Practice Makes Perfect:
On Professional Standards

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Abstract

Practising is a matter of increasing the reliability of ones skills rather than relying on a tool or a strike of genius to get it right. Once perfection has been achieved the individual will aim for higher quality since the effort is more likely to be worthwhile. Furthermore because the returns to achieving perfection are higher the harder it is to achieve, the perfectionist equilibrium only arises in situations where genius is rare and reliability is low. From this follows that as tools improve, even though perfection then has become easier to achieve, professional standards may nonetheless decline. This mechanism is captured in an oligopoly model, where the failure rate and the quality are endogenously determined.

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1 Introduction

'errare humane est'

It is human to err, but as every aspiring musician knows successful practice makes perfect.[1] However, as every young economist knows, there is an opportunity cost of time. Is it optimal to aim for perfection? A musician would answer that there is no choice, since perfection is the standard that is expected and furthermore unless you have reliable skills it is quite risky to attempt learning to play the repertoire that is expected.

Classical music is but one example of a profession which is characterized by perfection and very high quality of the good that is produced.[2] This paper presents a highly stylized model with both normative and positive results. On the positive side it explains why

- it is when perfection is very hard to achieve that we tend to observe it in combination with very high quality, e.g. such as in, conservation, music, and ballet;[3]
- professional standards may fall when improved tools become available, e.g. such as computers and the presence of typos, or power drills and skew screws;[4]
- why some highly skilled professions may die out when the opportunity cost of time goes up.

On the normative side it addresses when perfectionism is desirable and whether the individual incentives are biased in equilibrium.

[1]To practice need not necessarily be a successful endeavor. Spending hours playing scales without the right articulation will achieve nothing and might even be damaging.

[2]Quality and professional standards are being used interchangeably throughout the paper.

[3]These professions are often also characterised by the superstar phenomenon (see Rosen (1981)).

[4]This is an example of the effect described by Chamberlin (1953) in his paper about the product as a variable. He provided several examples of when new technology resulted in lower quality. Sällström (1999) showed that this effect was present in a monopoly with heterogeneous consumers.

The intuition for the positive results are as follows.

If there are professionals around with reliable skills, you will have to match the professional standards they set if you wish to compete with them. If the chances are small an individual can manage without reliable skills, it will be optimal for the individual to aim for perfection as well and only compete if successful in achieving it. Furthermore if perfectionists only expect there to be competition from others who managed to achieve perfection, they will aim for higher professional standards than they would in a situation where there are enthusiasts around giving it a go even if they do not have the skills that enable perfection.

When improved tools become available the profession may change from a perfectionist equilibrium to a lazy equilibrium in which nobody aims for perfection and instead relies on the tools to get it right. Even though the tool has made it easier to achieve perfection, by being a substitute for skills it has weakened the incentive to acquire the skills. As a result professional standards may fall. An illustrative example is the number of typos in printed books compared with say fifty years ago, where individuals rely on computer software rather than acquiring the skill of typewriting and proof reading.

When the opportunity cost of time increases, the perfectionist equilibrium may cease to exist when genius is rare and reliability is low. Examples of this effect can be found for some highly skilled crafts, where unless reliable skills are acquired it is not worthwhile even trying. Hence, if nobody has invested the time to achieve perfection, there will be no one out there who can do it any more.

These effects arise when the accumulation of human capital and the production process both entail an element of risk of failure, which is a characteristic feature of creative industries as noted by Caves (2003). Spending hours practising is a way of trying to eliminate this risk in making ones skills more reliable. However, spending hours practising is risky as well since there is no guarantee the individual will be successful in achieving perfection despite the practice. In some cases it will also take longer to realise you are not going to make it, than in other cases. For example it takes ten years to learn to play the piano. But unless you spend the time you will never learn whether practice would have helped. Anyone is allowed to try to meet the standards of the profession, but those who have practiced and been successful in increasing their reliability are more likely to succeed in meeting any standards and will therefore have incentives to aim for higher quality.

The game between e.g. aspiring musicians, can be modelled as a patent race[5] between two independent producers with three important additions. First, there is a risky option to accumulate human capital, which if successful will eliminate the risk of the production process. Second, the quality of the output is endogenised too. It is chosen after the individual has had the opportunity to try to improve the reliability of the production process, but before the individual learns about his competitors achievements or failures. Third, the risk depends both on strike of genius and reliability of skills. The less reliable the more time it takes before perfection can be achieved if ever. Those who have been successful in meeting the same professional standards then compete a la Cournot.

Perfectionism is an important element in the history of moral thought from Plato and Aristotle through Spinoza and Hegel, the Aristotelian thesis being that 'developing human nature fulfils our function or purpose as humans'. The perfection considered in this paper is a combination of Hurka's (1993) list of human excellences: physical perfection, theoretical rationality and practical rationality, since in most professions skills that make a process more reliable will be a combination of the physical, intellectual and practical capabilities of a human being. It is precisely because either of these may be limiting that individuals can not be certain of achieving perfection even if they try.

I am not aware of any formal model which addresses the problem of risky human capital and its relation to risky technology and quality of output.[6] It is, however,

[5]See Reinganum's (1989) masterful survey of patent races and the timing of innovation.

[6]The literature on human capital has dealt with situations where individuals choose how much to invest in human capital when they will actually get it. For example as in endogenous growth models

very prevalent in creative industries, and is one of the factors which makes these industries distinct from other industries. In his excellent review article on contracts between art and commerce Caves (2003) noted that this is an area in great need of analytical models. The only models that have been done so far have been related to the nature of the contracts. This paper therefore fits in nicely by looking at one of the sunk costs that has only been addressed verbally so far. The model in this paper also has wider applicability since the parameter in the model that in the case of artistic professions represents genius, would in other professions represent the reliability of the tools. Since genius is a gift of nature, whereas tools can be improved, the model furthermore explains why perfection has remained an equilibrium in e.g. classical music, but ceased to be in e.g. the building industry.

The outline of the paper is as follows. The model is outlined in section 2 followed by an analysis of professional standards. In this section more detailed results are presented for how quality depends on expectations about strategies played by others, and how genius and reliability influence the level. In Section 3 I characterise and derive conditions under which the perfectionist, enthusiastic and lazy equilibrium will exist. This section also contains a numerical example of the effect of improved tools on professional standards and the equilibrium. Section 4 derives the welfare for the different equilibria, and shows when the private and social incentives coincide. The paper concludes with a discussion of the assumptions in Section 5.

2 The Model

Consider two individuals who are making decisions about how to prepare themselves for and whether to pursue a career in e.g. music.

Let γ be the probability that the effort results in the intended outcome. It depends

such as in Romer(1990), or in empirical work such as Black and Lynch (1996), who estimated the productivity gains from investment in human capital.

on the prior probability that you can rely on a tool or genius to get it right α,[7] and when genius does not strike the reliability *ex ante* $\beta \in [0, 1]$.[8] The prior probability that putting in the effort will be worthwhile is

$$\gamma = \alpha + (1 - \alpha)\beta. \tag{1}$$

The timing of the game is as follows. The *first* choice the individual has to make is whether or not to try to achieve perfection by practising and putting in the effort required to fill the gap, $e = 1 - \beta$. The chances of being successful in this endeavour are γ, and the cost of the effort is ke^2. The posterior reliability if the individual attempts to achieve perfection by putting in effort $e_1 = 1 - \beta$ is,

$$\gamma_1 = \begin{cases} 1 & \text{if success,} \\ \beta & \text{if failure.} \end{cases} \tag{2}$$

If an individual is successful in achieving perfection she knows she can rely on her skills to a hundred percent. Her posterior probability of a strike of genius is $\alpha_1 = \frac{\alpha}{\alpha + (1-\alpha)\beta}$, and the reliability of her skills $\beta + e_1 = 1$. If she fails improving the reliability of her skills despite having practiced, she has learnt she is definitely not a genius or that she cannot rely on her tools to get it right, e.g. the posterior probability of genius is $\alpha_1 = 0$, but that she still can succeed with probability β in successfully completing the task.

The *second* choice is whether or not to pursue a career and if yes what quality s to aim for. Up until this point all actions, and results remain private information. If the individual puts in effort $e_2 = s$ it will materialise in s with probability γ_1. If the individual is successful in achieving s, it becomes public information, e.g. once you are ready to give a concert your competitors will know it. At this stage those

[7]The parameter α measures the relative importance of tools or genius, versus skills in getting it right. Hence, with a self-correcting tool, α would be high. For example if your word processor automatically corrects for typos, being a skillful typist has lower returns.

[8]Note that β also is a measure of how hard it is to achieve perfection. The smaller is β the harder it is.

who have been successful in achieving the same standard s compete a la Cournot, e.g. decide on how many concert tickets to make available.

Since there are only two players, for analytical convenience, someone who has been successful in learning to play e.g. Rachmaninov's second piano concerto, will either be in a monopoly position or in a duopoly position. If the demand for quality takes the standard Mussa and Rosen (1978) and Gabszewicz and Thisse (1979) form e.g. $\theta s - p$, and the taste parameter θ is uniformly distributed on $[0, 1]$, the maximized revenue for the monopoly and duopoly cases can be written as follows,[9]

$$R^M = \frac{Vs}{4}, \quad (3)$$

$$R^D = \frac{Vs}{9}, \quad (4)$$

where V reflects the returns to quality in the market. For these standard preferences the revenue will be linear in quality of the good or service provided.

The expected payoff when choosing the professional standard s depends on expectations about the strategy employed by the other player.

There are three possible strategies.

1. **L**azy, no practice, relies on genius and good luck in pursuing the career.
2. **P**erfectionist, practices hard and will only pursue a career if perfection is achieved.
3. **E**nthusiast, practices hard and pursues the career regardless.

The probability of facing competition in the final period is γ if the other player plays L or P and $\gamma + (1-\gamma)\beta$ if the other one plays E. Hence, the expected payoff if successful in delivering s is

$$\gamma\frac{Vs}{9} + (1-\gamma)\frac{Vs}{4} = \frac{9-5\gamma}{36}Vs \quad (5)$$

if the other player is lazy or a perfectionist, and

$$(\gamma + (1-\gamma)\beta)\frac{Vs}{9} + (1-\gamma)(1-\beta)\frac{Vs}{4} = \frac{9-5(\gamma+(1-\gamma)\beta)}{36}Vs \quad (6)$$

[9]In this case the revenue from a concert will be maximized for $\max_\theta V\theta s(1-\theta)$ which gives revenues $R^M = \frac{Vs}{4}$, etc.

if the other player is an enthusiast.

2.1 Professional standards

The professional standards, i.e. the quality that is expected, are set by those who have reliable skills unless nobody is expected to have reliable skills in equilibrium in which case the 'lazy' sets the standard.

An individual with reliable skills will choose the quality to maximise the expected payoff. Note that since reliable skills means that there is no risk that these standards will not be met, the individual maximises

$$s_P = \arg\max \left(\frac{9-5\gamma}{36}\right) V s_P - k s_P^2 \tag{7}$$

if she expects the competitors to be either lazy or perfectionists. The optimal standard in this case is

$$s_P^* = \frac{9-5\gamma}{36}\frac{V}{2k}, \tag{8}$$

taking the first derivative with respect to α gives

$$\frac{\partial s_P}{\partial \alpha} = -\frac{5(1-\beta)}{36}\frac{V}{2k} \tag{9}$$

which is negative. The first derivative with respect to β is

$$\frac{\partial s_P}{\partial \beta} = -\frac{5(1-\alpha)}{36}\frac{V}{2k} \tag{10}$$

which is also negative. The professional standards will be higher the harder it is to achieve due to genius being rare and/or the task being intrinsically difficult. This is because having achieved it makes it more likely the individual will be unique in which case there will be higher returns to the quality of the output. There is no positive effect from neither α nor β. This is because, once perfection has been achieved, their only role is to determine to what extent others might have been able to achieve the same. The reliability influences the cost of practising, but this is a sunk cost and will therefore not matter for the quality later on. Similarly genius α will increase the chances that the individual will achieve perfection, but once perfection has been achieved, it becomes irrelevant, since with reliable skills the individual no longer has to rely on a strike of genius to get it right.

If the individual expects competition from an enthusiast, she chooses

$$s_E = \arg\max \frac{9 - 5(\gamma + (1-\gamma)\beta)}{36} V s_E - k s_E^2. \tag{11}$$

The optimal standard in this case is

$$s_E^* = \frac{9 - 5(\gamma + (1-\gamma)\beta)}{36} \frac{V}{2k}, \tag{12}$$

which is less than when faced with competition from a perfectionist. If faced with competition from someone who will give it a go, regardless of whether they have reliable skills to meet the quality standards, it is optimal for someone who has reliable skills to set lower standards. This is because it is more likely she would be faced with competition, and therefore returns to quality will be lower.

Since $(\gamma + (1-\gamma)\beta) = \alpha + (1-\alpha)\beta(2-\beta)$, the first derivative with respect to α can be written,

$$\frac{\partial s_E}{\partial \alpha} = -\frac{5(1 - \beta(2-\beta))}{36} \frac{V}{2k}. \tag{13}$$

It will be negative but smaller in magnitude than if the individual expected competition from a perfectionist. The first derivative with respect to β is

$$\frac{\partial s_E}{\partial \beta} = -\frac{5(1-\alpha)2(1-\beta)}{36} \frac{V}{2k}. \tag{14}$$

Again the effect is negative, but in this case it is larger in magnitude than when competition is expected from a perfectionist.

The increased chance that others may have genius as well has a greater negative effect on quality when the individual expects competition from a perfectionist (or a lazy individual) than when she expects competition from an enthusiast. Whereas, the task being more difficult (lower β) has a greater positive effect on quality if the individual expects competition from an enthusiast, than from a perfectionist. This is because there is an additional effect from β if the individual expects competition from an enthusiast, since β is also the posterior probability γ_1 for those who failed and thus the likelihood they will show up at the final stage.

These standards have to be matched by someone who decides to pursue a career, unless we have a lazy equilibrium in which nobody attempts to acquire reliable skills. In an equilibrium where everybody plays the lazy strategy and expects everybody else to play the lazy strategy as well, the professional standards solve

$$s_L = \arg\max \gamma \left(\frac{9-5\gamma}{36}\right) V s_L - k s_L^2. \tag{15}$$

The professional standards when nobody attempts to achieve perfection will be

$$s_L^* = \gamma \frac{9-5\gamma}{36}\frac{V}{2k} = \gamma s_P^*. \tag{16}$$

The fact that an individual who employs a lazy strategy will only be successful in delivering s with probability γ if he puts in an effort $e_2 = s$, implies he will not aim as high as an individual with reliable skills would.

The first derivative with respect to γ is

$$\frac{\partial s_L^*}{\partial \gamma} = \frac{9-10\gamma}{36}\frac{V}{2k}. \tag{17}$$

The lazy standard is increasing in α and β reaching a maximum at $\gamma = \frac{9}{10}$, and decreases thereafter. Hence, it is only when the chances of succeeding are very high that the standards start falling for an even higher γ. This is because there are two effects. The first one is that a higher γ implies it is more likely the effort will be worthwhile which has a positive effect on quality. The second is that a higher γ implies that it is more likely other people will have been successful as well, which has a negative effect.

The professional standards converge as $\gamma \to 1$. A higher γ implies that there is less to be gained from becoming a perfectionist relative to those who are not, and furthermore it is less likely that one would be able to enjoy a monopoly position if successful.

It is noteworthy that an individual who has achieved perfection will aim for lower professional standards if she expects the other player to be an enthusiast rather than lazy or a perfectionist. The reason for this is that both the perfectionist and a lazy person are less likely to show up and compete in the final period than the enthusiast.

Note that since, $s_L = \gamma s_P$, it is easily verified that the standards in a lazy equilibrium are strictly less than those that an individual with reliable skills would set. The question is whether the professional standards when there are enthusiasts around are ever going to be lower than the standards that will be chosen when everybody is lazy. Hence is $s_E > s_L$? This is true if

$$\frac{9 - 5(\gamma + (1-\gamma)\beta)}{36}\frac{V}{2k} > \gamma\frac{9 - 5\gamma}{36}\frac{V}{2k}. \tag{18}$$

Simplifying and collecting terms

$$(1-\gamma)(9-5\gamma) > 5(1-\gamma)\beta \tag{19}$$

substituting for $\gamma = \alpha + (1-\alpha)\beta$ we get

$$\alpha(1-\beta) + 2\beta < \frac{9}{5} \tag{20}$$

which is not satisfied for β close to one. When perfection in skills makes a very small difference, quality will be higher in a lazy equilibrium than in an enthusiastic equilibrium. In the enthusiastic equilibrium people have on average more reliable skills, but they also face more competition, and the latter effect dominates when β is high.

Another interesting observation is how the difference in standards between the perfectionist equilibrium and the enthusiastic equilibrium varies with α and β.

$$s_P - s_E = \frac{5(1-\gamma)\beta}{36}\frac{V}{2k} = \frac{5(1-\alpha)(1-\beta)\beta}{36}\frac{V}{2k} \tag{21}$$

The difference is decreasing in α, whereas for $\beta < \frac{1}{2}$ it is increasing and for $\beta > 1/2$ it is decreasing, reaching a maximum for $\beta = 1/2$. When β is very small there is hardly any difference in level of competition in the final period for the two strategies, and standards will therefore be very similar. If β is very high, it is not very likely an enthusiast would fail, and therefore it makes very little difference that he would give it a go even if he failed. It is when β is in the intermediate range, that the difference is most marked.

To sum up. Quality is the highest and will be delivered with certainty if everybody is a perfectionist. When individuals are enthusiasts, the quality will be slightly lower, and there is a chance it will not be delivered. Quality is the lowest, and the failure rate the highest when individuals are lazy, unless genius is very common and/or tasks are easy, in which case quality will be higher than in the enthusiastic equilibrium. However, reliability will still be lower.

Thus the quality, as well as the reliability with which it is delivered will depend on which strategies are employed in equilibrium.

3 Pure Strategy Equilibria

There are three possible symmetric pure strategy equilibria in the model. In this section I analyse their properties and conditions under which they will exist.

3.1 Perfectionist

In the perfectionist equilibrium individuals aim for perfection and only pursue their careers if they achieve perfection. The equilibrium standards are

$$s_P = \frac{9-5\gamma}{36}\frac{V}{2k}, \tag{22}$$

with equilibrium payoff

$$\Pi^*(P,P) = \gamma\left(\frac{9-5\gamma}{36}\right)^2\frac{V^2}{4k} - k(1-\beta)^2 = k\left(\gamma s_P^2 - (1-\beta)^2\right). \tag{23}$$

The first γ is the probability that the individual will succeed in achieving perfection in which case she will also succeed in delivering a good of quality s_P with probability one. However, the cost of practising $k(1-\beta)^2$ will be incurred regardless. This payoff is positive if,

$$s_P^2 > \frac{(1-\beta)^2}{\gamma}. \tag{24}$$

This condition will be satisifed as long as the returns to quality V are sufficiently high relative to the opportunity cost of time k. Hence, if k increases at a higher rate than V this condition may no longer be satisfied. This is precisely the problem faced in some highly skilled crafts where the higher opportunity cost of time has not been matched by a corresponding increase in the returns to quality, implying that the expected payoff from a perfectionist strategy is negative.

The next question is how does the profit vary with genius and difficulty of the task? Taking the first derivative of the equilibrium profit with respect to α gives

$$\frac{\partial \Pi}{\partial \alpha} = ks_P \left[(1-\beta)s_P + \gamma 2 \frac{\partial s_P}{\partial \alpha} \right] \quad (25)$$

$$= \frac{(1-\beta)V}{72} s_P \left[9 - 15\gamma \right]. \quad (26)$$

The profit will be increasing in α as long as $\gamma < \frac{9}{15}$. After that it will be decreasing. There are two effects from genius. The first is that it increases the chances of being able to achieve perfection, which has a positive effect. the second it that it also increases the chance somebody else will have achieved perfection as well, thus competition becaomes more likely which has a negative effect. For α sufficiently small the first effect dominates.

$$\frac{\partial \Pi}{\partial \beta} = k \left[(1-\beta)s_P^2 + \gamma 2 s_P \frac{\partial s_P}{\partial \beta} + 2(1-\beta) \right] \quad (27)$$

$$= \frac{(1-\alpha)V}{72} s_P \left[9 - 15\gamma \right] + 2k(1-\beta). \quad (28)$$

Since β plays two roles, there will be an additional positive effect since a higher β lowers the effort needed to achieve perfection.

When the expected payoff is positive there exists parameter values under which it will indeed be an equilibrium. It is an equilibrium if it is neither profitable to deviate by employing the enthusiastic strategy nor the lazy one if the individual expects the other player to play the perfectionist strategy of a perfectionist equilibrium.

First, an individual who tried but failed in the first period should not wish to continue in the second period

$$\beta \left(\frac{9-5\gamma}{36} V s_P \right) - ks_P^2 < 0. \quad (29)$$

This can be written

$$(2\beta - 1)ks_P^2 < 0. \tag{30}$$

The enthusiastic strategy would result in a negative payoff if the standards are those of a perfectionist equilibrium if $\beta < 1/2$. Thus if the task is sufficiently difficult there is no incentive to deviate in period two. A player who plays the enthusiastic strategy is better informed about his true chances to succeed in delivering s, than someone who plays the lazy. If he succeeded he will get a higher payoff than a lazy, whereas if he failed his expected payoff will be lower. Hence, a lazy individual is more likely to give it a go than an enthusiast who failed.

Second, trying to achieve s_P with no practice should result in a lower expected payoff than playing the perfectionist strategy. The payoff from the lazy strategy if the other player plays the perfectionist strategy is

$$\Pi(LP) = \gamma \left(\frac{9 - 5\gamma}{36} \right) V s_P - ks_P^2 = (2\gamma - 1)ks_P^2. \tag{31}$$

Since this strategy gives a negative payoff for $\gamma < 1/2$, there is no incentive to deviate by being lazy when genius is rare and reliability is low. To see this one can solve for β which gives

$$\beta < \left[\frac{1}{2} - \alpha \right] \frac{1}{1 - \alpha}. \tag{32}$$

It can be confirmed that this is indeed a more stringent condition on β than (30), since the right hand side is less than $1/2$ for $\alpha > 0$. Here we see that it is when genius is rare, i.e. α is small, that there is no incentive whatsoever for an individual to play the lazy strategy, provided that the task is sufficiently difficult, i.e. β is small enough.

Furthermore the lazy strategy does not only give less in expectation from the point of view of period two, but also from the point of view of the entire game. Comparing the expected payoff $\Pi(EP) < \Pi(LP)$ one gets

$$(2\beta - 1)ks_P^2 < (2\gamma - 1)ks_P^2. \tag{33}$$

If there is no incentive to deviate by being lazy, there certainly will not be an incentive to deviate by being an enthusiast either.

Condition (32) is a sufficient condition for there to be a perfectionist equilibrium. For $\gamma > 1/2$ there may still be an equilibrium provided that $\Pi(PP) > \Pi(LP)$, i.e.

$$\gamma k s_P^2 - k(1-\beta)^2 > (2\gamma - 1)k s_P^2 \tag{34}$$

Since $1 - \gamma = (1-\alpha)(1-\beta)$ this condition can be written

$$s_P^2 > \frac{1-\beta}{1-\alpha} \tag{35}$$

e.g. the perfectionist equilibrium quality has to be higher than the ratio of difficulty of the task $(1-\beta)$ to how much the individual relies on having reliable skills $(1-\alpha)$. The left hand side is decreasing in α and β whereas the right hand side is increasing in α and decreasing in β. If α goes up the condition is less likely to be satisfied, whereas if β goes up the effect is ambiguous. A higher α implies that the relative importance of having reliable skills decreases. For example, having type writing skills become relatively less important when the individual no longer has to use a typewriter but can rely on computer software. In this case it is less likely people will acquire the skills, since they cost the same, but even though they increase the chances of a perfect outcome, it can be achieved without them. Hence, perfection is a strategy that arises, in situations where it is not very likely you will get it right unless you have reliable skills.

Finally the individual should not get a higher payoff by doing nothing, i.e. the equilibrium payoff has to be positive for it to be an equilibrium. On this account comparing (29) and (35) reveals that if genius is rare

$$\alpha < \frac{1-2\beta}{2(1-\beta)} \tag{36}$$

it will not be profitable to deviate by being lazy when the payoff in the perfectionist equilibrium is positive. It should be noted that this is the same condition as (32).

Thus when genius is rare and perfection is difficult to achieve, there will be a perfectionist equilibrium if the expected payoff in equilibrium is positive.

Condition (35) can also be rewritten in a form that is intuitively appealing. Namely

$$\gamma < 1 - \left(\frac{e_1}{s_P}\right)^2 \tag{37}$$

The probability of succeeding has to be smaller than one minus the ratio of first to second period effort squared. If the effort required to achieve perfection is higher than the effort required to meet the professional standards, this condition can not be satisfied for any γ. It is a necessary condition that effort increases over time, $e_1 < e_2$, since $e_2 = s_P$. .

This is equivalent to requiring that

$$1 - \beta < \frac{9 - 5\gamma}{36} \frac{V}{2k}. \tag{38}$$

If the ratio between the parameters V and k is high enough, $\frac{V}{k} > \frac{72}{5}$, we have the following result. If

$$\alpha > 1 - \frac{72k}{5V} \tag{39}$$

the effort will increase if β is high enough, since (38) can then be written

$$\beta > \frac{72k - V(9 - 5\alpha)}{72k - 5V(1 - \alpha)}. \tag{40}$$

Note that the right hand side is less than one. Whereas for

$$\alpha < 1 - \frac{72k}{5V} \tag{41}$$

the effort will increase if

$$\beta < \frac{V(9 - 5\alpha) - 72k}{5V(1 - \alpha) - 72k} \tag{42}$$

which is trivially satisfied since the right hand side is greater than one.

Hence if α is high, β has to be high enough for effort to increase over time. Whereas if α is small, effort will increase over time regardless of β. This result occurs when the marginal returns to quality V are high enough relative to the opportunity cost of time k.

To sum up. The perfectionist equilibrium arises when reliability is low and genius is rare. For example condition (36) reveals that if $\beta = 1/3$, $\alpha < 1/4$. If either genius is common or tasks are not too difficult, the individual would have an incentive to deviate and play the lazy strategy instead.

The questions is whether there is ever an enthusiastic equilibrium, in which people try to achieve perfection and keep on going even if they fail.

3.2 Enthusiast

If there is an enthusiastic equilibrium everybody tries to achieve perfection. Those who succeed set the standard expecting competition also from those who failed.

The equilibrium standard is

$$s_E = \left(\frac{9-5(\gamma+(1-\gamma)\beta)}{36}\right)\frac{V}{2k} \tag{43}$$

with expected equilibrium payoff

$$\begin{aligned} \Pi^*(E,E) &= (\gamma+(1-\gamma)\beta)\left(\frac{9-5(\gamma+(1-\gamma)\beta)}{36}\right)^2\frac{V^2}{4k} - k(1-\beta)^2 && (44)\\ &= (\gamma+(1-\gamma)\beta)ks_E^2 - k(1-\beta)^2 && (45)\end{aligned}$$

This payoff is positive if

$$s_E^2 > \frac{(1-\beta)^2}{\alpha+(1-\alpha)\beta(2-\beta)}. \tag{46}$$

Taking the first derivative with respect to α gives

$$\frac{\partial \Pi_E}{\partial \alpha} = \frac{(1-\beta)^2 V}{72} s_E\left[9-30(\gamma+(1-\gamma)\beta)\right]. \tag{47}$$

There is the same trade off as in the perfectionist equilibrium, however, the competitive effect will dominate earlier, since there is more competition in the enthusiastic equilibrium. For β one gets

$$\frac{\partial \Pi_E}{\partial \beta} = \frac{(1-\beta)(1-\alpha)V}{36} s_E\left[9-15(\gamma+(1-\gamma)\beta)\right] + 2k(1-\beta). \tag{48}$$

This is an equilibrium if it is optimal to stay in for someone who attempted to achieve perfection but failed. Hence, the perfectionist strategy gives a lower payoff if

$$\beta\left(\frac{9-5(\gamma+(1-\gamma)\beta)}{36}\right)^2\frac{V^2}{2k} - ks_E^2 > 0. \tag{49}$$

Thus the enthusiastic equilibrium requires $\beta > 1/2$.

Furthermore, it should not be possible for a lazy individual to get a higher payoff in this equilibrium. The payoff to a lazy individual is,

$$\gamma \left(\frac{9 - 5(\gamma + (1-\gamma)\beta)}{36} \right)^2 \frac{V^2}{2k} - ks_E^2 = (2\gamma - 1)ks_E^2 \tag{50}$$

This payoff will be positive for $\beta > 1/2$, since this implies $\gamma > 1/2$. Hence we need to compare it with the expected payoff from the enthusiastic strategy,

$$(\gamma + (1-\gamma)\beta)ks_E^2 - k(1-\beta)^2 > (2\gamma - 1)ks_E^2 \tag{51}$$

this equivalent to

$$(1-\gamma)(1+\beta)ks_E^2 > k(1-\beta)^2 \tag{52}$$

which can be written,

$$s_E^2 > \frac{1-\beta}{(1-\alpha)(1+\beta)}. \tag{53}$$

This condition is interesting. The left hand side is decreasing in α and β, whereas the right hand side is decreasing in β but increasing in α. Hence, the condition is more likely to be satisfied if α is small, since the professional standards are then going to be higher. Hence the enthusiastic equilibrium is more likely to arise when genius is rare and tasks are not too difficult.

If condition (53) is satisfied, the individual will also enjoy a positive payoff in equilibrium. We can see this by noting that

$$\frac{1-\beta}{(1-\alpha)(1+\beta)} > \frac{(1-\beta)^2}{\alpha + (1-\alpha)\beta(2-\beta)} \tag{54}$$

which can be simplified to $\alpha + (2\beta - 1)(1-\alpha)$ hence it is trivially satisfied for $\beta > \frac{1}{2}$. This implies that there are instances where the expected revenue in the enthusiastic equilibrium is higher than the cost of practising, but it is not sufficient for it to be an equilibrium. This stands in sharp contrast to the perfectionist equilibrium which under conditions when genius is rare and tasks are difficult will exist provided that the expected revenue is higher than the cost of practising.

When α is low we have a situation where skills are important to get it right. Depending on how reliable those skills are *ex ante* there will be a perfectionist equilibrium if reliability is low, such as in classical music, and an enthusiastic equilibrium when reliability is medium to high.

If α is high, professional standards would be lower in both the perfectionist and the enthusiastic equilibrium, which would make it less costly for a lazy individual to match those and give it a go without practising. Hence, there will then be an incentive to deviate by being lazy.

3.3 Lazy

Now, consider the lazy equilibrium where standards are set by a lazy individual who does not expect anyone to aim for perfection in their skills. In this case the professional standards are

$$s_L = \gamma \left(\frac{9 - 5\gamma}{36} \right) \frac{V}{2k} \tag{55}$$

which gives equilibrium payoff

$$\Pi^*(LL) = \gamma^2 \left(\frac{9 - 5\gamma}{36} \right)^2 \frac{V^2}{4k} = ks_L^2. \tag{56}$$

Here the expected payoff is always positive, since the standards are chosen to maximise this payoff and there is no cost of practising. Thus there is no sunk cost in this case. Furthermore it has the same maximum as s_L, i.e. it is increasing for α and β for $\gamma < 9/10$. Hence, it reaches a maximum later than the perfectionist equilibrium.

This is an equilibrium if neither the perfectionist nor the enthusiastic strategy would in expectation give a higher payoff. Hence, $\Pi(LL) > \Pi(PL)$,

$$ks_L^2 > \gamma \left(\frac{9 - 5\gamma}{36} V s_L - ks_L^2 \right) - k(1 - \beta)^2 \tag{57}$$

simplifying this gives

$$ks_L^2 > \gamma(2 - \gamma) s_L \frac{9 - 5\gamma}{36} \frac{V}{2} - k(1 - \beta)^2 \tag{58}$$

simplifying further

$$s_L^2 < \frac{1-\beta}{1-\alpha}. \tag{59}$$

Note that even though the probability that a lazy individual and a perfectionist would show up in the end game, their payoffs will be different. This is because the perfectionist will only incur a cost for s_L if successful in achieving perfection, whereas the lazy will save on not having tried to achieve perfection.[10] The saving to the perfectionist will be lower the lower is s_L, whereas the saving to the lazy will be higher the smaller is β.

Second, we need to check that $\Pi(LL) > \Pi(EL)$,

$$ks_L^2 > (\gamma + (1-\gamma)\beta)\left(\frac{9-5\gamma}{36}Vs_L\right) - ks_L^2 - k(1-\beta)^2 \tag{60}$$

simplifying

$$\frac{\gamma(1-\beta)}{2(1-\alpha)\beta} > s_L^2. \tag{61}$$

This is a less stringent condition than (59) if

$$\frac{\gamma(1-\beta)}{2(1-\alpha)\beta} > \frac{1-\beta}{1-\alpha} \tag{62}$$

simplifying

$$\alpha > \frac{\beta}{1-\beta} \tag{63}$$

Hence, if α is high enough, then if it is not profitable for a perfectionist to deviate it will not be for an enthusiast either.

Condition (59) can alternatively be written

$$\gamma > 1 - \left(\frac{e_1}{s_L}\right)^2. \tag{64}$$

[10]Note that we have made the implicit assumption that the professional standards define the quality that people expect. This has two implications. First, as long as it is met there will neither be any complaints nor any money back issues. Second, there will not be any rewards to doing more. Hence, if the lazy equilibrium prevails, a perfectionist has nothing to gain, other than his own self-esteem, aiming for more than s_L.

This condition is trivially satisfied if the effort required to achieve perfection is higher than the effort required to meet the standards in the lazy equilibrium. If the reverse is true, it is required that γ is high enough. This is an intuitive result. If it is more costly to improve ones skills than just giving it ago, there are no incentives to practice. However, the higher the effort required to meet the professional standards relative to the effort required to achieve perfection, the higher the returns to being able to deliver reliably.

It should also be noted that for

$$s_L^2 < \frac{1-\beta}{1-\alpha} < s_P^2 \tag{65}$$

both the perfectionist and the lazy strategy are Nash equilibria. It then depends on what people expect which equilibrium will prevail.

We shall conclude this section by looking at a numerical example to illustrate the results.

Consider at first $\alpha = \beta = \frac{1}{4}$. For these parameter the standards in a perfectionist equilibrium would be

$$s_P(\frac{7}{16}) = \frac{109}{4^2 6^2} \frac{V}{2k}. \tag{66}$$

There exists a perfectionist equilibrium if (35) is satisfied, i.e.

$$\left(\frac{109}{4^2 6^2} \frac{V}{2k}\right)^2 > 1. \tag{67}$$

This will be satisfied provided that V/k is high enough. Let $\Pi_i(\gamma)$ denote the equilibrium payoff in equilibrium i. Then

$$\Pi_P(\frac{7}{16}) = \frac{7}{16} \left(\frac{109}{4^2 6^2}\right)^2 \frac{V^2}{4k} - k\frac{9}{16} \tag{68}$$

Now suppose that the tools are improved so that $\alpha = \frac{1}{2}$, whereas β remains at $\frac{1}{4}$. Then the standards that would prevail in the two candidate equilibria would be

$$s_P(\frac{5}{8}) = \frac{47}{8 \cdot 6^2} \frac{V}{2k}, \tag{69}$$

$$s_L(\frac{5}{8}) = \frac{5}{8} \frac{47}{8 \cdot 6^2} \frac{V}{2k}. \tag{70}$$

The perfectionist equilibrium will no loger exist if (35) is no longer satisifed, i.e.

$$\left(\frac{94}{4^2 6^2}\frac{V}{2k}\right)^2 < \frac{3}{2}. \tag{71}$$

This will be satisfied provided that V/k is not too high. Hence, there will be a move from a perfectionist to a lazy equilibrium for a range of parameter values if the lower and upper bounds are compatible. The lower bound on V/k in (67) is less than the upperbound in (71) if

$$\left(\frac{94}{109}\right)^2 < \frac{3}{2}, \tag{72}$$

which is indeed satisifed.

The quality and reliability falls when we move from a perfectionist equilibrium to a lazy equilibrium due to an increase in α,

$$s_P(\frac{7}{16}) - s_L(\frac{5}{8}) = \left[\frac{4 \cdot 109 - 5 \cdot 47}{8^2 6^2}\right] \frac{V}{2k} > 0 \tag{73}$$

Note that this is true in general since s_P is decreasing α. Thus for any $\alpha'' > \alpha'$ we have that $s_L(\alpha'') = \gamma s_P(\alpha'') < s_P(\alpha'') < s_P(\alpha')$.

Improved tools will result in lower professional standards regardless of whether the equilibrium changes from perfectionist to lazy or not. However, the reduction will be even larger and reliability, of those who try to produce the good, lower if there is a switch to a lazy equilibrium. However, the *a priori* chances the good will be delivered at all have increased from $\gamma = \frac{7}{16}$ to $\gamma = \frac{5}{8}$.

The expected equilibrium payoff in the lazy equilibrium is

$$\Pi_L(\frac{5}{8}) = \frac{25}{64}\left(\frac{47}{8 \cdot 6^2}\right)^2 \frac{V^2}{4k} \tag{74}$$

This payoff is higher than the individual got in the perfectionist equilibrium with a lower α. To see this note that if the expected payoff in the perfectionist equilibrium was higher, the following would have to be true.

$$\left(\frac{V}{k}\right)^2 > \frac{36(4^2 6^2)^2}{7(109)^2 - \frac{25}{4}(94)^2} \tag{75}$$

However, the right hand side exceeds the upper bound on V/k. Hence, the individual payoff cannot be higher in the perfectionist equilibrium if it changes to a lazy.

This example has illustrated that if the returns to quality relative to opportunity cost of time are high but not too high, a profession that used to be characterised by a perfectionist equilibrium may switch to a lazy equilibrium when tools improve.

Even though the chances of being successful in achieving perfection have improved, standards will fall. Thus when tools improve, such as typewriters being replaced by computers. Several things will happen. It is then more likely to succeed without reliable skills, which lowers the return to practising to make ones skills more reliable. As a result the professions may move from a perfectionist equilibrium, in which only those with type writing skills would prepare manuscripts to a lazy equilibrium in which everybody relies on the software to get it right. The result being that there are more typos in printed work, i.e. professional standards have fallen, but more people are actually doing it.

4 Welfare

Is the perfectionist equilibrium socially desirable? And are the individual incentives biased?

The expected welfare of the game is the probability that either of the two players end up in a monopoly position, in which case the welfare is given by,

$$W_M = \int_{\theta_M}^{1} Vs\theta d\theta = \frac{3}{8}Vs \tag{76}$$

plus the probability that they compete a la Cournot, in which case the welfare is

$$W_C = \int_{\theta_C}^{1} Vs\theta d\theta = \frac{4}{9}Vs \tag{77}$$

From this we can infer that the consumers' surplus is

$$S_M = W_M - \Pi_M = \frac{1}{8}Vs \tag{78}$$

$$S_C = W_C - 2\Pi_C = \frac{2}{9}Vs. \tag{79}$$

Total welfare for the three equilibria is as follows:

$$\begin{aligned} W(PP) &= \left[\gamma^2 \frac{4}{9} + 2\gamma(1-\gamma)\frac{3}{8}\right] V s_P - 2k\left[\gamma s_P^2 + (1-\beta)^2\right] \\ &= \gamma \frac{V^2}{4k}\left(1 - \frac{1}{3}\gamma\right)\left(\frac{9-5\gamma}{36}\right) - 2k(1-\beta)^2 \\ W(LL) &= \left[\gamma^2 \frac{4}{9} + 2\gamma(1-\gamma)\frac{3}{8}\right] V s_L - 2k s_L^2 = \gamma^2 \frac{V^2}{4k}\left(1 - \frac{1}{3}\gamma\right)\left(\frac{9-5\gamma}{36}\right) \end{aligned} \quad (80)$$

$$\begin{aligned} W(EE) &= \left[\gamma^2 \frac{4}{9} + 2\gamma(1-\gamma)\frac{3}{8} + (1-\gamma)^2\left(\beta^2 \frac{4}{9} + 2(1-\beta)\beta\frac{3}{8}\right)\right] V s_E - 2k\left[(1-\beta)^2 + s_E^2\right] \\ &= \frac{V^2}{72k}\left[\gamma(32-11\gamma) + (1-\gamma)\beta\left[(1-\gamma)(27-11\beta)+5\right] - 9\right]\left(\frac{9-5(\gamma+(1-\gamma)\beta)}{36}\right) \\ &\quad -2k(1-\beta)^2 \end{aligned} \quad (81)$$

The perfectionist equilibrium generates a higher welfare than the lazy equilibrium if

$$\left[\gamma^2 \frac{4}{9} + 2\gamma(1-\gamma)\frac{3}{8}\right] V[s_P - s_L] > 2k\left[\gamma s_P^2 + (1-\beta)^2 - s_L^2\right] \quad (82)$$

hence, if the expected welfare gain from higher quality is larger than the expected increment in costs. This can alternatively be written

$$\gamma(1-\gamma)\frac{V^2}{4k}\left(1 - \frac{1}{3}\gamma\right)\left(\frac{9-5\gamma}{36}\right) > 2k(1-\beta)^2. \quad (83)$$

The difference in the expected value of what is produced in the perfectionist and lazy equilibrium respectively has to be higher than the sunk cost to the individuals which is incurred when they practice. The sunk cost is times two, since both individuals practice in the perfectionist equilibrium.

This condition allows us to make two observations. First, comparing with the difference in equilibrium payoff between the perfectionist and the lazy equilibrium

$$\gamma(1-\gamma)\frac{V^2}{4k}\left(\frac{9-5\gamma}{36}\right)^2 > k(1-\beta)^2, \quad (84)$$

one can show that from a welfare point of view the perfectionist equilibria will be preferable tp the lazy for a larger range of parameter values than from the individuals point of view. Hence, at a point when the individual would be better off in the lazy equilibrium due to the cost of practice, it would be better from a welfare point of view if he did not switch.

Second, whether or not the individual switches depends on whether the lazy strategy would give a higher payoff if the other palyes plays the perfectionist strategy. Rearranging terms this can be written in a form similar to (35),

$$\gamma\left(\frac{3-\gamma}{6}\right)\left(\frac{9-5\gamma}{36}\right)\frac{V^2}{4k^2} > \frac{1-\beta}{1-\alpha}. \tag{85}$$

When $\beta < 1/2$, there is either a perfectionist or a lazy equilibrium. Social and private incentives for perfection coincide if

$$\gamma\left(\frac{3-\gamma}{6}\right)\left(\frac{9-5\gamma}{36}\right)\frac{V^2}{4k^2} = \left(\frac{9-5\gamma}{36}\right)^2\frac{V^2}{4k^2} \tag{86}$$

which can be simplified to

$$\gamma^2 - \frac{23}{6}\gamma + \frac{3}{2} = 0. \tag{87}$$

This equation has two roots. The positive one can be ruled out since it is outside the domain of γ. The negative root is

$$\tilde{\gamma} = \frac{23-\sqrt{313}}{12} \approx \frac{1}{2}. \tag{88}$$

For $\gamma < \tilde{\gamma}$ the social incentive is stronger than the private, i.e. *genie oblige* and for $\gamma > \tilde{\gamma}$ the social incentive is weaker, i.e. the best is the enemy of the good.

Is the perfectionist equilibrium ever preferable to the enthusiastic equilibrium?

$$\gamma\frac{54-22\gamma}{72}V[s_P - s_E] + 2k[s_E^2 - \gamma s_P^2] - (1-\gamma)^2\left(\frac{54-22\beta}{72}\right)\beta V s_E > 0 \tag{89}$$

First effect is the higher quality in the perfectionist equilibrium. Second effect is the difference in cost. Third effect is the fact that there will be some production of the good even if the individuals fail in achieving perfection.

The first effect is positive. The second effect is positive if $s_E^2 - \gamma s_P^2$ which is true if

$$(1-\gamma)[(9-5\gamma)[9-5\alpha(1-\beta)-15\beta] + 25\beta^2(1-\gamma)] > 0 \tag{90}$$

This condition is satisfied as long as β is not too close to one. Hence, the more reliable production will compensate for the higher cost of quality in the perfectionist equilibrium as long as reliability is not too high a priori. The third effect is however negative, since it is the welfare gain from having the good materialising more frequently thanks to the enthusiasm of those who failed. Hence, it depends on which effect dominates.

The enthusiastic equilibrium has a higher expected payoff if $W(EE)-W(LL) > 0$,

$$(s_E-s_L)\left[\gamma V\left(\frac{3}{4}-\frac{11}{36}\gamma\right)-2k(s_E+s_L)\right]+(1-\gamma)^2\left(\beta^2\frac{4}{9}+2(1-\beta)\beta\frac{3}{8}\right)Vs_E-2k(1-\beta)^2. \tag{91}$$

5 Conclusion

This paper has answered the question why perfection tends to happen when it is hard and rare to be able to achieve. Furthermore, by answering this it has also provided a rationale for changes in terms of to what extent individuals aim for perfection in their skills and the standards of quality they aim for as professionals, and finally to what extent a highly skilled profession remains or ceases to exist.

The results were derived in a highly stylized model, which the author believes to be the simplest representation of the intuition behind the results. In this concluding section the various assumptions will be discussed in turn.

The assumption that the individual faces the same opportunity cost of time when acquiring skills as when working is not crucial for the result. Different costs here would only add complexity to the model without changing the results. Quadratic opportunity cost of time is the reason why we get critical values of one half. It does not affect the qualitative results. The assumption that the probability of being able to achieve perfection in skills is the same as the probability being able to deliver professionally without practice is not limiting either. We can get the same results when these probabilities differ. Having only two players is also for analytical convenience. The intuition that there will be less competition if it is harder to achieve perfection would still be valid with more players, since when we have Cournot competition there will be a non-linear reduction in profits as the number of competitors increase. Hence, the two player case is the simplest possible scenario which captures the effect of different levels of competition. The assumption on the demand side of linearity again only affect parameter values and have no qualitative impact.

The assumption is made that unless practising for perfection is successful reliability will not be improved. This captures situations where failing despite practising is an indication that the way the individual practices is not effective and therefore a pure waste of time.

The assumption which deserve a more detailed comment is the discrete nature of reliability of skills. The author has also solved the problem where the reliability is a continuous choice variable, and derived conditions under which there will be a corner solution. i.e. if she practices she will aim for perfection. Again we get in this case a more complex model with the same qualitative results. Hence, it is the simplest model which captures the qualitative results of more realistic and complex models of the same problem.

Adding a bit of complexity could generate some additional insights by allowing comparative statics for a larger set of parameter values, but would not change the fundamental insight.

The model does reflect received wisdom by having an element of *beginner's luck*, i.e. you can get it right without practice, but you may fail completely if you try again. Hence, the model describes a situation where practice is about making ones skills more reliable rather than being able to do it at all. This feature gives rise to a situation in which the very high standards that the perfectionist will aim for, will prevent anyone else to attempt it unless they have achieved perfection as well even though welfare would be higher if they did, i.e. *the best is the enemy of the good*. Furthermore, it encapsulates a quote by Franz Liszt that *genie oblige*. Even though a genius is guaranteed to achieve perfection if he aims for it, facing a higher probability of being a genius will make the individual lazy and practice less. Unless the individual is told 'genie oblige', e.g. if you can do it, you should do it, he may choose not to.

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