Self-control at College

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Abstract

In this paper we develop a model in which students face a self-control problem when making choices about *how*, rather that *whether*, to learn. Students with heterogeneous learning styles acquire education using a combination of study and tuition (S and T). In a model with fully rational agents, the efficient solution is to allow students to choose their preferred bundle of S and T. When students choose a college they commit to a level of T, but they cannot commit to S. Thus they face an asymmetric self-control problem.

We compare a situation in which agents are naïvely unaware of the self-control problem to one where foresight permits them to partially correct for it. We show that the self-control problem interacts with learning styles, and thus the ability to self-correct by pre-commitment will vary across students. Finally we show how the inefficiencies caused by the self-control problem can be reduced by appropriate pricing of tuition.

Keywords:
Human Capital, Learning Style, Self-control
JEL codes:
A12, D91, I20, I23, D03.

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"We have one of the highest high school dropout rates of any industrialized nation. And half of the students who begin college never finish."

- President Barack Obama (2009)

1. Introduction

In this paper we investigate how self-control problems might impact on the capacity of students to acquire human capital. Students themselves will frequently admit that when it comes to studying they have good intentions to which they subsequently fail to live up. Self-control problems are particularly important at college as students experience freedom for the first time.

The recent behavioral economics literature on self-control has parallels with the educational literature on student motivation and self-regulation. Although these literatures address different concerns, they can both be interpreted as attempts to understand how we behave in situations where effort is determined by motivation.

In contrast to the education literature, the economic literature on education treats the process of learning as a 'black box'. In earlier work (Huxley and

Peacey (2014)) we attempt to open this black box by modeling how heterogeneous students learn. The model, derived from basic microeconomic principles, introduces a production function with two inputs (Study and Tuition) and defines two learning style parameters (Independence and Flexibility). The focus of this work was on how students learn rather than their motivation.

The way people work affects their motivation. For example, Yahoo recently discouraged home working. One of their concerns was that "Speed and quality are often sacrificed when we work from home" (Swisher (2013)). Another example, in the context of personal fitness, is the motivational benefit from training with a partner or employing a personal trainer. We believe the way students learn can matter for similar reasons. In this paper we set out a model in which students motivation interacts with their learning style to determine their human capital.

We develop a self-control model in which students' motivation is reduced by a present bias. We show that, for a given degree of self-control, how students learn can amplify or ameliorate the original problem. In our model the self-control problem will be most acute for students who choose to learn on their own. We go on to show that how colleges price and bundle tuition may have surprising implications for the problems caused by self-control. Finally we consider whether there are safeguards that self-aware students can take to reduce the severity of the problem.

2. Literature

2.1. Behavioral economics (self-control) and higher education

Self-control modifies the model of inter-temporal choice. In the traditional model consumers set their rate of time preference equal to the market interest rate. When self-control problems arise individuals typically behave as if the market determined discount rate is higher than it is. This is modeled by altering the specification of time-preference.

Thaler and Shefrin (1981) suggests a "two-self model" in which preferences are in conflict at a single point in time. The conflict is introduced by viewing the

individual as a long-lived principal who derives utility from n short-lived agents. Each agent seeks to maximize her one period consumption, which conflicts with the optimal choices of the principal.

This time inconsistency can be formalized with a hyperbolic function (Loewenstein and Prelec (1992)). Hyperbolic discount rates are time-dependent, with a high discount rate in the short run and a lower rate over the long run. This creates a conflict between the preferences we hold today and those we will hold in the future Laibson (1997) introduces a much simpler discrete version of this model with a quasi-hyperbolic discount rate, which is now the standard way of modeling self-control.

O'Donoghue and Rabin (2003) and (2006) have used this framework to show how problems of self-control can be ameliorated using "sin taxes". These papers are motivated with examples of individuals who consume both a good where consumption today only influences utility today (carrots) and a good with negative health consequences tomorrow (chips). The papers explore how the interaction between heterogeneous preferences and the levels of self-control result in deviations from the efficient outcome. In their work O'Donoghue and Rabin (1999) emphasize the importance of self-awareness. Individuals who understand that they have a self-control problem ('Sophisticates') will act differently to those who do not ('Naifs'). They show that sophisticated individuals can sometimes take steps to reduce consequences of self-control. In other cases self-awareness can lead to a worse outcome (O'Donoghue and Rabin (2000)). For a summary of their work on self-control see O'Donoghue and Rabin (2007).

In contrast to the actions taken by governments in O'Donoghue and Rabin (2003) and (2006), DellaVigna and Malmendier (2004) use the example of health clubs to investigate how firms respond to consumer biases. Parallels have frequently been drawn between human capital investments in education and health (Becker (2007)). Both these investments require time and effort (study/exercise) and expenditure (tuition/medical treatment). DellaVigna and Malmendier (2004) show that firms selling to such consumers have incentives to reduce the self-control problems experienced by their customers. In their model

firms sell both "leisure goods" and "investment goods". Investment goods have current costs and future benefits whereas leisure goods have current benefits and future costs. Firms charge two-part tariffs with usage prices less than marginal cost for investment goods and higher than marginal cost for leisure goods.

Mental accounting has been proposed as a response to self-control problems (Thaler (1985)). This involves a process whereby fungible assets are mentally framed into different accounts. Since these accounts are assumed to be non-fungible, mental accounting will influence decisions. It is starting to be understood that these ideas can be applied to how students learn (Levitt et al. (2012)).

If we associate mental accounting with the ability to set goals and therefore study effectively, recent evidence (Bettinger and Baker (2011)) can be interpreted as demonstrating that mental accounting can be taught. The study found that dollar-for-dollar spending on this kind of coaching had a greater impact on retention rates than providing financial incentives. The paper concludes by stating that the assumption that students know how to prioritize and plan their study needs to be called into question.

Koch and Nafzigera (2014) create an endogenous model of mental accounting. Throughout the paper an example is given of students allocating time between study and leisure. Here individuals set goals to tackle their self-control problems. These goals result in reference points that ensure poor performance is painful. The paper sets out the conditions under which setting goals can work. In the context of the student, accounts can be defined as either time (e.g. effort) or outcome (e.g. grades). The paper looks at the breath of such accounts (e.g. daily or weekly accounting) and shows that, holding effort levels constant, a broader account yields higher overall utility.

Learning contracts are a similar idea which have recently been much discussed in the pedagogy literature (Stephenson and Laycock (1993)). These collaboratively written agreements between students and teachers are indented to promote self-directed learning. The contract will define a set of learning objectives and mechanisms by which these objectives can be achieved. A possible

explanation for the success of this policy is that the contract creates reference points that give rise to mental accounts.

The work by Romer (1993) shows that, after controlling for motivation and ability, attendance in class is strongly correlated with performance. It is clear that learning takes place both inside and outside the classroom, and policies to promote learning can operate on both.

2.2. Pedagogy (motivation)

There exists a large educational literature on self-control and student motivation (Ames (1992)) and for a survey see Schunk et al. (2013)). This literature addresses three questions: What are the determinants of motivation amongst students? How does motivation affect attainment? How can teachers promote student motivation? Explanations for poor motivation include (Legault et al. (2006)): low expectations of success (e.g. locus of control), low aspirations (e.g. reference points) and failure to perceive benefits (e.g. hyperbolic discounting).

Numerous studies have investigated the relationship between motivation and classroom attainment (Schunk et al. (2013)). For example Pintrich and De Groot (1990) look at the performance of seventh grade students. They found that self-reported measures of self-efficacy and intrinsic value were positively related to cognitive engagement and performance. In addition, the recent literature on human capital and personality formation has shown that motivation is a malleable personality trait (Almlund et al. (2011)). In that literature motivation has a large impact on attainment.

Levels of motivation may vary systematically amongst students, depending on observable characteristics such as race, class or gender. This has led to an emphasis on the role of culture and context in determining motivation. For example, Chinese students are more likely to attribute success to effort than their US counterparts and therefore Chinese students may have more inherent motivation to study (Salili et al. (2001)). Well-documented gender differences include the finding that boys respond better to competition than girls (Gneezy

and Rustichini (2004)). These ideas, combined with the belief that motivation is plastic, has led to a literature offering advice to teachers (e.g. Brophy (2010)) and to governments (Almlund et al. (2011)). The advice to teachers seeks to encourage intrinsic motivation and provide appropriate extrinsic incentives.

There is a related literature on learning styles (see Bransford et al. (1999)). This literature emphasizes that students are heterogeneous, not just in ability but also in learning style (see Gardner (1993) and Bransford et al. (1999), part II). The goal is to develop pedagogic strategies that achieve the best match between teacher and student. We interpret variation in learning style as the responsiveness of students to different teaching technologies, and therefore to the production function. In contrast, the literature on student motivation is closer to economic approaches that emphasis incentives and behavioral approaches. We believe that there are interesting interactions between how students learn and levels of motivation and these jointly determine outcomes.

3. Self control problems in production

In our model students are producers of education and consumers of the income stream generated by this education. A meaningful self-control problem cannot be formalized by simply discounting either the inputs or outputs of the production function. In the context of producer theory discounting therefore needs to be carefully motivated.

In an undergraduate textbook firms maximize profit, π, with a general analysis, that considers the firm's utility of profit $U(\pi)$, usually finessed[1]. In the context of consumer theory discounting is straightforward - entering via a weighting of the inputs in the utility function (e.g. future consumption). Discounting can only be motivated in producer theory by introducing time preference and therefore a utility maximizing owner[2].

[1] Since, in a one period model maximizing π is equivalent to maximizing $U(\pi)$

[2] Discount rates may also appear as prices in a firms cost function. However this represents the market rate of interest rather than an individual's time preference.

In our model the student produces education which determines future earnings. Although the self-control problem undermines the ability to study, the hyperbolic discount parameter does not enter the education production function. The student behaves as if the graduate premium is smaller than it is, therefore it is the weight attached to the graduate premium that must be hyperbolically discounted.

4. Model

This is a three period model: choices are made in period 0, costs are incurred in period 1 and benefits realized in period 2. Time periods are normalized to 1 and $\delta = 1$.

In period 0, the student makes decisions about college attendance. Students choose between colleges that offer different levels of tuition (T), which the student will bundle with a chosen level of study (S) to obtain education $E_i(S, T)$. The student is fully informed about their education production function (section 4.1).

Thus the student chooses S^* and T^* to maximize her lifetime utility:

$$U^t = w^2(E_i(S,T)) + w^1(1 - S - T) - pT \tag{1}$$

where w^1 is the non-graduate wage, w^2 is the graduate wage (a function of E) and p is the price of tuition.

In period 1, the student attends the college of her choice. We assume that the T^* chosen in period 0 is fixed but that the student can reconsider how much S to choose[3]. At college present-bias will mean the student behaves as if the graduate premium is smaller than it is, and this gives rise to a self-control problem. Thus a student will choose S' to maximize:

$$U^t = \beta w^2(E_i(S,T^*)) + w^1(1 - S - T^*) - pT^* \tag{2}$$

[3]Since we assume that S cannot be observed, strategies for dealing with self-control must operate through T by influencing the level of S. This is true for both students and colleges. This contrasts with the existing literature where policy would be expected to operate directly on S.

Where $\beta \leq 1$ measures the level of the self-control problem (Laibson (1997)).

In period 3, the student graduates with education $E_i(S', T^*)$. This means that with a self-control problem, realized utility is less than the first best:

$$w^2(E_i(S^*, T^*)) + w^1(1 - S^* - T^*) - pT^* > w^2(E_i(S', T^*)) + w^1(1 - S' - T^*) - pT^* \tag{3}$$

For convenience we use $w^2 = w^1 + E_i(S, T)$ and this allows us to define the *Graduate Premium* (GP) as:

$$GP = (E_i(S, T)) - w^1(S + T) - pT \tag{4}$$

By evaluating Equation 4 at (S^*, T^*) and (S', T^*) we can define the *Potential Graduate Premium* (PGP) and *Realized Graduate Premium* (RGP).

4.1. Education production function

Following Huxley and Peacey (2014) students produce education from S and T via an individual specific CES function:

$$E_i(S, T) = (\alpha_i S^{\rho_i} + (1 - \alpha_i) T^{\rho_i})^{\frac{1}{\rho_i}} \tag{5}$$

where α_i and ρ_i are a student's learning style parameters: *Independence* and *Flexibility*. Independence measures the weight given to each input in the production function. Independent learners will choose to make most of their human capital investments in the form of study and therefore the output elasticity for study will be higher than for tuition. Flexibility is a measure of how a student can adapt to different combinations of the two inputs. The more easily the inputs can be substituted the more flexible the learner will be. Flexibility determines whether learners view tuition and study as gross substitutes or gross complements.

4.2. Naifs and Sophisticates

Following O'Donoghue and Rabin (1999) we consider students who are Naifs and Sophisticates.

Naive students, unaware of their self-control problem, believe they will behave as they would like to behave. Whereas Sophisticated students, aware of their self-control problem, correctly predict how their future selves will behave.

A Naif will act in the manner set out in Section 4. A Sophisticate, knowing that she will choose $S(\beta,T) < S^*(T)$ according to Equation 2, will choose $\hat{T}$ in period 0 to maximize:

$$U^t = w^2(E_i(S(\beta,T),T)) + w^1(1 - S(\beta,T) - T) - pT \tag{6}$$

This results in a choice of $\hat{T} \neq T^*$, and a hence a realization of $\hat{S} \neq S'$. In Section 5.3, we show that the success of the Sophisticate's strategy will vary with her learning style.

5. Results

In this section we simulate the model and generate a set of results. Each simulation considers otherwise identical students with different values of β. The program (see appendix) evaluates all the possible combinations of (S,T) to calculate the maximand, (S^*,T^*), of Equation 1. S^* and T^* are used to calculate PGP. In the same way and now using T^*, the program then calculates the maximand, S', of Equation 4. S' and T^* are then used to calculate the RGP[4]. The simulation is then run for different sets of the learning style parameters (α,ρ) and different prices of tuition (p).

In the sections 5.1 and 5.2 we consider the interactions between these parameters for a Naif learner[5]. In section 5.1 we focus on the interaction between learning style and β by holding price constant. In section 5.2 we consider how changing the price of tuition influences the severity of the self-control problem. In section 5.3 we show that the benefits of being self aware vary with learning style[6].

[4]The simulations measured units in 0.01hours ($\Omega = 24$), and considered 1000 values of $\beta \in [0,1]$.

[5]A detailed discussion between the learning style parameters and the effects of price can be found in Huxley and Peacey (2014).

[6]The program for the Sophisticate (see appendix), works in a similar way to the Naif set

5.1. Learning style and β

The results in this section are illustrated in Figures 1a,b,c. Each Figure is drawn for one value of the flexibility parameter[7]. For each Figure we consider an independent and a directed learner[8]. This gives six types of learner and for each we allow the level of self-control to vary over the full range; with $\beta \in [0, 1]$ on the horizontal axis.

In general the graduate premium (vertical axis) will vary with learning style, however symmetric values of alpha (e.g. $\alpha = 0.25$ and $\alpha = 0.75$) generate the same potential graduate premium[9]. This is shown by the dashed horizontal line at the top of each Figure. RGPs for each learner are shown by curves, since these are influenced by β (Result 1). If the individual does not attend college then the graduate premium is zero, shown by the dashed horizontal line through the origin.

Result 1. *Higher levels of self-control reduce the gap between PGP and RGP for all learners.*

When $\beta = 1$, in period 1 a student will stick to her plan to study $S' = S^*$ and this means RGP=PGP. As her level of self-control declines she increasingly fails to achieve her potential. When $\beta = 0$ the self-control problem is so serious that when the student arrives at college present bias means that she behaves as if there is no benefit to acquiring education. Therefore she will devote no time to private study (i.e. $S' = 0$). Since $S' < S^*$, RGP<PGP[10]. Result 1 can be seen in Figures 1a,b,c: The RGP curves for both learners slope upwards and converge on the dashed PGP line.

Result 2. *In the presence of self-control problems RGP can be negative.*

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out above.

[7] $\rho = 0.5$ (gross substitutes), $\rho = 0$ (Cobb-Douglas) and $\rho = -5$ (gross compliments).

[8] We consider $\alpha = 0.25$ and $\alpha = 0.75$

[9] For a given ρ and when $p = 0$ (See Huxley and Peacey (2014)).

[10] Even with $S' = 0$, since she contracted T^* in period 1, she may still acquire education.

There is a time cost to college that results from attending classes and from studying. Present bias can result in employing fewer inputs and producing less education. This reduction in S, may mean that the return from T^* is now lower the forgone wage. Since T^* was contracted in period 1, this would result in a negative graduate premium. In this case the individual should not have attended college.

The critical level of self-control, $\tilde{\beta}$, for which $\beta < \tilde{\beta}$ would result in the learner attending college and receiving a negative graduate premium will depend on learning style. $\tilde{\beta}$ is illustrated in Figures 1a,b,c by the point where the two RGP curves cross the dashed GP=0 line[11].

Result 3. *The consequences of a given level of self-control depend on learning style.*

Independent learners plan to study more than their directed counterparts to generate the same level of education and thus their failure to study has more serious consequences. In general, independence increases the cost of a given level of self-control (in Figure 1a,b,c compare the RGP for each learner). If the self-control problem is severe the graduate premium may be negative (Result 2). In this case there can be an offsetting gain because, while both learners receive very little education[12], the independent learner contracted for less tuition (in Figures 1b,c the RGP curves for the two learners cross at GP=0). In other words, losses are limited because less time and money is wasted on an investment that will never yield a positive return.

Since the RGP is initially more responsive to β for an independent learner, $\tilde{\beta}$ will be higher than for an equivalent directed learner. This result implies there is a range of self-control levels for which directed learners should and independent learners should not enroll in college. This is shown in Figures 1b,c.

[11] Moreover, for some learners this $\tilde{\beta}$ may not exist. Directed learners for whom Study and Tuition are highly substitutable would still have a positive RGP even if $S' = 0$ and $\beta = 0$. An example of such a student is represented by the directed learner in Figure 1a.

[12] This "offsetting gain" can only arise if S and T are sufficiently complementary (See Figure 1a).

The interactions between flexibility and self-control are difficult to present in simulations of this kind. This is because for the flexibility parameter, in contrast to the independence parameter, symmetric comparisons are not possible[13].

Complementarity means that a reduction in study will reduce the marginal product of the Tuition that has already been contracted for. Increasing complementary has two implications. Firstly, the cost of not studying (given T^*) will increase. This means the student is less likely to succumb to her self-control problem. Secondly, when she does succumb to her self-control problem, there will be larger reductions in the RGP. For independent learners the first effect is likely to dominate, whereas for directed learners the second effect is likely to dominate (compare RGP for directed learners in Figures 1a,1b and 1c).

5.2. Price of tuition and β

In this section we investigate the relationship between self-control and price for a given learner (i.e. holding α, ρ constant).

Result 4. *Increasing the price of tuition reduces the RGP for students with a high β, however it can increase the RGP for students with a low β.*

A rise in the price of Tuition will always lead to a fall in T^*. However, both expenditure on Tuition and S^* may increase or decrease, depending on the elasticity of substitution. If the price rise results in a substitution away from Tuition the individual is worse off for two reasons. Firstly, the new bundle will cost more. Secondly, this new bundle leaves the learner more susceptible to her self-control problem (because she now relies more heavily on study).

However, if the self-control problem is severe the student may commit in period 0 to investments that will yield a negative return (Result 2). In this case, a price rise can reduce expenditure on Tuition, making the student better off. Figure 2 illustrates this case for students facing a high and low price.

[13] See Huxley and Peacey (2014).

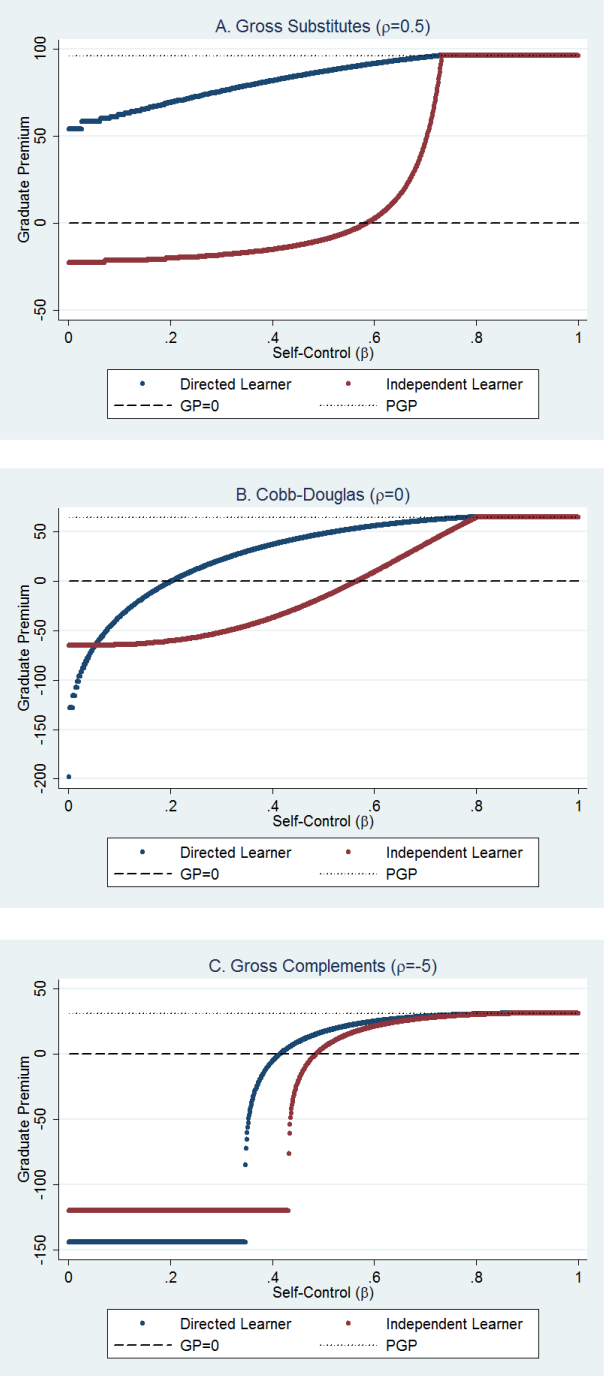

Figure 1: The severity of self-control problems depends on learning style

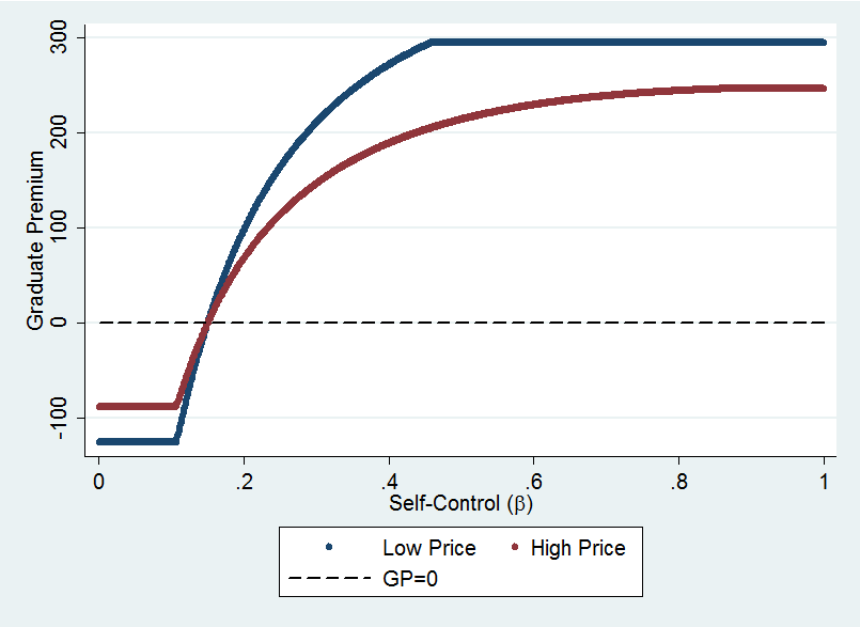

Figure 2: Changing the price of tuition

5.3. Sophisticates and Naifs

As explained in section 4.2, in period 0 Sophisticates can take steps to reduce the consequences of their self-control problem once they enroll in college. In this section we examine the welfare effects of this strategy by comparing the outcomes for Naifs and Sophisticates.

Result 5. *For any learning style, the RGP of a Sophisticate will be weakly greater than the RGP of a Naif. If $\beta > \tilde{\beta}$ this benefit increases in independence and flexibility.*

In our model, all students are perfectly informed about their learning style. Naifs use this to calculate (S^*, T^*) whereas Sophisticates understand that in practice $S' < S^*$, and this has implications for their optimal choice of Tuition (see section 4.2).

If $\beta > \tilde{\beta}$, Sophisticates will purchase additional tuition in period 0. This has two effects. The first effect is a direct effect: students purchase extra T in

order to compensate for the low S that they anticipate will result from their self-control problem. The second effect is an indirect effect: by increasing the cost of self-control, students will increase the amount of study they undertake at college. This is similar to increasing the complementarity between S and T. This formalizes Thaler's example of self-aware alcoholics who chooses to take the drug Antabuse (Thaler and Shefrin (1981))[14].

If $\beta < \tilde{\beta}$, Sophisticates will not attend college and therefore never obtain a negative RGP. In other words, they know when not to back a loser.

For high levels of complementary between S and T, the benefits of being self-aware are limited. For these students the scope for benefiting from both the direct and indirect effect is limited. Their learning style means that substitution is not practical, and there is little potential to increase the marginal benefits from study. For these students the benefit of knowing when not to enroll in college still exists.

Provided the learner is sufficiently flexible, both effects operate. Independent learners can more readily substitute S for T, and this permits sophisticates to 'claw back" some of the losses that result from their self-control problem.

Figure 3 compares the RGP of a Naif and Sophisticate. Each quadrant corresponds to a different learning style: the columns show independence and the rows show flexibility. At the top right of each figure, when $\beta = 1$, $RGP_N = RGP_S = PGP$ as there is no self-control problem. For $\tilde{\beta} < \beta < 1$, $RGP_N < RGP_S$. This difference is greater for flexible learners (compare rows of Figure 3) and independent learners (compare columns of Figure 3). For $\beta < \tilde{\beta}$, $RGP_S = 0$ as the student decides not to attend college.

6. Conclusion

Previous work on the formation of human capital has usually ignored motivation. Models assume fully rational students will never have problems getting up

[14]This example is a commitment strategy which increases the cost of an action - rather than ruling it out.

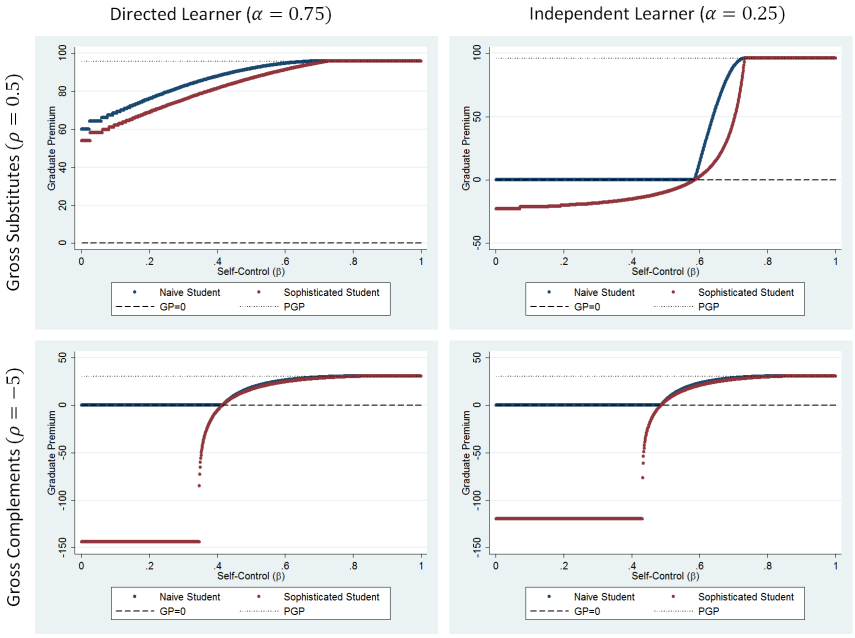

Figure 3: Naifs and Sophisticates

in the morning, starting an essay, or keeping to a revision program. In the standard model, attainment is a function of two factors: exogenously determined ability; and effort, which is entirely determined by the reward structure (as in the principal-agent literature). The process whereby students make investments in human capital should surely incorporate insights from the literature on self-control.

In our model students face choices about how they learn. Using a two-input model (S and T) allows us to investigate the possibility that self-control problems operate differently on different inputs and therefore that the mix of study and tuition chosen will have implications for the severity of the self-control problem. This is not possible in a one-input model.

It is well known that high-ability individuals can have problems with motivation (Heckman and Rubinstein (2001)). Our paper provides one explanation for college dropout by showing how these students overestimate their willingness

to study once they arrive at college, and therefore obtain a negative graduate premium. Successful programs (e.g. Oreopoulos et al. (2014), Bettinger and Baker (2011)) to improve graduate rates have addresses this by focusing on motivation. We show the success of such programs may depend on learning style.

The consequences of self-control are more severe for independent learners, and the scope for helping these learners is large. We go on to show that if the complementarity between study and tuition is high, policies that increase tuition will also promote study.

The approach to policy taken by behavioral economics has been strongly associated with policies that involve "libertarian paternalism" (Thaler and Sunstein (2003) and Colin et al. (2003)). It should come as no surprise that models built on neoclassical foundations incorporating cognitive biases emphasize voluntary interventions. This suggests a policy that corrects for the bias with minimal impact on the choices made by rational agents. The implications of this paper (and the literature e.g. Romer (1993)) point toward some form of compulsory attendance (e.g. compulsory classes or handing in of work). Compulsion benefits students with low levels of self-control who are tempted to skip class when they should not. However this gain must be offset against the cost of compulsion, as some students may benefit from skipping class to study independently (Huxley and Peacey (2014)).

We show that students who are self-aware when choosing a college can make choices to ameliorate the consequences of their problem. This suggests a role for policies that focus on nudging naive students into making sophisticated choices when applying to college.

We show how the inefficiencies caused by the self-control problem can be reduced by appropriate pricing structures. For students who drop out of college, this would involve increasing the price of tuition to deter them from going in the first place. For students with a less severe problem, subsidizing tuition is analogous to a 'sin tax' (O'Donoghue and Rabin (2003)) and will lead to behavior changes that improve outcomes.

Almost by definition, colleges cannot influence the way students study on their own. However, as we have emphasized study only ever takes place alongside some tuition. In this paper we have shown how self-control and learning style will jointly determine choices and therefore success at college.

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