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Abstract

The choice between performing a task today or procrastinating it until tomorrow or later is the building block of any economic action. In our paper we aim to enrich the theoretical literature on procrastination by outlining conditions for bad and good procrastination and looking at the special cases of pathological procrastination, the curse of perfectionism and productive procrastination. We discuss how our theoretical framework may be applied to explain different types of (education, investment and production) microeconomic decisions and which policy measures can be taken to avoid bad procrastination.

Keywords: Time-Inconsistent Preferences, Optimal Effort, Procrastination, Intertemporal Choice.

Jel Numbers: A12, D03, D11, D74, D91.

1 Introduction

Procrastinators are individuals who think that doing something tomorrow is better than doing it today and, at the same time, doing it tomorrow is better than not doing it at all. Procrastination may be productive if it helps to improve performance with the task being effectively implemented in a future date while it may become pathological if tomorrow never arrives. The choice between performing a task today or procrastinating it until tomorrow or later is the building block of any economic action. This is why there is a growing interest in the economic literature on the analysis of the effects of procrastination and on the design of incentive schemes stimulating people to complete their tasks on time. Both psychological and economic research, as well as common intuition, find that people procrastinate mainly because of their time-inconsistent preferences for immediate gratification. According to these studies, immediately available rewards (or investment costs) have a disproportionate effect on preferences relative to more delayed rewards. Along this line time-inconsistent preferences and self-control problems[1] have been the subject of many theoretical analyses (Ainslie, 1991 [2]; Hoch and Loewenstein, 1991 [19]; Baumeister and Muraven, 2000 [7]; O'Donoghue and Rabin, 1999 [23], [24]; 2000 [25]; Prelec, 2004 [28]; Strotz, 1956 [33]; Shefrin and Thaler, 1981 [31]; Shafir and Tversky, 1992 [30]; Bargh and Gollwitzer, 1994 [6]; Laibson, 1994 [20]; Laibson, Repetto and Tobacman, 1998 [21]; etc.), while empirical studies have also tested how the models of hyperbolic discounting can explain trends in data better than models based on exponential discounting (see for instance, Laibson, Repetto, Tobacman, 1998 [21]; Angeletos, Laibson, Repetto, Tobacman, and Weinberg, 2001 [3]; Ariely and Wertenbroch, 2002 [4]; Shui and Ausubel, 2004 [5]; Della Vigna and Paserman, 2005 [10]; Shapiro, 2005 [29]; Gruber and Mullainathan, 2005 [17] and Della Vigna and Malmendier, 2006 [9]). Many researches on procrastination applied these models to analyse how people put off unpleasant tasks in a way that their long-run selves do not appreciate (O'Donoghue and Rabin, 1999 [23] and [24]; 2001 [25]) and to design incentive schemes for firms and individuals in order to avoid the negative consequences of this phenomenon (O'Donoghue and Rabin, 1999 [24]).

In this paper we aim to investigate different aspects of procrastination including the seemingly counterintuitive possibility that it may have positive effects on individual well-being. In particular, we use the term procrastination to denote the tendency to postpone an activity under one's control, or even not to perform it at all (Gafni and Geri, 2010[16]). Our objective is to enrich the theoretical framework of procrastination by taking into account

[1] A self-control problem occurs when long-term goals and values collide with short-term temptations (Ainslie, 1975[1]; Loewenstein, 1996[22])

additional features such as the role of reservation utility and subjective evaluations of probability of success and its rewards. To this aim we distinguish between *bad* and *good* procrastination: the first has only negative consequences, while the second can lead to positive side effects.
To motivate our enriched framework we consider that individual decisions are based on subjective evaluations which can be incorrect due to the incompleteness of the information set. In particular, the initial assessment of the importance of the task and the probabilities of success may be very important for the consequences of procrastination. For instance, procrastination may be good if ex post it is known that the task was less rewarding and satisfying than expected. Our objective is to incorporate in a theoretical framework the above mentioned features of procrastination and their consequences.
The paper has seven sections (including introduction and conclusions), and is organized as follows. In section 2 we outline the basics of our model which strictly follows O'Donoghue and Rabin, 1999 [23] and we discuss the role of different factors affecting decisions about when or whether doing the task and the related consequences. In sections 3 and 4 we enrich the basic theoretical framework and define the possibilities for bad or good procrastination discussing policy measures which may avoid negative consequences of the former in different fields of economic action. In section 5 we analyze the case of people who procrastinate for perfectionism. In the same section we show that when the latter underestimate the expected value of task accomplishment in t, they may however invest in effort to improve their performance. We also document that the final result of their endeavour depends on procrastination time and on the cost, the level and the marginal productivity of effort. Based on that we outline effort and timing conditions under which costs prevails on benefits and the individual would better stop procrastinating in order to avoid "*the curse of perfectionism*". In section 6 we define our concept of "*productive procrastination*" and analyze the case in which procrastinators invest for an initial planned task, but they procrastinate and use that investment in other activities, whose final reward increases individual wellbeing more than if the initially planned task would have been accomplished. The last section concludes.

2 The Basic Model

2.1 Tasks and inconsistent preferences

Our starting point is the *present-biased preference* model devised by Laibson (1994) [20] [2]. Formally, let u_t be the instantaneous utility in period t of an

[2]The model was originally developed by Phelps and Pollak,1968 [27], in the context of intergenerational altruism.

individual whose intertemporal preferences at time t can then be represented by the following utility function

$$U^t(u_t, u_{t+1}, ..., u_T) \equiv \delta^t u_t + \beta \sum_{\tau=t+1}^{T} \delta^t u_\tau \tag{1}$$

where $\delta > 0$ represents standard "time-consistent" impatience, whereas $\beta > 0$ an additional time discounting component. For $\beta = 1$ preferences are time-consistent while, for $0 < \beta < 1$, at any given moment the person has an extra bias for the present over the future.

Following O'Donoghue and Rabin, 2001[25], we first assume that an agent must choose whether and when to perform the task x identified by the pair (c, ν), where the cost c is paid immediately while the flow of rewards $\nu \geq 0$ is earned from $\tau + 1$. We obviously have that $x \equiv (0, 0)$ at the time in which a subject procrastinates by doing nothing and $x \equiv (c, 0)$ when the subject tries to perform the task but fails. We assume that an agent is able to perform only the task x, hence, the only admissible set of actions available in each period is $A \equiv \{x\} \cup \emptyset$.
We define the strategy $s = (a_1, a_2, ...)$ as the decision to accomplish the action $a_t \in A$ in period t. By assuming the case of an individual who chooses to do nothing neither in t, nor in $t + 1$, etc., performing the task only in τ), her strategy may be represented by the set: $s \equiv (\emptyset, \emptyset, ..., a_\tau, \emptyset, \emptyset, ...)$, where $a_\tau = x$. We denote with $\tau(s)$ the period in which the person completes the task by following the strategy: $\tau(s) = min(t \mid a_t \neq \emptyset)$ and $x(s) = a_{\tau(s)}$, that is, the task x is realized in τ following the strategy s. On the contrary, the agent procrastinates forever and does nothing in each t if $\tau(s) = +\infty$ and $a_t = \emptyset$ for all t.
Based on these definitions the individual continuation utility function at time t, $U^t(a_t, s_t\beta, \delta)$, may be represented as

$$\begin{cases} -c + \beta\frac{\delta}{1-\delta}\nu & if \quad a_t = (c, \nu) \\ \beta\delta^\tau \left\{-c + \frac{\delta}{1-\delta}\nu\right\} & if \quad a_t = \emptyset, \tau = min(d > 0 \mid a_{t+d} \neq \emptyset),\ a_{t+d} = (c, \nu) \\ 0 & if \quad a_t = \emptyset \quad and \quad a_{t+d} = (0, 0) \quad for \quad all \quad d > 0 \end{cases}$$

The three cases in this equation correspond to the following three different situations in which the individual:
i) completes the task today thereby discounting by β the delayed reward ν while not the immediate cost c;
ii) expects to complete the task in period τ, that is, she delays until $t + d$,

where d is the chosen delay lag. In this case both costs and rewards are discounted by β;
iii) procrastinates the task forever deciding to do nothing in each period t and her payoff is zero.
Based on these three possible payoffs arising from the three different decisions the individual maximizes her utility V^t by choosing action a_t. Notice that, still following O'Donoghue and Rabin, 2001[25] the task x is β–*worthwhile*, if $[\beta\delta\nu/(1-\delta)] \geq c$, so it is convenient to accomplish the task x today rather then never (and today rather than tomorrow under the assumption that $\beta\delta^{\tau} \leq 1$, it could be even better to perform it tomorrow.

Our objective in the next sections is to enrich this theoretical framework by introducing reservation utility and subjective evaluations of the probability of success and of the expected reward in order to see how these factors affect individuals' decisions about procrastination and their consequences. Our additional assumptions are discussed in the next section.

2.2 Variables affecting procrastination

By referring to the Steel's equation on procrastination (2011[32]), we introduce several novel features affecting the decision to procrastinate or to accomplish the task. First of all we model p as the probability to realize the task x with success and assume that the probability of success that individuals take into consideration is the result of their own subjective evaluations. That is, there is an estimated probability $\hat{p}(I_t)$ which is a function of the information set (I_t) available to the individual at period t and which may be different from the true probability of success p_t. Subjective and objective probabilities coincide when the information set is complete, while they differ in case of imperfect information. In the basic version of the model this implies that, if a subject decides to realize x in t, $\hat{p}(I_t)$ measures her expectation to succeed in t and the action $a_t = x > 0$ implies an expected positive reward. When the subjective probability is higher (lower) than the true probability this means that individuals have overestimated (underestimated) their likelihood of success. We also assume in the model that a "discouragement" effect is at work, that is, if the individual has in her informative set the information that she has not performed in the past, her subjective probability of success becomes lower.

Secondly, we introduce in the basic model the value of the reward for success in task performance. We assume that such value gets lower the longer the procrastination time, that is, we assume a "shirking cake" effect across time with t, $\nu(t+1) < \nu(t)$. We define $\hat{\nu}(t)$ as the expected reward the agent perceives at time t. A third distinctive element of our model is the introduction of a reservation utility level which is enjoyed when procrastinating. More specifically, to take into account the possibility that a procrastinator may also benefit from doing nothing, we assume that $u(a_t) \geq 0$ also for

$a_t = \emptyset$, and, in particular, $u(\emptyset) = \underline{u}$. This implies that the opportunity cost of not procrastinating is nonzero (ie. the above described reservation utility may be the value of leisure and/or an unemployment subsidy for an unemployed which becomes her opportunity cost if, by deciding not to procrastinate, she accepts a job offer). The total effect on the final payoff of the above mentioned additional assumptions (subjective probability of success, discouragement effect, shrinking cake effect, reservation utility) will be evaluated in the next sections.

3 Bad and Good Procrastination

According to our previous considerations we may rewrite the individual continuation utility function U^t at time t, as follows:

$$V^t(a_t, s_t, \beta, \delta) = \begin{cases} -c + \beta \left\{ \hat{p}_t \frac{\delta}{1-\delta} \hat{\nu}(t) \right\} & \text{if} \quad a_t = (c, \hat{\nu}(t)) \\ \\ \underline{u}^e_\tau + \beta\delta^\tau \left\{ -c + \hat{p}_\tau \frac{\delta}{1-\delta} \hat{\nu}(\tau) \right\} & \text{if } a_t = \emptyset, \\ \qquad\qquad \tau = \min\{d > 0 \mid a_{t+d} \neq \emptyset\} \text{ and } a_{t+d} = (c, \hat{\nu}(\tau)) \\ \\ \underline{u}^e_\infty \quad \text{if} \quad a_t = \emptyset \quad \text{and} \quad a_{t+d} = \emptyset \quad \forall\, d > 0 \end{cases}$$

As before, there are three possible cases taking into account the subjective probabilities and perceived rewards, i.e.

i) the individual does not procrastinates, completes the task in t and her expected payoff is: $-c + \beta \left\{ \hat{p}_t \frac{\delta}{1-\delta} \hat{\nu}(t) \right\}$;

ii) the individual procrastinates for a limited time and enjoys the positive reward consisting in the reservation utility while procrastinating: $u(\emptyset) = \underline{u} \geq 0$ if $a_\tau = \emptyset$, and this holds true for all $\tau \geq t$. For simplicity, we assume that $\underline{u}$ is constant in each period so that the reward for doing nothing in t is the same as the reward for doing nothing in $(t+1, t+2, ...)$. We therefore denote the present value of the expected utility for doing nothing until τ with: $\underline{u}^e_\tau = \underline{u} \left\{ 1 + \beta\delta \frac{1-\delta^{\tau-1}}{1-\delta} \right\}$. As a consequence, if the individual expects to realize the task x in $\tau > t$, her expected payoff is: $-c + \beta \left\{ \hat{p}_t \frac{\delta}{1-\delta} \hat{\nu}(t) \right\}$;

iii) the individual procrastinates forever and enjoys $\underline{u}^e_\infty = \underline{u}(1 + \beta\delta^\tau \frac{\delta}{1-\delta})$ measuring the reward for doing nothing forever.

Definition 3.1 *A positive expectation that realizing x in t is worthwhile implies that:*

$$-c + \beta \left\{ \hat{p}_t \frac{\delta}{1-\delta} \hat{\nu}(t) \right\} \geq \underline{u}^e_\infty.$$

Such definition states that the consequence of the introduction of the new model features is such that *β-worthwhileness* is now more easily verified the

higher the values of $\hat{p}_t$ and $\hat{\nu}(t)$, while it is less likely to occur for high values of the reservation utility, that is, it may be less likely to occur when the value of leisure is higher (ie. when, in case of job search, an unemployment subsidy or a job in the informal market makes such reservation utility higher).

Procrastination occurs if an individual thinks the payoff expected in t for the task x realized in τ is higher than the expected utility of doing nothing forever (in this case there is not a definite abandonment of the plan of performing the task in a period τ in the future, even though the individual is putting it off today). Procrastination does not exclude worthwhileness in t, while implying that the task is more worthwhile in τ than in t. That is, it occurs when the payoff expected in t for the task x realized in τ must be higher than the expected payoff for the task accomplished in t (and, if this is true for each $\tau > t$, the individual postpones forever).

Therefore an agent procrastinates when she estimates:

$$\underline{u}^e_\tau + \beta\delta^\tau \left\{ -c + \hat{p}_\tau \frac{\delta}{1-\delta} \hat{\nu}(\tau) \right\} > \underline{u}^e_\infty \qquad \forall \tau \geq t \quad (4)$$

and

$$\underline{u}^e_\tau + \beta\delta^\tau \left\{ -c + \hat{p}_\tau \frac{\delta}{1-\delta} \hat{\nu}(\tau) \right\} > -c + \beta \left\{ \hat{p}_t \frac{\delta}{1-\delta} \hat{\nu}(t) \right\} \quad \forall \tau > t \quad (4')$$

that is, a subject procrastinates if she thinks that it is worthwhile doing the task sooner or later, so that she does not abandon the plan (as shown by inequality (4) implying that "tomorrow is better than never") and, at the same time, if she thinks that $\forall \tau > t$ her payoff will be higher than in t (as shown by inequality (4') implying that "tomorrow is better than today").

Definition 3.2 *A pathological procrastinator is an agent who estimates that (4) and (4′) are holding for $t \leq \xi < \tau$, but who perceives*

$$V^t = V^\tau \text{ if } \quad \xi = \tau$$

and

$$V^{\xi'} \geq V^\tau \quad \forall\, \xi' \geq \tau$$

A pathological procrastinator is therefore an agent who thinks that it is better to postpone the task until a given period of time but when the planned time arrives she realizes to face the same decisional problem as in t. So, she still thinks that it is better put off the task once again to get a higher expected future payoff. At the same time such pathological procrastinator never stops thinking that performing the task is worthwhile.

Definition 3.3 ***Bad and Good Procrastination***. *For a person behaving sub-definition 3.2, we define*

a) bad procrastination if procrastination has ex post negative consequences that is:

$$-c+\beta\left\{p_t\frac{\delta}{1-\delta}\nu(t)\right\}>\underline{u}^e_\infty \qquad (5)$$

and

$$-c+\beta\left\{p_t\frac{\delta}{1-\delta}\nu(t)\right\}>\underline{u}^e_\tau+\beta\delta^\tau\left\{-c+p_\tau\frac{\delta}{1-\delta}\nu(\tau)\right\}\ \forall\tau>t \qquad (5')$$

b) good procrastination if procrastination has ex post positive consequences that is:

$$\underline{u}^e_\infty>-c+\beta\left\{p_t\frac{\delta}{1-\delta}\nu(t)\right\} \quad (6)$$

and

$$\underline{u}^e_\infty>\underline{u}^e_\tau+\beta\delta^\tau\left\{-c+p_\tau\frac{\delta}{1-\delta}\nu(\tau)\right\} \qquad \forall\tau>t \quad (6').$$

Therefore a) occurs if a person procrastinates the task x, but the task was worth-while in t and the real payoff in τ is lower than the real payoff in t ("today was better than tomorrow and better than never"); while we have b) if, in each period, the utility of doing nothing is higher than that of doing the task, or in other words, the task is not worth-while neither in t, (6) nor in τ, (6').

So, according to b), if a person believed the task was worth-while in τ, but in τ she postponed the task again, for fear of a failure, or rethinking the importance of x, so she did not perform x even in τ, this was the best decision to take since ex post doing x would have implied higher losses or a lower welfare.

Note as well that there may be alternative definitions of good procrastination such as those represented in what follows.

Remark 3.4 *If the agent procrastinates the task x until τ and performs it in τ, then she faces good procrastination if*

$$-c+\beta\left\{p_t\frac{\delta}{1-\delta}\nu(t)\right\}<\underline{u}^e_\tau+\beta\delta^\tau\left\{-c+p_\tau\frac{\delta}{1-\delta}\nu(\tau)\right\} \qquad \forall\ \tau>t.$$

Moreover, we observe that if the task x is worth-while in t and the procrastinator is pathological, then procrastination always has negative consequences.

If a procrastinator is pathological, she expects to earn in the future more than today, and therefore she also expects the task is less worth-while in t than in τ. Note that, differently from what we will consider in section 4 with a further extension, the procrastinator does not invest in effort to improve the reward from a successful performance of the task in the future. Hence her costs do not increase, while the reward gets lower as time passes due to the "shirking cake" effect since $p_\tau<p_t$ and $\nu(\tau)<\nu(t)$, as a consequence

(5') is satisfied.
To sum up, the person procrastinated but her payoff in t would have been higher than in τ. She has losses from this behavior only if payoff from doing x in t would have been positive, that is if the task is worth-while in t; or in other words if (5) is satisfied.

4 Discussion and policy implications of bad and good procrastination

From the previous considerations we may conclude that:
i) a person is more used to procrastinate the lower her estimates of $\hat{p}_t$ and $\hat{\nu}(t)$ are. In this case she thinks (4') is satisfied while the true expression is (5'). This means that she procrastinates if she underestimates her probability of success in doing the task today and/or she overestimates the rewards from performing successfully the task in the future compared with what she gets if she realizes it immediately;
ii) if the procrastinator is pathological the most important thing to take the right decision is making a good estimate of the current situation in t. If the task is worth-while in t and the person can realize it now, then procrastination will surely have negative consequences.
The welfare loss for a pathological procrastinator is equal to:

$$W_{loss} = -c + \beta \left\{ p_t \frac{\delta}{1-\delta} \nu(t) \right\}$$

and is represented by the unrealized real payoff, while, on the contrary, the loss in case of realisation of the task with a failure is:

$$W_{loss} = c$$

which also measures the advantages (in terms of cost saved) from good procrastination.

As shown in section 3 conditions for bad procrastination are stated by inequalities (4), (4'),(5) and (5') which must simultaneously hold for a pathological procrastinator. The expected value of performing the task tomorrow must be higher than the expected values of never performing the task (4), and of postponing until tomorrow (4'). At the same time, the real value of performing the task today must be higher than the real value of performing the task either tomorrow (5') or never (5). As a consequence bad procrastination becomes less likely if reservation utility falls (since this reduces the expected (and actual) value of performing the task tomorrow or never), if impatience is higher, if the cost of effort is lower. On the contrary, it becomes more likely if the time window in which the task can be performed is larger (if we reasonably assume that there may always be a time period in which performing the task is expected to have high value).

Conditions for good procrastination are stated by inequalities (4), (4'), (6) and (6') which must simultaneously hold. The expected value of performing the task tomorrow must be higher than the expected values of never performing the task (4) and of postponing until tomorrow (4') while, at the same time, the actual value of postponing the task forever and not performing it must be higher than the actual values of performing the task either today (6) or tomorrow (6').

Our definition of bad and good procrastination creates room for policy action. Three main directions which come in mind are those aiming at: i) putting a deadline on the possibility of performing the task; ii) affecting the reservation utility value; iii) improving agents' information set in order to reduce the gap between subjective and objective evaluations of the probability of success and of the value of the task. The first option is not always available but when it is so (i.e. fixing a deadline to the possibility that university students take years off the graduation time), it is the most effective policy action if the government is certain that individuals are affected by bad procrastination (i.e. it believes that many individuals underestimate shirking cake and discouragement effects due to procrastination and therefore overestimate the expected value of doing the task tomorrow). For the same reason this policy choice is "risky" since it may reduce wellbeing if government evaluation is wrong and procrastination is good.

A second dilemma in choosing this deadline-to-performance policy is whether never doing the task is better than doing it tomorrow, or

$$\underline{u}^e_\infty > \underline{u}^e_\tau + \beta\delta^\tau \left\{ -c + p_\tau \frac{\delta}{1-\delta} \nu(\tau) \right\}.$$

In that case the adoption of this policy does not produce any incentive to perform.

By choosing the second option the government may reduce the value of performing the task tomorrow by manipulating the reservation utility value. Among the many available instruments the government has, we think of temporary subsidies or tax allowances for performing the task now or of time limits to unemployment subsidy in a job search problem (which affect the individual reservation utility but are not deadlines to her opportunity of performing/postponing the task). Differently from the previous policy option this choice has less clear cut effects on individual decisions since it may be not clear to the government whether and for how many individuals this manipulation modifies incentives in order to shift them from bad procrastination to performing the task today.

Given what said about the two previous policy options the third option (improvement of the information set) is more convenient the higher the limits in the government information set but not so easy to realize. It may be feasible in case of job search when wage patterns are made more evident

and individuals may evaluate more clearly the future expected gains from performing the task.

Note that all policy suggestions to avoid bad procrastination must be read in the opposite way if we want to stimulate good procrastination. Hence we should help individuals to be less impatient, increase costs of effort (so that individuals will think more accurately before taking the decision to act), increase reservation utility and extend the time window in which the decision can be taken. The most difficult issue is therefore to understand whether we are in a situation of bad or good procrastination. Here again the third option aiming to improve individual information sets is more desirable if the government is aware of its informational limits. In this perspective measures aimed to improve the information set and bridge the gap between subjective and objective values of the probability of success and the value of the task are not affected by government biased information on bad and good procrastination and useful under both frameworks.

Last but not least, measures against procrastination may be more needed in countries where the weather is mild and therefore the value of leisure is higher even though, also in this case, our model may lead us to conclude that procrastination is not bad from the individual point of view. In this respect a procrastination model may help to microfound the well known stylized fact of the negative impact of latitude (closeness to equator) on economic growth interpreting it in the sense of poorer quality physical and human capital investment due to procrastination.

5 The curse of perfectionism

In the previous section we have seen that an individual is more likely to procrastinate with negative consequences, if she overestimates p_τ and $\nu(\tau)$. In the reality it may be objected that it is unlikely that a rational individual makes this mistake if she is aware she is doing nothing to improve her performance while she procrastinates. In this section we therefore introduce a novel feature by reasonably assuming that, if the agent procrastinates because she is afraid of failure, she will probably invest her delayed time in an effort ρ which may produce in τ either a higher reward and/or a higher probability of success. We put these considerations into our model assuming that:

$$i)\ p_\tau(\rho) > p_\tau(0),\ \rho > 0$$

and effort investment ρ enables the subject to realize in τ the task x i.e.

$$ii)\ x(\rho) > x(\rho') \qquad \text{for } \rho > \rho'.$$

Note that the overall effect of effort on the final reward remains uncertain after this change, because the positive impact of effort on future reward may

be offset by the "shirking cake" effect which progressively reduces the reward over time.

In this section our objective is therefore to evaluate when it is convenient for a person to stop procrastinating and doing the task in order to avoid that costs of postponement become higher than benefits.

Consider now the situation of a hard-minded procrastinator who wants to perform the task in the best possible way and procrastinates to improve her performance, while not understanding that excess deferral may be dangerous. This individual may overinvest in effort (i.e. he could be able to realize successfully the task sooner and with a lower level of effort) even though realized earnings from this improvement are lower than losses related to the delay. We define this situation as "*the curse of perfectionism*".[3]

Things may get worse because people often do not only wait for something to happen but invest to improve their performance and still end up never performing the task. This attitude produces additional losses with respect to our benchmark case of welfare loss of pathological procrastination described in section 4.

Based on these considerations we modify our model by assuming that the agent may decide not to perform the task x today while investing in the same period in the effort ρ at a cost $c(\rho)$. For simplicity, we also assume that the cost of effort is paid (and effort is exerted) only today, while producing a positive earning only in τ.

We also assume that the reward ν is affected by both the time at which the task is realized (due to the already mentioned shirking cake effect) and the effort made to realize a better result. Therefore we set $\nu \equiv \nu(\rho, t)$, with ν increasing with respect to ρ and decreasing with respect to t. [4] Finally, we assume that there is a limited maximum effort ρ^* beyond which the probability of successfully performing the task cannot be further increased i.e. $p(\rho) \leq p(\rho^*)$ for all $\rho \geq \rho^*$.

[3]The literature tells us that an important issue in the curse of perfectionism is the fear of failure which makes the submission of a work acutely painful. Flett and Hewitt (2002)[15] show that perfectionists may also experience painful emotions like guilt, shame, anger, or embarrassment when they fail to meet their normative objectives. Fear of such a negative self-evaluation can motivate individuals to avoid important tasks in which they do not expect to perform very well (Ferrari et al.(1995)[14]). For example, they may enter less ambitious educational programs (Enns et al.(2001)[12]) or may be tempted to deviate from their long-term normative objectives depending on the tradeoff between emotional costs and benefits of perfectionism. Some may choose various forms of downshifting to stop the emotionally stressful race toward their normative ideals (Kopylov, 2012[18]). Even though failure aversion could be modelled by adding an extra disutility in case of task failure we do not follow this approach and show that the curse of perfectionism may arise also without explicitly modelling this feature.

[4]An example of this may be students who postpone taking an examination today to study more in order to obtain higher scores in a later period. But the benefit (the higher score) has also a cost (studying more intensively and more time, paying taxes, paying rents for non resident students, etc.)

Under these new assumptions the previous individual continuation utility function V^t at time t, turns into:

$$\hat{V}^t_\rho(a_t, s_t, \beta, \delta) = \begin{cases} -c + \beta\left\{\hat{p}_t(0)\frac{\delta}{1-\delta}\hat{\nu}(0,t)\right\} & \text{if} \quad a_t = (c, 0, \hat{\nu}(0,t)) \\ \\ \underline{u}^e_\tau + \beta\delta^\tau\left\{-c + \hat{p}_\tau(0)\frac{\delta}{1-\delta}\hat{\nu}(0,\tau)\right\} & \text{if} \quad a_t = \emptyset, \\ \quad \tau = \min(d > 0 \mid a_{t+d} \neq \emptyset) \text{ and } & a_{t+d} = (c, 0, \hat{\nu}(0,\tau)) \\ \\ -c(\rho) + \underline{u}^e_\tau + \beta\delta^\tau\{-c + \hat{p}_\tau(\rho)\frac{\delta}{1-\delta}\hat{\nu}(\rho,\tau)\} & \text{if } a_t = \emptyset, \\ \quad \tau = \min(d > 0 \mid a_{t+d} \neq \emptyset), & a_{t+d} = (c, c(\rho), \hat{\nu}(\rho,\tau)), \\ \\ \underline{u}^e_\infty \quad \text{if} \quad a_t = \emptyset \quad \text{and} & \quad a_{t+d} = \emptyset \quad \forall\, d > 0 \end{cases}$$

In the first case the individual performs the task in t at the cost c, without investing in any effort ($\rho = 0$). In the second case she performs her task without investing in any effort. In the third case the task is realized in $\tau > t$ and the agent invests in effort at time t to improve her performance so to realize in τ a task $x(\rho) > x(t)$. Finally, in the fourth case she does nothing from t onward.

Let us define the objective individual continuation utility function ${V_\rho}^t$ at time t, as we did for $\hat{V}^t_\rho(a_t, s_t, \beta, \delta)$, considering the objective probabitities p and rewards ν instead of the subjective ones $\hat{p}$ and $\hat{\nu}$, moreover let us assume there exist an optimal period of time τ^* and an optimal effort level ρ^* such that:

$$a_{\tau^*} = \arg\max {V_\rho}^t =$$

$$\arg\max\left\{-c(\rho) + \underline{u}^e_\tau + \beta\delta^\tau\left\{-c + p_\tau(\rho)\frac{\delta}{1-\delta}\nu(\rho,\tau)\right\}\right\} \quad (7)$$

Given that individuals do not know the true values of probabilities and rewards, they will try to realize the optimal strategy s that maximizes the expected payoff:

Definition 5.1 ***The Effort-Time perfect action*** *For a (β, δ)–agent there exists a subjective action $a_{\tilde{\tau}}(\beta, \delta)$ such that*

$$a_{\tilde{\tau}} = \arg\max \hat{V}^t_\rho = \arg\max\left\{-c(\rho) + \underline{u}^e_\tau + \beta\delta^\tau\left\{-c + \hat{p}_\tau(\rho)\frac{\delta}{1-\delta}\hat{\nu}(\rho,\tau)\right\}\right\}$$

The optimal values of effort and timing chosen by the agent are $(\tilde{\rho}, \tilde{\tau})$ which maximize the function above. Remark that they may be different from the real optimal values $(\rho*, \tau*)$ if the subjective evaluations of probabilities of success and rewards are incorrect i.e.

$$-c(\rho^*) + \underline{u}^e_{\tau^*} + \beta\delta^{\tau^*}\left\{-c + p_{\tau^*}(\rho^*)\frac{\delta}{1-\delta}\nu(\rho^*,\tau^*)\right\} \geq$$

$$-c(\tilde{\rho}) + \underline{u}^e_{\tilde{\tau}} + \beta\delta^{\tilde{\tau}} \left\{ -c + \hat{p}_{\tilde{\tau}}(\tilde{\rho}) \frac{\delta}{1-\delta} \hat{\nu}(\tilde{\rho}, \tilde{\tau}) \right\}$$

We may give the following:

Definition 5.2 ***The curse of perfectionism.*** *A person procrastinates for too long time and invests in too much effort so to incur in the curse of perfectionism when:*

$$-c(\tilde{\rho}) + \underline{u}^e_{\tilde{\tau}} + \beta\delta^{\tilde{\tau}} \left\{ -c + \hat{p}_{\tilde{\tau}}(\tilde{\rho}) \frac{\delta}{1-\delta} \hat{\nu}(\tilde{\rho}, \tilde{\tau}) \right\} >$$

$$-c(\rho^*) + \underline{u}^e_{\tau^*} + \beta\delta^{\tau^*} \left\{ -c + \hat{p}_{\tau^*}(\rho^*) \frac{\delta}{1-\delta} \hat{\nu}(\rho^*, \tau^*) \right\} \quad if \;\; \tilde{\tau} > \tau^*, \tilde{\rho} > \rho^* (8)$$

From definition 5.2 we infer that it is more likely to incur in the curse of perfectionism when: i) the additional cost afforded for the unnecessary effort compared with the true optimal effort is low, that is, $c(\tilde{\rho}) < c(\rho^*)$; ii) the value of $p_{\tilde{\tau}}(\tilde{\rho})\nu(\tilde{\rho}, \tilde{\tau})$ is strictly higher than $p_{\tau^*}(\rho^*)\nu(\rho^*, \tau^*)$.

The problem of the curse of perfectionism is that the shirking cake effect makes the task payoff lower between $\tilde{\tau}$ and τ^* while the effect of extra effort $\tilde{\rho} > \rho^*$ does not produce ay improvement in the probability of success. Hence the curse produces a fall in the expected payoff.

Note that if the perfectionist agent behaves also as a pathological procrastinator it is impossible to avoid the "curse", since she will always keep on postponing after the real optimal stopping time τ^*. Note as well that, as obvious, policy measures against the curse of perfectionism are those discussed in section 4 as remedies against bad procrastination.

6 Productive Procrastination

In this section we extend our reasoning to cases in which procrastination may be productive by assuming that procrastinators invest in the time lag between t and τ to improve their performance and to do x better in the future. Nevertheless, if x is worthwhile in t but never realized, they may also use that investment for an alternative activity y which produces a positive reward only in τ: $\nu_y(\rho, \tau) > 0$, while $\nu_y(0, t) = 0$ for $t < \tau$. Alternatively we can also imagine that a person uses her delayed time not just for a productive task but for some other activities (such as spending time with friends, family, as volunteers, etc.) which produce in the meanwhile a higher satisfaction $\bar{u}$ than the utility of doing nothing at all $\underline{u}$. In this case procrastination is not necessarily a waste of time and it may become a good strategy. This happens when the payoff of procrastinating until τ produces an extra utility gain due to the reward for y in τ. This gain must be higher than the payoff of doing x in t. Notice that productive procrastination is not just doing something else as in a multiple-choice task performance problem. The central issue here

is that the reward y is due to the investment made for x but not used for it, given that the subject never realizes x. This does not happen because agents have to choose what task to accomplish (x or y). On the contrary, using ex post for y resources they have initially planned to use for x, enables them to do y better (if they have never planned to do x they would have never invested in these resources which increased their welfare for y).

Alternatively, we may have productive procrastination because, while procrastinating x, individuals devote their time to relational leisure and this activity positively contributes to their utility. They can do that just because they have planned x (and refused to do whatever other task z), but they are not doing it and they can't do z any more, so they have free time to devote to these goods: the agents would never do that if they had done x or z. To sum up x becomes a sort of "hidden" incentive to do y (or to do y better): planning x but not doing it may be useful for y which increases my welfare more than x itself or for a huge $\bar{u} > \underline{u}$ coming from relational activities.

We translate all these considerations into analytical terms, under the assumption that investing for x is costly, but this investment is also useful to realize y in the future. We denote with ρ_{xy} the effort made for x but also useful to do y in the future and for simplicity, we also assume that this effort let people certainly realize and with success y so that: $p_y = 1$. Let define $\bar{u}^e_\tau = \bar{u}\left\{1 + \beta\delta\frac{1-\delta^{\tau-1}}{1-\delta}\right\}$, then

Definition 6.1 *Under the above assumption we will have productive procrastination in τ if:*

$$-c(\rho_{xy}) + \bar{u}^e_\tau + \beta\delta^\tau(-c + \tfrac{\delta}{1-\delta}\nu_y(\tau, \rho_{xy})) > -c + \beta\{p_t\tfrac{\delta}{1-\delta}\nu(t)\}\ \forall\tau > t$$

If this condition is satisfied people could procrastinate forever without negative consequences because, even if $p_\tau\nu(\tau) = 0$, so that the task for x is never realized, nevertheless there will be a positive reward from doing y, that is, $\hat{\nu}_y(\tau, \rho_{xy}) > 0$.

Our main conclusion in this section is that in some cases it may be important not to plan how to avoid procrastination, but how to procrastinate well, that is how to provide incentive to invest one's own effort in doing or learning something which can be also useful for a task or a class of tasks that are at the present ruled out, but which may become profitable if well performed in the future. In this way, postponing becomes a way to have more free time to work on small things that could grow into big things, or to afford productive procrastinators to work later successfully on better tasks.

These considerations create room for additional policy actions. For instance, with respect to job search, programmes delivered by the government in funded courses and funded training strongly reduce the cost of effort $c(\rho)$

for the unemployed, or for "discouraged" workers who are not searching any job, engaging them in activities which provide them with the skills and qualifications needed to find a better job in the future. In the same way, Universities could offer preparation classes in various topics, alongside to language and computer courses, in a multi-disciplinary approach to provide a useful background for whatever kind of classes and examinations students decide to take in the future. Finally, incentives and opportunities to foster partecipation in associations, political activities, other regarding activities such as volunteering, etc. or in increasing social relationships, also at a distance, as social networks (as wireless, free access to Internet; etc.) can raise the value of $\bar{u}$ so that definition 6.1 may be easily satisfied.

7 Conclusions

The decision to perform or to postpone an action is the crucial building block of some of the most important economic activities such as physical and human capital investment, job search and consumption. This is why the interest on the theoretical analysis of procrastination is growing.

Procrastination implies deferring task performance tomorrow in the belief that doing it tomorrow will yield a better outcome than doing it today, while still thinking that doing it tomorrow will be better than not doing it at all. Procrastination may be good if postponement leads to a higher quality performance tomorrow (and higher utility than never doing the task) or bad if this is not the case. It becomes pathological when it leads to an infinite deferral of the decision to perform a potentially successful task, a situation which occurs when the individual falls in an endless "tomorrow-better-than-today, tomorrow-better-than-never" trap.

The theoretical literature has so far related pathological procrastination to present discount bias and hyperbolic discounting. In our paper we aim to enrich this perspective by introducing some additional features in this framework such as subjective evaluation of the probability of success and of the expected value of the task, a nonzero reservation utility enjoyed when postponing the task and the possibility of associating a productive effort to procrastination time.

Our enriched theoretical framework provides interesting insights for policy solutions. If public authorities deem that their citizens are affected by bad procrastination a solution may be affecting the value of their reservation utility or fixing a time deadline to the possibility of performing the task. Pros and cons of these alternative solutions are discussed. Relevant applications of them are making unemployed subsidies temporary or conditional to non procrastination (that is, non refusal of job offers) in job search, creating time limits to the possibility for University students of taking years off graduation and making tax allowances temporary in investment and consump-

tion. However, since the capacity of policymakers to understand whether procrastination is good or bad is limited, measures aiming to improve the information set of individuals are less prone to mistakes in generating positive welfare effects in procrastination problems.

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