

Program Duplication in Higher Education is Not Necessarily Bad

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Abstract

Public systems of higher education have recently attempted to cut costs by providing financial incentives to cut duplicated programs, i.e. programs that are offered at different institutions. We study the profit and welfare effects of reducing program duplication, 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 students' low willingness to travel to other institutions and to the limited fixed cost and variable cost savings. 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 reduction in the number of duplicated programs saves on fixed costs, without generating too large losses to consumers (students).

This paper provides a framework to consider the effects of reducing program duplication 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 program duplication 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 (bachelor) 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 there are strong benefits from maintaining program duplication across different institutions. This follows from the students' low willingness to travel to other institutions offering the same bachelor programs. Using alternative approaches to measure fixed costs of offering products, we find that the social desirability of cutting specific programs at individual institutions is limited to about 10% of the cases. Reducing program duplication apparently results in consumer surplus losses that typically outweigh the possible 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.

The issue of diversity in higher education has received a lot of attention in the educational policy literature. Birnbaum (1983) provides an influential early study, distinguishing between institutional and program diversity. Huisman, Meek and Wood (2007) give an updated review of the literature, and provide recent evidence on the evolution of higher education diversity in several countries. This literature is largely descriptive and it appears to be preoccupied with a concern of guaranteeing sufficient diversity without accounting for cost considerations. Surprisingly, there is no economic literature that looks at the benefits and costs of product diversity in higher education.¹ Our paper therefore contributes to the policy debate by quantifying the benefits from product diversity in the specific form of program duplication across multiple institutions. Furthermore, we provide an economic framework for comparing these benefits with the potential costs involved. To accomplish this, we estimate a rich model of student choices at the most disaggregated level of the individual institution and study program, building on earlier empirical work on educational choice by Long (2004) and Kelchtermans and Verboven (2009).²

Our paper also relates to the empirical industrial organization literature on product diversity.³ Several studies have estimated demand models to measure the effects of new product introductions or eliminations. They typically focus on consumer surplus and *gross* welfare effects, i.e. excluding fixed costs.⁴ We contribute to this literature in showing the

¹Some economic studies shed indirect light on the cost side of the debate. For example, Riew (1966) and Cohn et al. (1989) found evidence of scale economies at the secondary school and higher education level, respectively. Bergstrom et al. (1988) devised a test to determine whether governments spend too much on education.

²Long (2004) considers student choices at the institution level. Kelchtermans and Verboven (2009) consider choices at the more detailed level of institutions and aggregate fields (arts, social, exact, and biomedical sciences) and ask questions about the effects of tuition fee increases on enrollment and welfare. In this paper, we consider the most detailed choice level, i.e. institutions and programs (e.g. nursing), since this is the relevant level of detail to address the policy questions on program duplication.

³For 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).

⁴Petrin (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

importance of product diversity in a public and strongly regulated sector. Only few empirical studies have looked at the *net* welfare effects, since fixed costs are difficult to observe. 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. This approach is not possible in our application to a regulated sector, since the decision to supply study programs is subject to an untransparent 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. A sensitivity analysis and a comparison with alternative direct fixed cost measures shows this brings us quite far in drawing unambiguous conclusions about the net 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.

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.

2.1 Institutions and study programs

There are two types of higher education institutions: colleges and universities. Colleges offer one-cycle or two-cycle vocational study programs, whereas universities 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.

To summarize our findings we will often distinguish between ten main study fields: architecture, engineering, sciences, economics & business, education sciences, other social sciences, medicine & paramedics, bio-engineering, languages and cultural studies. However, the unit of analysis will be at the more detailed level of the study program. For example, “hotel

and gross profits, using assumptions about pricing behavior.

management” and “marketing” are study programs in the vocational economics & business field, “nursing” is a program in the vocational medicine/paramedics field, and “dentistry” and “medical sciences” are programs in the academic medicine/paramedics field. The total number of unique study programs across the region is 149.

There is a broad geographic coverage of higher education. There are 44 college and 9 university campuses, resulting in a high density of one campus per 250 km². The total number of different programs across different institutions is 562. Hence, the average rate of program duplication across institutions is 3.8 (=562/149). This results in a fairly small average scale of 67 incoming students per program/institution.

The high product diversity, both in terms of content and coverage, thus explains the policy interest in rationalization and motivates our welfare analysis.

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 provides subsidies to the institutions, and intervenes by regulating tuition fees and exercising direct control over the quality and the diversity of supply. For example, institutions are not automatically eligible to offer all official study programs.

The 2005 reform proposals aimed to make the funding system more efficient. The constant subsidy per student is cost-based and has recently been made in line with more accurate estimates of the variable cost per student. Since we will use the subsidies as a measure for the variable costs in our analysis below, we briefly describe how they are computed. The starting point is a study by the Center for Higher Education Policy Studies (Deen et al., 2005). This study computes weighting factors that reflect real variable cost differences between study fields.⁵ These weighting factors are then multiplied by a base subsidy amount (retrieved from legislative documents, e.g. Decree of 12 June 1991). Table 1 summarizes this 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 clearly reflect the differences in the variable costs between fields, as estimated by Deen et al. (2005).

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 programs. The

⁵This study involved a comparison of variable costs in higher education in seven countries (UK, Norway, Sweden, Australia, New Zealand, Denmark and the Netherlands). It showed that in all of these countries variable costs and subsidies vary by study field. In particular, classroom-based subjects have lower costs and receive lower subsidies than laboratory-based subjects.

emphasis was not so much on reducing program diversity per se, but rather on reducing program duplication across several institutions. These incentives served as an alternative to earlier attempts to reduce program duplication 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 offering study programs jointly. 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.⁶ We will refer to this system as the CI funding system. It provides an incentive to reduce the number of study 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 individual study 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.⁷ 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).

⁶In 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.

⁷For 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 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.

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.⁸ 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 study alternative, total demand across all institutions is inelastic and simply equals the 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.⁹ 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 . As discussed in section 2.2, this 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} :

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

⁸There 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.

⁹Institutions 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, 2002). While we do not rule out the presence of such objectives, we assume them to be separable from the direct program-related profits.

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 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 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}_{jk}^1 (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}_j^1 (with infinite prices for program j at all institutions where j is offered).

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 :

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

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 .¹⁰ 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 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:

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

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 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. $C_k(\mathbf{p}_{jk}^1) - C_k(\mathbf{p}^0) > 0$, 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 an 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.

¹⁰The 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.

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

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

which is clearly negative since the program drop involves a (prohibitive) tuition fee increase for the eliminated program. The effect of dropping program j at institution k on producer surplus is

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

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:

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

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 Drawing profit and welfare inferences

A comparison of (1) and (2) clearly shows that the profit incentives and welfare effects of a program cut are not necessarily well-aligned. Our empirical analysis aims to assess this, but faces the challenge that fixed costs are difficult to measure. We therefore proceed as follows.

The first part of our analysis focuses on the *gross* profit and welfare effects from reducing product diversity, i.e. without incorporating the fixed cost savings. 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), who also abstracted from fixed cost considerations. This analysis is based on the educational choice model estimated in section 4 and our variable cost proxy

$c_j = s_j$, as discussed in section 2.2. Section 5.1 will present the results from this gross profit and welfare analysis.

The second part of our analysis (section 5.2) will subsequently aim to assess the *net* profit and welfare effects from reducing product diversity, i.e. after accounting for fixed cost savings. More specifically, for each possible program cut j we compute the sign of the net profit incentive $\Delta\pi_{jk}$, as given by (1), and the sign of the net welfare effect ΔW_{jk} , as given by (2). This leads us to classify all possible program cuts in four categories. A “desirable status quo” case occurs if the CI funding system does not create an incentive to cut a program and if this would not be socially desirable anyway. In an “undesirable status quo” case the program cut is unprofitable although it would be socially desirable. In an “undesirable reform” case, the CI funding system would make a program cut profitable although it is not socially desirable. Finally, “desirable reform” cases are program cuts that are both profitable and socially desirable. This classification thus allows us to evaluate the effectiveness of the funding reform.

To measure the fixed cost savings F_{jk} entering the net profit and welfare effects $\Delta\pi_{jk}$ and ΔW_{jk} , we follow two complementary approaches. As a first approach, we use a direct measure of fixed costs. Since a direct measure is not available at the study program level, we combine several sources to construct it.¹¹ As a starting point, the Statistical Yearbook of the Flemish Ministry of Education (Ministerie van de Vlaamse Gemeenschap, 2002) specifies the total costs for university and college higher education. For 2002, the period of our dataset, these numbers are € 716,165,000 and € 575,247,000, respectively. Next, we calculate the total variable costs of both universities and colleges. This is the variable cost per student as discussed in section 2.2 ($c_j = s_j$) times the number of students, summed over all programs and universities/colleges. Subtracting total variable costs from the total costs gives a measure of fixed costs for colleges and universities. Finally, we allocated the fixed costs at the university/college level to the individual study programs according to the cost weights of Deen et al. (2005). As a robustness check, we also used a different allocation rule, where we assigned an equal share of fixed costs to each study program, and this had only very limited impact on the results reported in section 5.2.¹²

¹¹Specifically, we combine accounting cost information from the Flemish Ministry of Education (Ministerie van de Vlaamse Gemeenschap, 2002), legislation on university funding (Decree of 12 June 1991), and an analysis of costs at the study program level by the Center for Higher Education Policy Studies (Deen et al., 2005).

¹²We verified the validity of our disaggregate fixed cost measures at the study program level by comparing the implied institutional budgets with the budgetary statistics obtained from the Ministry. If our measures of fixed and variable costs of individual study programs are reasonable, then aggregating them up to the level of institutions should result in numbers that correspond closely to those based on institutional financial

While the use of direct cost information has some appeal, it is necessarily only an approximation since fixed costs are difficult to measure at the program level. As an alternative, complementary approach, we derive bounds on the fixed cost per program, and therefore at least sufficient conditions under which unilateral program cuts raise or lower net profits or welfare. It turns out that, in our application, this approach gives us conclusive answers for a large number of cases. The results are consistent with the first approach that uses direct cost information.

More specifically, to obtain bounds on the fixed costs of any program j at any institution k , we make the following assumptions. First, we assume that fixed costs are positive, i.e. $F_{jk} > 0$ for all j, k . Second, we assume that institutions find it profitable to supply the existing programs under the old funding system, where the concentration index is not yet at work.¹³ 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:

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

Note that as the diversion ratio increases (becomes closer to 1), the upper bound on the fixed cost becomes tighter. Combine the fixed cost bounds (3) with (1) and (2) gives 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 $\Delta CS_{jk} - \sum_{k=1}^K \sum_{j=1}^{J_k} c_j (q_{jk}(\mathbf{p}_{jk}^1) - q_{jk}(\mathbf{p}^0)) > 0$, and undesirable*

accounts reported by the Ministry. The comparison shows that institutional budgets as calculated from our disaggregate study program costs approximate university subsidies fairly accurately. For the two biggest universities, the KU Leuven and University of Ghent, the difference between the two numbers is less than 10%. We take this as an indication of the robustness of our calculation of study program costs.

¹³This 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 simply add more programs to their portfolio as long as that is profitable. We therefore set the lower bound on fixed costs to zero.

$$\text{if } (1 - DR_{jk})p^0 q_{jk}(\mathbf{p}^0) + \Delta CS_{jk} - \sum_{k=1}^K \sum_{j=1}^{J_k} c_j (q_{jk}(\mathbf{p}_{jk}^1) - q_{jk}(\mathbf{p}^0)) < 0.$$

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

Intuitively, the sufficient conditions state that the CI funding system provides no profit 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. Furthermore, 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.

The assumption that only profitable study programs are supplied under the old funding system may not be entirely realistic for public institutions. This may particularly be true because allocating costs to individual small-scale study programs is a difficult task for the institutions. In a sensitivity analysis we therefore make the considerably weaker assumption that only profitable study *fields* are supplied under the old funding system. For each individual study program we then impose the upper bound that the fixed costs are no larger than the revenue losses that would result from eliminating the entire field. Since each institution on average offers 3.4 programs within a field, the upper bounds on fixed costs per program become larger by a factor of 3.4 on average. It will thus be of interest to see whether our results remain robust, in particular whether we can still obtain conclusive results under these larger upper bounds for fixed costs.

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 (i.e. 149 unique programs spread across 53 different 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.¹⁴

¹⁴Sampling over alternatives in non-logit discrete choice models does not generally give consistent maximum likelihood estimates. Bierlaire et al. (2006) show that it is still possible to obtain consistent maximum

In a previous paper Kelchtermans and Verboven (2009) considered educational choice at the level of four possible aggregate fields per institution (arts, social, biomedical and exact sciences). In contrast, we consider the much more disaggregate level of individual programs (e.g. “nursing”). This does not only make the model richer, but it is necessary for our purposes since policy makers consider the reduction in program duplication at this level of detail. The detailed disaggregation level raises the question whether the empirical model will really capture the determinants of student preferences, if institutions impose entry restrictions on specific programs. However, for almost all programs there are no restrictions at all, i.e. all students with a high school degree are eligible to start. Restrictions apply to only 2 out of 149 unique programs, medicine and civil engineering, and even here there is no direct cap on the number of students, but only a “soft” restriction in the form of an entry exam at the start. It therefore appears that our empirical results and the estimated welfare effects are not distorted by entry restrictions at the disaggregate level we consider. Nevertheless, in the Appendix we perform a sensitivity analysis by comparing welfare effects between the disaggregate and aggregate level.

To simplify, our logit model does not include an outside good or “no-study alternative”. Kelchtermans and Verboven (2009) included an outside good in a nested logit framework. Since we found that students are extremely cost inelastic regarding the decision whether or not 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 consider a much more disaggregate level of educational choices here.

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

likelihood estimates in “block additive generalized extreme value models”, which includes the logit but not the nested logit model. Kelchtermans and Verboven (?) 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.

specification:

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

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 reflecting travel costs. This function is increasing in the distance from the institution but possibly at a decreasing rate, because students may go on residence if they live far away, as explained below.

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 $g(x_{ik})$ reflecting travel costs. The parameter vector α captures the determinants of the students' marginal utility of income, which we assume to be constant so that there are no income effects.¹⁵ The variable x_{ik} refers to the annual travel costs of a commuting student. It consists of transportation costs and the opportunity cost of time (McFadden and Train (1978)). The transportation costs (in Euro) are proportional to the distance per trip d_{ik} (in km). The opportunity cost of time (also in Euro) is proportional to the travel time per trip t_{ik} (in min). More specifically, we set the annual travel cost of a commuting student equal to $x_{ik} = 75d_{ik} + 40t_{ik}$.¹⁶

A student does not, however, necessarily commute; she may also go on residence if the institution is too far from home. If she commutes, her annual travel cost is simply $g(x_{ik}) = x_{ik}$. If she goes on residence, she saves a fraction ϕ of the trips, but pays an extra annual cost r_k on rent and other monetary and psychological costs of leaving home, so that her implicit price becomes $g(x_{ik}) = (1 - \phi)x_{ik} + r_k$. A cost-minimizing student thus

¹⁵Since (parental) income of the student is unobserved, we assume the marginal utility of income is constant. Income then cancels out of the choice probabilities. We do however control for socio-economic variables such as high school background, which is correlated with parental income. Furthermore, we also considered a Cobb-Douglass specification where $y_i - p_{jk} - g(x_{ik})$ enters logarithmically. In this case income does not cancel out of the students' choice probabilities, and we used income at the postal code level as a proxy. This approach did not affect our empirical conclusions.

¹⁶This assumes that a commuting student engages in 10 trips per week during 30 weeks in 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.

commutes if and only if she is located sufficiently close to institution k , i.e. $\phi x_{ik} \leq r_k$. The deterministic component of utility (4) can then be written as:

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

where $I(\cdot)$ is an indicator function equal to 1 if its argument is positive, and equal to 0 otherwise. Utility therefore decreases in 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 $w'_i (1 - \alpha) \phi$ for high values of x_{ik} (when the student goes on residence). Intuitively, this captures the fact that travel costs increase in distance, but at a decreasing rate (as an alternative to a reduced form specification that is quadratic in distance).

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 program 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.¹⁷

¹⁷Furthermore, 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.

Our data set comes from the Flemish Ministry of Education. It contains information on students' and institutions' locations necessary to compute the students' travel costs x_{ik} , as discussed above. Furthermore, it 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).

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 2 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 3, 4a and 5b. It is however also 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 3 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 3 shows that the size factor parameter is close to 1, indicating that the study programs within a program field are relatively heterogeneous.

Tables 4a and 5b show how individuals value the various characteristics of the study

alternatives $(w'_i \gamma_{jk})$.¹⁸ The first column of Table 4a 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 4a 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 vocational 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 4a 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 5b 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.

¹⁸These results extend Kelchtermans and Verboven (2009) by (1) considering more detailed study fields (Table 4a), and (2) adding richer interaction terms between the study fields/types and the student characteristics (Table 5b). Nevertheless, several parameters are imposed to zero because of a too low number of observations on some of the interactions.

5 The effects of reducing product diversity

Section 5.1 discusses the demand, and *gross* profit and welfare effects from reducing product diversity, without accounting for the difficult to measure fixed cost savings. Section 5.2 then considers the *net* profit and welfare effects, based on our direct fixed cost measures and our derived bounds as given by (3).

The estimates are based on the disaggregate logit model of section 4. As discussed earlier, we have also compared the effects of eliminating aggregate fields in the disaggregate model with the aggregate model of Kelchtermans and Verboven (2009). The results, presented in Appendix, give further confidence on the plausibility of the estimated effects.

5.1 Demand, gross profit and gross welfare effects

Demand 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 6 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.

Gross profit effects Table 7 shows how these substitution effects translate into the two gross profit components: tuition fee revenues and revenues from the CI funding scheme, see equation (1). 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 from the diversion ratios, i.e. 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.

Gross welfare effects Table 8 shows the effects of unilateral program cuts on the two gross welfare components: consumer surplus and variable costs, see equation (2). 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. The absolute value of these consumer surplus effects may also be interpreted as the students' total net willingness to pay for the eliminated program (on top of the paid tuition fees and travel costs). In per student terms (not shown on table) this net willingness to pay is about €900, varying from about €700 per student for academic arts programs to about €1200 per student for engineering programs. These numbers are on average about twice as high as the tuition fees (€500).¹⁹ But they are more moderate when compared with students' overall annual travel costs (of about €3000–€4500 according to our travel cost measure and according to a recent survey by HIVA (2006)).

Second, the variable cost savings from output reallocation may also be negative (third and fourth column of Table 8). This is the case for cutting programs with low variable costs, such as programs in the economics&business or cultural fields, which 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 gross welfare changes are positive (last two columns of Table 8). Hence, eliminating these programs would result in a 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 in the next subsection.

The discussion focused on the gross welfare losses from *unilateral* program cuts. These reduce program duplication across the country but do not reduce program availability altogether, since almost all programs are offered at multiple institutions. It is of interest to compare the unilateral program cuts with *joint* program cuts, i.e. common program cuts across all institutions. Joint program cuts go much further by reducing program availability rather than simply reducing program duplication. Table 9 presents the welfare effects from

¹⁹This can also be seen by comparing total (rather than per student) willingness to pay in Table 7 with total tuition fee expenditures in Table 6.

joint program cuts (analogous to Table 8 for unilateral program cuts). We focus our discussion here on the consumer surplus losses. As expected, the consumer surplus losses from joint program cuts are considerably larger than those from the unilateral cuts in Table 8. What is more interesting, however, is that the consumer surplus losses from the joint program cuts are disproportionately larger. Consider, for example, engineering programs at colleges. These are available at 25 campuses. If all these campuses simultaneously cut one of their engineering programs, this results in a joint reduction of 25 programs, but the consumer surplus loss is not just 25 but rather 43 times larger than the loss from a unilateral cut at one campus only (i.e. a loss of € 4,977,878 versus € 116,347, from comparing Table 9 with Table 8). In per student terms (not shown on table), the consumer losses from a joint program cut vary between €1500-€1800, compared with the earlier reported losses of €900 from a unilateral program cut. This confirms the intuition that it is most relevant from a policy perspective to consider unilateral program cuts, which reduces program duplication but still maintains program availability across the country.

5.2 Evaluating the funding reform: net profit and welfare effects

To evaluate the CI funding system reform we now assess the net profit and welfare effects, i.e. after incorporating fixed cost savings from program cuts. As discussed in section 3.3, we use two approaches to measure fixed costs. First, we measure it based on cost accounting information, and second we use bounds on fixed costs given in inequality (3). As discussed above, both approaches give a classification of all 562 potential program cuts into four groups: desirable status quo, undesirable status quo, desirable reform and undesirable reform cases, depending on the signs of $\Delta\pi_{jk}$ and ΔW_{jk} in (1) and (2).

Table 10 applies this classification. The top panel uses the direct fixed cost measures. The left column shows that 90% of the program cuts would be socially undesirable (504 out of 562). This striking result follows from the low student mobility and the correspondingly large total willingness to pay for programs at individual institutions, which outweigh the duplicated fixed costs involved. Out of these 504 programs there are 289 desirable status quo cases, i.e. the CI funding system does rightly not give a profit incentive to cut the program. However, an important remaining number of 215 cases are undesirable reform cases, where the system actually provides the wrong profit incentive to cut the program.

The third column of Table 10 shows that it would be socially desirable to cut programs in only 10% of the cases (58 out of 562). The CI funding system provides the right profit incentives to do so for the majority of the cases (desirable reform in 47 out of 58 cases). But it fails to provide the proper incentives in about 20% of the cases (undesirable status quo).

These findings are confirmed in the second panel, where we use the fixed costs bounds in (3). Recall that this approach may give inconclusive results about the signs of $\Delta\pi_{jk}$ and ΔW_{jk} (since the conditions in Proposition 1 are only sufficient conditions). Nevertheless, we can almost always unambiguously sign the welfare effect (555 out of 562 cases). The profit effect cannot be signed in about one third of the cases (188 out of 562). For the conclusive cases the general message of the bounds approach is broadly consistent with the first approach based on direct cost information. According to the first column of Table 10, the large majority of program cuts would unambiguously be undesirable (504 cases). From these at least 30% of the program cuts (136) would be unprofitable (desirable status quo), but at least 40% of the program cuts (197) would be profitable (undesirable reform).

As a further sensitivity check the third panel of Table 10 repeats the bounds approach under the much weaker assumption that the fixed cost of a program should be smaller than the variable profits of the entire study field. This leads to higher upper bounds (by a factor of 3.4 on average, as discussed in section 3.3) and therefore to more inconclusive results. Nevertheless, for the majority of the program cuts we can still sign the profit and welfare effects.²⁰ The results are broadly confirmed. It would be socially undesirable to cut programs in 85% of the conclusive cases (279 cases with an unambiguous negative welfare effect, versus 51 cases with a positive welfare effect). Yet the CI funding system would often create an incentive to do so (undesirable reform in 93 out of 185 conclusive cases).

We can draw two policy conclusions and one methodological conclusion from this discussion. First, a common view among policy makers 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 (51–58) 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 – in this application – it is possible to draw unambiguous net profit and welfare conclusions in many cases.

²⁰The number of cases where the sign of the net profit (welfare) effect cannot be determined from the upper bounds raises to 267 (232), or about 48% (42%) of the cases.

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 only about 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.

The conclusion that program duplication in higher education is not necessarily bad is based on a simple economic framework in which we balance the estimated consumer surplus losses against fixed cost and variable cost savings. From a methodological perspective, our analysis 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. How sensitive are our conclusions to these assumptions?

Two observations would in fact reinforce our conclusions. First, it has been observed that mergers between institutions may not result in fixed cost savings, but rather increase fixed costs because consolidation leads to increased incentive problems to keep costs low. Jacobs and Van der Ploeg (2006) report case study evidence from the Netherlands showing the merger process between higher education institutions over the last 20 years was accompanied by huge increases in fixed costs on infrastructure, governance and other overhead. Second, our framework assumed that institutions keep their behavior constant. In practice, it is likely that a reduction in the number of programs also reduces competition among universities, so that institutions may have reduced incentives to maintain program quality. These two observations suggest that the benefits from reducing program duplication are even smaller than our analysis suggests.

There are, however, also reasons to think our framework overestimates the gains from program duplication. First, governments could implement program cuts simultaneously with free transportation to students or other measures to promote student mobility. This would eliminate at least part of students' travel costs and hence may make students more likely to choose their preferred alternative at another campus (rather than choosing a second-best alternative on the same campus).²¹ In fact, governments have recently encouraged mobility at the master level through the Bologna reforms. So further research could investigate how student mobility of both bachelor and master students has recently changed. Second, we have assumed that there are no social costs of public funds. In practice, governments need to finance educational expenditures out of distortionary taxes. The cost savings from cutting programs would then receive a higher weight relative to the consumer losses we found, and the social desirability to cut more programs may increase.

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²¹However, the transportation costs are then borne by the government, so this should also be taken into account in a welfare analysis.

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Table 1: 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 2: 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
<i>classical languages</i>	0.14	0.05	0.33	0.15	0.13
<i>modern languages</i>	0.24	0.22	0.27	0.23	0.24
<i>economics</i>	0.19	0.19	0.17	0.17	0.20
<i>sciences</i>	0.20	0.11	0.40	0.24	0.18
<i>mathematics</i>	0.30	0.15	0.60	0.34	0.27
technical high school	0.33	0.47	0.04	0.29	0.35
<i>'product'-focused</i>	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 3: 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)
<i>classical languages</i>	0.49*	(4.00)
<i>modern languages</i>	-0.28*	(-2.44)
<i>economics</i>	-0.45*	(-3.43)
<i>sciences</i>	0.13	(1.09)
<i>mathematics</i>	0.07	(0.60)
technical high school ¹	-1.72*	(-9.69)
<i>'product'-focused</i>	1.38*	(9.98)
Size factor	0.91*	(49.63)
Slope parameters (γ_j)		
Catholic Institution ²	<i>included, see table 4a</i>	
Academic program ³	<i>included, see table 4a</i>	
Two-cycle Vocational program ³	<i>included, see table 4a</i>	
Study field ⁴	<i>included, see table 4a</i>	
Academic program x Study field ⁵	<i>included, see table 5b</i>	
Two-cycle Vocational program x Study field ⁵	<i>included, see table 5b</i>	
Fixed effects (β_j)		
Observations	732,040	
<i>number of individuals</i>	36,602	
<i>number of sampled alternatives</i>	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 4a: 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* (-5.80)	0.35 (1.23)	-0.51* (-2.92)	-0.16 (-0.68)	-3.25* (-14.04)	-2.91* (-5.42)	-2.74* (-12.93)	-1.05* (-5.00)	-1.52* (-6.58)	-3.25* (-12.28)	-3.20* (-9.17)	-2.39* (-6.55)	
male	-0.01 (-0.19)	<i>See higher-order interaction terms in table 5b</i>											
foreign	-0.38* (-2.47)	0.92* (3.97)	0.56* (2.34)	0.43 (0.91)	0.97* (2.51)	0.52 (0.95)	0.77* (2.12)	-0.07 (-0.18)	0.55 (1.44)	0.73 (1.82)	0.53 (1.09)	0.60 (1.43)	
years of repetition	-0.13* (-5.14)	<i>See higher-order interaction terms in table 5b</i>											
catholic high school	1.44* (38.08)	<i>See higher-order interaction terms in table 5b</i>											
general high school ⁴	-0.05 (-0.66)	<i>See higher-order interaction terms in table 5b</i>											
<i>classical languages</i>	0.18* (3.46)	1.73* (22.25)	0.67* (6.91)	-0.37* (-2.41)	-0.63* (-4.94)	-0.74* (-4.92)	-0.49* (-4.33)	-0.64* (-5.16)	-0.44* (-4.04)	-0.20 (-1.62)	-0.24 (-1.82)	0.49* (3.92)	
<i>modern languages</i>	-0.07 (-1.43)	-0.02 (-0.37)	0.25* (3.08)	-0.07 (-0.46)	-0.08 (-0.62)	0.24 (1.35)	0.37* (3.48)	-0.08 (-0.74)	0.29* (2.78)	-0.10 (-0.79)	0.22 (1.45)	1.16* (9.95)	
<i>economics</i>	0.04 (0.82)	0.33* (4.49)	0.77* (8.49)	0.07 (0.40)	0.02 (0.13)	0.00 (0.01)	1.73* (13.85)	0.61* (4.54)	0.30* (2.30)	0.42* (2.86)	-0.01 (-0.06)	-0.23 (-1.60)	
<i>sciences</i>	-0.07 (-1.34)	1.27* (17.73)	1.05* (11.98)	0.67* (4.45)	1.25* (9.92)	1.25* (8.04)	0.43* (3.76)	0.81* (6.69)	0.02 (0.14)	1.48* (11.87)	1.92* (13.89)	-0.30* (-2.20)	
<i>mathematics</i>	0.04 (0.88)	1.89* (29.11)	1.35* (16.73)	1.91* (12.87)	2.54* (20.20)	2.26* (13.12)	1.69* (15.70)	0.94* (8.16)	0.25* (2.28)	1.20* (9.82)	2.18* (14.46)	0.25* (2.05)	
technical high school ⁴	-0.28* (-3.88)	<i>See higher-order interaction terms in table 5b</i>											
<i>product-focused</i>	-0.01 (-0.14)	0.67* (4.56)	0.60* (4.96)	1.51* (6.73)	3.18* (16.52)	1.51* (4.46)	-0.30 (-1.60)	-0.14 (-0.72)	-0.56* (-2.68)	0.00 (-0.02)	2.61* (11.95)	-1.76* (-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 4b: Logit model: valuation of study fields within the higher education type

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

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 5: 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 6: Gross profit changes resulting from unilateral program cuts (in Euros)

Study field	Current tuition revenues		Change in tuition revenue		Change in revenue from concentration index	
	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 7: Gross welfare changes resulting from unilateral program cuts (in Euros)

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

Table 8: Gross welfare changes resulting from joint program cuts (in Euros)

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

Table 9: Welfare and profit effects for the 562 study programs

a) Direct fixed cost measures

Profit incentive	Welfare effect			Total
	Negative	Unknown	Positive	
Negative	289	n.a.	11	300
Unknown	n.a.	n.a.	n.a.	n.a.
Positive	215	n.a.	47	262
Total	504	n.a.	58	562

b) Fixed cost bounds

Profit incentive	Welfare effect			Total
	Negative	Unknown	Positive	
Negative	136	2	1	139
Unknown	171	0	17	188
Positive	197	5	33	235
Total	504	7	51	562

c) Fixed cost bounds: weaker upper bound

Profit incentive	Welfare effect			Total
	Negative	Unknown	Positive	
Negative	58	1	1	60
Unknown	128	122	17	267
Positive	93	109	33	235
Total	279	232	51	562

n.a. = not applicable

negative profit, negative welfare = desirable status quo

positive profit, negative welfare = undesirable reform

negative profit, positive welfare = undesirable status quo

positive profit, positive welfare = desirable reform