universities than at colleges (average across all fields of 28% versus 19%). Universities would thus loose comparatively fewer students after unilateral program cuts. This is due to their larger size and less competition. There are some interesting differences in the diversion ratios between the fields. For example, the diversion ratio is particularly low for language programs at colleges (8%), indicating that students do not perceive other programs offered at the same institution as good substitutes for languages. At the other extreme, the diversion ratio is over 30% for architecture, engineering, medicine and education sciences at universities, showing that programs from these fields have relatively good substitutes within the same university.

Table 8 shows how these substitution effects translate into two of the profit components: tuition fee revenues and revenues from the CI funding scheme, see equation (1). (The third profit component, i.e. fixed cost savings, is addressed in the next subsection.) For all fields the tuition fee revenues decrease in response to a program cut, but by less than the current tuition fee revenues. This follows directly from the diversion ratios, i.e. the fact that students may substitute to other programs within the university after a program cut. Furthermore, the revenue changes from the concentration index based funding scheme may or may not compensate for these tuition fee revenue losses. Program cuts from large fields such as educational sciences would result in a lower concentration index and hence create additional revenue losses. In contrast, program cuts from the smaller fields, such as bio-engineering at colleges or sciences and medicine at universities, result in large increases in the concentration index, generating revenue gains that actually outweigh the tuition fee revenue losses. For those cases, the funding system provides incentives to cut programs even without any fixed cost savings.

Table 9 shows the effects of unilateral program cuts on two of the welfare components: consumer surplus and variable costs, see equation (2). (The third component is again fixed costs and addressed in the next subsection.) First, the consumer surplus effects are evidently always negative when a program is eliminated (first two columns). This is especially so for the larger programs at colleges and universities. Recall that the absolute value of these consumer surplus effects may also be interpreted as the students' net willingness to pay for the eliminated program, i.e. their willingness to pay on top of the paid tuition fees. This willingness to pay is usually quite large, for some fields it is three to four times larger than the students' actual tuition fee expenditures (shown earlier in Table 8).[16] This is due to a low student mobility and willingness to travel to other institutions, as found in our empirical analysis. Second, the variable cost savings from output reallocation may also

[16]For example, the net willingness to pay for a study program in engineering at universities is on average €522,386, which is about 3.5 times higher than the actual tuition fee expenditures (€148,479).

be negative (third and fourth column of Table 9). This is the case for cutting programs with low variable costs, such as economics&business or cultural programs, which both cause substitution towards more expensive programs. The variable cost savings may, however, also be positive, most notably for the high variable cost programs such as science and medicine at universities. In these cases the variable cost savings even outweigh the consumer surplus losses so that the total gross welfare changes are positive (last two columns of Table 9). Hence, eliminating these programs would result in a total welfare gain even without any fixed cost savings. Program cuts from other fields, however, usually involve negative gross welfare effects, even when variable cost savings are positive. They would therefore require sufficient fixed cost savings for total welfare to increase. Whether this is indeed the case, will be addressed separately in the next subsection, based on our estimated bounds on the fixed cost savings.

To put this welfare discussion in perspective, Table 10 presents the analogue welfare effects from *joint* program cuts, i.e. program cuts common for all institutions offering the same program. We focus our discussion here on the consumer surplus losses (first two columns). As expected, the consumer surplus losses from joint program cuts are considerably larger than those from the unilateral cuts in Table 9. What is more interesting, however, is that the consumer surplus losses from the joint program cuts are disproportionally larger. Consider, for example, engineering programs at colleges. These are available at 25 college campuses (Table 1), but the consumer surplus loss is more than 40 times larger under a joint program cut than under a unilateral program cut (loss of € 4,977,878 versus € 116,347). This motivates our focus on unilateral program cuts which may reduce inefficient duplication of fixed costs across multiple campuses, rather than on joint program cuts which cause disproportionate consumer surplus losses.

5.2 Evaluation of the funding system reform

To assess the total profit and welfare effects of the CI funding system, we now introduce the fixed cost bounds given in inequality (3). Based on these bounds, Proposition 1 showed that the CI funding system provides no incentive to cut a program if this reduces the concentration index, while it does provide such an incentive if the additional revenues from an increase in the concentration index outweigh the tuition fee revenue losses. Similarly, Proposition 1 showed that a program cut is socially desirable if the sum of the consumer surplus losses and the variable cost savings from output reallocation is positive; a program cut is undesirable if the sum of consumer surplus losses, variable cost savings and tuition fee revenue losses is negative. Table 3 provided the corresponding classification of program cuts in desirable status quo, undesirable status quo, desirable reform and undesirable reform cases.

Table 11 applies this classification. It counts how many out of the 562 possible program cuts can be unambiguously classified into one of these four cases, using our estimated fixed cost bounds and the profit and welfare components of the previous subsection. We begin with the left column. The bottom cell shows that for the large majority of cases (504 out of 562, or about 90%) it is socially undesirable to cut programs at individual institutions. This striking result follows from the low student mobility and the correspondingly large total willingness to pay for programs at individual institutions. The large consumer surplus losses from program cuts are typically not compensated by sufficient variable or fixed cost savings. The other cells in the first column show the profit incentives for these 504 undesirable program cuts. We can unambiguously classify 136 out of the 504 programs as desirable status quo cases, i.e. the CI funding system does rightly not give a profit incentive to cut the program. However, we can also classify 197 programs as undesirable reform cases, where the system actually does provide the wrong profit incentive to cut the program. For the remaining 171 undesirable program cuts, we cannot draw an unambiguous conclusion about the profit incentive without further fixed cost information. In sum, for at least 40% (197 cases) to possibly over 70% (197+171 cases) of the 504 cases where it is undesirable to reduce product diversity, the CI funding system nevertheless wrongly provides an incentive to do so.

The right column of Table 11 shows that it would be socially desirable to cut programs in a small minority of 51 cases (less than 10%). But the CI funding system actually provides the good profit incentives to do so for only 33 of these 51 cases. It fails to provide the proper incentives for at least 1 and possibly up to 18 cases.

We can draw two policy conclusions and one methodological conclusion from this discussion. First, the common view that there is too much product diversity in higher education appears to be largely unfounded. Because of low student mobility unilateral program cuts are typically not socially desirable, suggesting that the duplication of fixed costs across multiple campuses is economically justified. Second, government policies such as the CI funding system that aim to provide decentralized incentives to reduce product diversity may easily be ineffective. For the majority of cases (504) where reducing product diversity is not desirable, the incentives are nevertheless often given (undesirable reform). For the minority of cases (51) where reducing product diversity would be desirable, the proper incentives may not be given (undesirable status quo). Third, from a methodological perspective, our approach to bound the fixed costs shows that it is possible to draw unambiguous total welfare conclusions in almost all cases (504+51=555 out of 562), even without knowing the actual level of the realized fixed cost savings. Drawing unambiguous conclusions about the profit incentives is somewhat more difficult in this application (139+235=374 out of 562), yet the general tendencies remain clear.

6 Conclusions

We have analyzed the profit and welfare effects of reducing product diversity in higher education. The background was a funding system reform proposed by the Flemish government, where universities and colleges would obtain part of their subsidies based on their achieved concentration index (i.e. average number of students per program). A first main lesson from our analysis is that the social desirability of reducing product diversity is considerably more limited than commonly thought. Social welfare increases for less than 10% of the possible program cuts, so the large majority of cuts would involve a reduction in social welfare. While there may be fixed cost as well as variable cost savings from cutting the expensive programs, these apparently do not outweigh the large consumer losses because of a relatively low student mobility. Put differently, while there is frequent duplication of fixed costs because programs are available at multiple campuses, this is typically not inefficient because of the students' limited willingness to travel to other campuses.

The second main lesson is that a funding system which gives decentralized financial incentives to cut programs may easily be ineffective. Our example of the funding system based on the concentration index shows there tends to be a severe mismatch between the social desirability to reduce product diversity and the actual incentives provided. The idea behind the proposed system was to encourage institutions to cut the relatively small programs (since this would raise the institutions' concentration index). However, we find that for the majority of cases where program cuts are not desirable, the system nevertheless frequently creates the incentives to do so. Furthermore, for the small minority of cases where program cuts are actually desirable, the proper incentives may not be given. These findings of undesirable reform and undesirable status quo emphasize the complex task of governments in regulating product diversity in higher education. They also serve as a word of caution towards the various other recent initiatives that have recently been taken to reduce product diversity, such as minimum size requirements to be eligible for funding, financial incentives to jointly operate programs between institutions, or the promotion of mergers or associations between institutions, etc.

Our analysis is based on a simple economic framework, illuminating the role of consumer surplus losses, variable cost savings and fixed cost savings. From a methodological perspective, it shows how it is possible to reach unambiguous welfare and profit conclusions by deriving bounds on the fixed costs, without observing the actual fixed costs. At the same time, our analysis is based on a number of assumptions. First, we do not take into account income effects. It is possible that some program cuts hurt low income groups more, and this may affect the social desirability of certain program cuts. Second, we do not take into account the social cost of public funds. If these are important, the social desirability to cut product diversity would be higher. Third, we have looked at undergraduate education. It is possible that the desirability for diversity reduction is greater in graduate education where student willingness to travel may be considerably greater. Finally, we have assumed that the private gains from higher education (consumer surplus) coincide with the social gains. In practice, the social gains may exceed the private gains because of positive spillovers (non-appropriability of the returns to education). To the extent that spillovers exist and apply to all study programs, this would actually strengthen the conclusions regarding the undesirability of reducing program diversity. Further theoretical and empirical work would be interesting to further explore these issues.

7 References

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Table 1: Supply of Higher Education in Flanders (2001)

	Number of campuses	Number of study programs	Number of students	Students/ study program
	Colleges (vocational programs)			
Total	44	414	25,182	61
by study field				
Architecture	9	11	912	83
Engineering	25	76	4,425	58
Science	0	0	0	n/a
Economics & Business	22	105	7,853	75
Education Science	26	67	6,065	91
Other Social Sciences	13	15	1,572	105
Medicine & Paramedics	23	54	1,904	35
Bio-engineering	15	26	644	25
Languages	5	5	738	148
Cultural Studies	10	55	1,069	19
	Universities (academic programs)			
Total	9	148	12,299	83
by study field				
Architecture	3	3	198	66
Engineering	3	3	834	278
Science	7	33	1,169	35
Economics & Business	7	12	1,700	142
Education Science	3	6	711	119
Other Social Sciences	6	19	3,701	195
Medicine & Paramedics	6	19	933	49
Bio-engineering	6	13	1,177	91
Languages	6	17	842	50
Cultural Studies	6	23	1,034	45

Own calculations based on a dataset from the Flemish Ministry of Education. The first column counts the number of campuses offering at least one study program of a given study field. The second to fourth column show averages over all study programs of a given study field.

Table 2: Variable subsidies per student in Euros

	Colleges	Universities
Average	3,203	4,075
Architecture	3,527	5,290
Engineering	3,594	5,290
Science	n/a	5,290
Economics & Business	2,333	2,921
Education Science	3,633	3,767
Other Social Sciences	3,220	2,785
Medicine & Paramedics	3,711	5,444
Bio-engineering	3,721	4,527
Languages	2,760	2,719
Cultural Studies	2,331	2,713

The base subsidy for a study program is 2,300 Euro. Weighting factors are subsequently applied depending on the resource-intensiveness of the program as indicated in the new funding scheme for higher education. The Table reports student-weighted averages of subsidies over study programs per study field for colleges and universities

Table 3: Possible profit incentives and welfare effects of unilateral program cuts

	Welfare Effect	
Profit Incentive	$(1-DR_{jk})p^0 q_{jk}(\mathbf{p}^0)+\Delta CS_{jk}- \sum_{k=1}^{K}\sum_{j=1}^{J_k} c_j \left(q_{jk}(\mathbf{p}^1_{jk})-q_{jk}(\mathbf{p}^0)\right)<0$	$\Delta CS_{jk}- \sum_{k=1}^{K}\sum_{j=1}^{J_k} c_j \left(q_{jk}(\mathbf{p}^1_{jk})-q_{jk}(\mathbf{p}^0)\right)>0$
$r\left(C_k(\mathbf{p}^1_{jk})-C_k(\mathbf{p}^0)\right)<0$	desirable status quo	undesirable status quo
$-(1-DR_{jk})p^0 q_{jk}(\mathbf{p}^0)+ r\left(C_k(\mathbf{p}^1_{jk})-C_k(\mathbf{p}^0)\right)>0$	undesirable reform	desirable reform

Table 4: Summary statistics of 2001 eligible pupils

	All students	College	University	Non-catholic	Catholic
Demographic (w_i)					
male	0.45	0.45	0.45	0.47	0.43
foreign	0.01	0.01	0.01	0.02	0.01
catholic high school	0.78	0.79	0.76	0.67	0.87
Scholastic ability (w_i)					
years of repetition	0.36	0.46	0.16	0.40	0.34
	(0.95)	(0.99)	(0.83)	(1.05)	(0.87)
general high school	0.60	0.44	0.94	0.63	0.58
classical languages	0.14	0.05	0.33	0.15	0.13
modern languages	0.24	0.22	0.27	0.23	0.24
economics	0.19	0.19	0.17	0.17	0.20
sciences	0.20	0.11	0.40	0.24	0.18
mathematics	0.30	0.15	0.60	0.34	0.27
technical high school	0.33	0.47	0.04	0.29	0.35
'product'-focused	0.12	0.17	0.02	0.11	0.12
Mobility (x_{ik})					
Distance (kms) by road to campus	34.71	30.96	42.38	35.73	33.90
	(28.17)	(25.65)	(31.37)	(28.19)	(28.13)
Time (mins) by road to campus	30.74	28.33	35.67	32.13	29.64
	(17.33)	(16.2)	(18.47)	(17.59)	(17.03)
Travel cost to campus (in €10,000)	0.38	0.35	0.46	0.40	0.37
	(0.28)	(0.25)	(0.31)	(0.28)	(0.28)
Number of observations	37,481	25,182	12,299	16,557	20,924

Standard errors for the continuous variables are in parentheses. Demographic and scholastic ability data are based on the dataset from the Flemish Ministry of Education. Mobility statistics are based on own calculations using postal code information.

Table 5: Logit model: overview and travel cost parameters

Parameter	Estimate	t
Travel cost (α)		
intercept	-6.19*	(-28.54)
φ	0.49*	(45.20)
male	0.1	(1.32)
foreign	-0.26	(-0.68)
catholic high school	0.43*	(4.62)
years of repetition	-0.2*	(-3.33)
general high school[1]	0.13	(0.67)
classical languages	0.49*	(4.00)
modern languages	-0.28*	(-2.44)
economics	-0.45*	(-3.43)
sciences	0.13	(1.09)
mathematics	0.07	(0.60)
technical high school[1]	-1.72*	(-9.69)
'product'-focused	1.38*	(9.98)
Size factor	0.91*	(49.63)
Slope parameters (γ_j)		
Catholic Institution[2]	*included, see table 6a*	
Academic program[3]	*included, see table 6a*	
Two-cycle Vocational program[3]	*included, see table 6a*	
Study field[4]	*included, see table 6a*	
Academic program x Study field[5]	*included, see table 6b*	
Two-cycle Vocational program x Study field[5]	*included, see table 6b*	
Fixed effects (β_j)	*included, see table 6a*	
Observations	732,040	
number of individuals	*36,602*	
number of sampled alternatives	*20*	
Log likelihood	-51,816	

t-statistics in parentheses. * statistical significance at 5% level

[1] base category = professional/arts secondary high school

[2] base category = non-catholic study program

[3] base category = one-cycle vocational study program

[4] base category = cultural studies

[5] base category = one-cycle vocational x cultural studies

Table 6a: Logit model: valuation of a study option's catholic orientation, type of higher education and study field

Parameter	Catholic institution[1]	Type of Higher Education[2]		Study field[3]								
		Academic	Vocational Two-cycle	Arch	Eng	Science	Econ & Business	Educ	Other Social Sc	Med & Paramed	Bio-Eng	Lang
intercept	-0.70*	0.35	-0.51*	-0.16	-3.25*	-2.91*	-2.74*	-1.05*	-1.52*	-3.25*	-3.20*	-2.39*
	(-5.80)	(1.23)	(-2.92)	(-0.68)	(-14.04)	(-5.42)	(-12.93)	(-5.00)	(-6.58)	(-12.28)	(-9.17)	(-6.55)
male	-0.01	*See higher-order interaction terms in table 6b*										
	(-0.19)											
foreign	-0.38*	0.92*	0.56*	0.43	0.97*	0.52	0.77*	-0.07	0.55	0.73	0.53	0.60
	(-2.47)	(3.97)	(2.34)	(0.91)	(2.51)	(0.95)	(2.12)	(-0.18)	(1.44)	(1.82)	(1.09)	(1.43)
years of repetition	-0.13*	*See higher-order interaction terms in table 6b*										
	(-5.14)											
catholic high school	1.44*	*See higher-order interaction terms in table 6b*										
	(38.08)											
general high school[4]	-0.05	*See higher-order interaction terms in table 6b*										
	(-0.66)											
classical languages	0.18*	1.73*	0.67*	-0.37*	-0.63*	-0.74*	-0.49*	-0.64*	-0.44*	-0.20	-0.24	0.49*
	(3.46)	(22.25)	(6.91)	(-2.41)	(-4.94)	(-4.92)	(-4.33)	(-5.16)	(-4.04)	(-1.62)	(-1.82)	(3.92)
modern languages	-0.07	-0.02	0.25*	-0.07	-0.08	0.24	0.37*	-0.08	0.29*	-0.10	0.22	1.16*
	(-1.43)	(-0.37)	(3.08)	(-0.46)	(-0.62)	(1.35)	(3.48)	(-0.74)	(2.78)	(-0.79)	(1.45)	(9.95)
economics	0.04	0.33*	0.77*	0.07	0.02	0.00	1.73*	0.61*	0.30*	0.42*	-0.01	-0.23
	(0.82)	(4.49)	(8.49)	(0.40)	(0.13)	(0.01)	(13.85)	(4.54)	(2.30)	(2.86)	(-0.06)	(-1.60)
sciences	-0.07	1.27*	1.05*	0.67*	1.25*	1.25*	0.43*	0.81*	0.02	1.48*	1.92*	-0.30*
	(-1.34)	(17.73)	(11.98)	(4.45)	(9.92)	(8.04)	(3.76)	(6.69)	(0.14)	(11.87)	(13.89)	(-2.20)
mathematics	0.04	1.89*	1.35*	1.91*	2.54*	2.26*	1.69*	0.94*	0.25*	1.20*	2.18*	0.25*
	(0.88)	(29.11)	(16.73)	(12.87)	(20.20)	(13.12)	(15.70)	(8.16)	(2.28)	(9.82)	(14.46)	(2.05)
technical high school[4]	-0.28*	*See higher-order interaction terms in table 6b*										
	(-3.88)											
product-focused	-0.01	0.67*	0.60*	1.51*	3.18*	1.51*	-0.30	-0.14	-0.56*	0.00	2.61*	-1.76*
	(-0.14)	(4.56)	(4.96)	(6.73)	(16.52)	(4.46)	(-1.60)	(-0.72)	(-2.68)	(-0.02)	(11.95)	(-3.58)

t-statistics in parentheses. * statistical significance at 5% level

[1] base category = non-catholic study program

[2] base category = one-cycle vocational study program

[3] base category = cultural studies

[4] base category = professional/arts high school

Table 6b: Logit model: valuation of study fields within the higher education type

Parameter	Arch	Eng	Science	Econ & Business	Educ	Other Social Sciences	Med & Paramed	Bio Eng	Lang	Cult
	Academic Higher Education[1] x									
male	0.64	2.45*	1.45*	1.17*	-0.23	0.05	-0.19	0.02	-0.16	0.57
	(1.70)	(6.80)	(4.16)	(3.40)	(-0.64)	(0.15)	(-0.53)	(0.05)	(-0.46)	(1.64)
years of repetition	-0.99*	-0.98*	-0.16	-0.03	0.15	0.37*	-0.15	-0.15	0.21	0.26
	(-3.36)	(-4.66)	(-0.92)	(-0.21)	(0.85)	(2.34)	(-0.79)	(-0.80)	(1.16)	(1.67)
catholic high school	-0.28	-0.36	-0.72*	-0.68*	-0.68*	-0.80*	0.00	-0.22	-0.34	-0.93*
	(-0.73)	(-1.06)	(-2.17)	(-2.05)	(-2.01)	(-2.47)	(-0.01)	(-0.65)	(-1.02)	(-2.84)
general high school[2]	1.71*	4.25*	2.32*	4.09*	3.49*	4.82*	3.83*	3.28*	3.37*	1.81*
	(3.28)	(8.87)	(3.86)	(9.58)	(8.25)	(11.99)	(8.26)	(6.26)	(7.01)	(5.26)
technical high school[2]	0.15	2.20*	2.21*	3.45*	2.79*	3.56*	3.35*	2.05*	2.33*	0.86*
	(0.20)	(3.80)	(3.37)	(6.85)	(5.53)	(7.75)	(6.17)	(3.38)	(4.10)	(2.01)
	Two-cycle Vocational Higher Education[1] x									
Parameter	Arch	Eng	Science	Econ & Business	Educ	Other Social Sciences	Med & Paramed	Bio Eng	Lang	Cult
male	0.39	2.00*	n/a	0.96*	n/a	n/a	-0.17	0.99*	-0.34	0.64
	(1.10)	(5.78)		(2.75)			(-0.46)	(2.23)	(-0.96)	(1.83)
years of repetition	0.01	-0.22	n/a	-0.03	n/a	n/a	0.35	-1.33*	0.19	0.01
	(0.06)	(-1.36)		(-0.17)			(1.85)	(-2.79)	(1.10)	(0.04)
catholic high school	0.35	0.24	n/a	0.04	n/a	n/a	-0.51	0.35	-0.09	-0.08
	(0.98)	(0.74)		(0.12)			(-1.39)	(0.71)	(-0.25)	(-0.24)
general high school[2]	0.19	1.46*	n/a	2.11*	n/a	n/a	2.54*	1.04	3.33*	-0.95*
	(0.46)	(3.44)		(5.01)			(5.31)	(1.35)	(7.00)	(-2.83)
technical high school[2]	0.00	1.60*	n/a	3.03*	n/a	n/a	4.10*	1.43	3.35*	-1.01*
	(0.00)	(3.37)		(6.45)			(7.79)	(1.65)	(6.36)	(-2.47)
	One-cycle Vocational Higher Education[1] x									
Parameter	Arch	Eng	Science	Econ & Business	Educ	Other Social Sciences	Med & Paramed	Bio Eng	Lang	
male	0.09	1.91*	n/a	0.74*	-0.37	-0.58	-1.26*	-0.31	n/a	
	(0.26)	(5.51)		(2.18)	(-1.10)	(-1.67)	(-3.63)	(-0.88)		
years of repetition	0.20	0.20	n/a	0.40*	0.26	0.41*	0.37*	0.16	n/a	
	(1.24)	(1.31)		(2.72)	(1.77)	(2.70)	(2.38)	(0.96)		
catholic high school	-0.26	1.58*	n/a	-0.27	-0.38	-0.48	-0.31	-0.18	n/a	
	(-0.79)	(3.84)		(-0.85)	(-1.19)	(-1.48)	(-0.96)	(-0.51)		
general high school[2]	-0.02	0.56	n/a	1.58*	1.52*	2.56*	2.64*	1.35*	n/a	
	(-0.05)	(1.55)		(4.71)	(4.57)	(7.41)	(7.26)	(3.12)		
technical high school[2]	0.72	-0.34	n/a	3.40*	2.63*	3.00*	3.75*	2.85*	n/a	
	(1.72)	(-1.05)		(8.54)	(6.63)	(7.32)	(8.93)	(6.08)		

t-stats between parentheses. * statistical significance at 5% level

[1] base category = one-cycle vocational x cultural studies

[2] base category = professional/arts high school

Table 7: Diversion ratios resulting from unilateral program cuts, by study field

Study field	Colleges	Universities
Architecture	0.11	0.36
Engineering	0.15	0.31
Science	n/a	0.29
Economics & Business	0.24	0.22
Education Science	0.22	0.34
Other Social Sciences	0.18	0.25
Medicine & Paramedics	0.20	0.31
Bio-engineering	0.20	0.30
Languages	0.08	0.28
Cultural Studies	0.18	0.25
Total	0.19	0.28

The diversion ratios are computed for each unilateral program cut, based on the parameter estimates of the logit model. The results are then averaged over all programs and institutions within a given field.

Table 8: Profit changes resulting from unilateral program cuts (in Euros)

	Current tuition revenues		Change in tuition revenue		Change in revenue from concentration index	
Study field	Colleges	Universities	Colleges	Universities	Colleges	Universities
Architecture	51,440	36,497	-40,916	-20,978	-29,318	7,385
Engineering	63,251	148,479	-32,127	-93,197	-9,585	-22,235
Science	n/a	83,564	n/a	-14,300	n/a	46,624
Economics & Business	152,231	103,980	-34,511	-52,456	7,003	-86,632
Education Science	104,185	153,169	-31,000	-46,373	-5,698	-2,702
Other Social Sciences	65,462	283,835	-46,700	-66,046	-19,978	-35,296
Medicine & Paramedics	33,807	84,144	-14,544	-18,187	25,823	29,763
Bio-engineering	20,252	93,676	-10,662	-32,316	41,517	-79,317
Languages	80,351	75,208	-74,406	-15,074	-44,938	16,293
Cultural Studies	60,703	98,238	-11,028	-16,029	25,421	15,665
Total	72,626	115,809	-28,797	-34,620	3,410	-12,265

Averages across programs and institutions by field. If an institution offers the same program on several campuses, the numbers indicate the (changes in) revenues at the campus level.

Table 9: Welfare changes resulting from unilateral program cuts (in Euros)

	Change in consumer surplus		Variable cost saving		Gross welfare	
Study field	Colleges	Universities	Colleges	Universities	Colleges	Universities
Architecture	-139,465	-122,359	7,424	129,958	-132,040	7,599
Engineering	-116,347	-522,386	8,294	518,385	-108,053	-4,001
Science	n/a	-61,304	n/a	69,316	n/a	8,012
Economics and Business	-116,828	-223,150	-68,665	-58,677	-185,492	-281,827
Education Science	-106,110	-233,903	31,800	63,963	-74,310	-169,940
Other Social Sciences	-161,877	-285,889	4,229	-90,552	-157,648	-376,440
Medicine and Paramedics	-50,735	-87,441	13,300	141,175	-37,435	53,734
Bio-engineering	-39,502	-153,821	6,730	26,009	-32,771	-127,811
Languages	-244,516	-69,663	-79,543	-14,222	-324,058	-83,886
Cultural Studies	-38,176	-68,978	-19,554	-18,879	-57,730	-87,857
Total	-100,102	-162,677	-2,923	46,653	-103,025	-116,024

Averages across programs and institutions by field.

Table 10: Welfare changes resulting from joint program cuts (in Euros)

	Change in consumer surplus		Variable cost saving		Gross welfare	
Study field	Colleges	Universities	Colleges	Universities	Colleges	Universities
Architecture	-1,415,166	-368,366	78,561	392,328	-1,336,605	23,963
Engineering	-4,977,878	-1,603,136	399,535	1,619,947	-4,578,343	16,812
Science	n/a	-433,835	n/a	494,186	n/a	60,350
Economics & Business	-2,907,661	-1,585,569	-1,753,484	-422,909	-4,661,146	-2,008,478
Education Science	-2,867,354	-704,974	900,427	192,877	-1,966,927	-512,096
Other Social Sciences	-2,163,779	-1,737,184	57,619	-556,513	-2,106,160	-2,293,696
Medicine & Paramedics	-1,445,258	-527,753	387,231	855,289	-1,058,027	327,536
Bio-engineering	-678,502	-935,694	116,748	160,087	-561,754	-775,607
Languages	-1,254,113	-421,354	-415,025	-86,234	-1,669,138	-507,588
Cultural Studies	-425,174	-415,203	-219,649	-114,050	-644,823	-529,252
Total	-18,134,886	-8,733,067	-448,037	2,535,010	-18,582,923	-6,198,057

Averages across programs and institutions by field.

Table 11: Welfare incentive for the 562 study alternatives by type and study field

	Welfare effect			
Profit incentive	Negative	Unknown	Positive	Total
Negative	136 cases (desirable status quo)	2 cases	1 case (undesirable status quo)	139 cases
Unknown	171 cases	0 cases	17 cases	188 cases
Positive	197 cases (undesirable reform)	5 case	33 cases (desirable reform)	235 cases
Total	504 cases	7 cases	51 cases	562 cases