

Collaborative is Superadditive in Political Economics

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The nature of research in economics has changed a great deal in the last century. The locus of expertise has moved from Europe and most notably the UK, to the USA. Books have overwhelmingly been replaced by journal articles and discussion papers, including postings on the web. Grand theorizing and words get much less attention these days; empirical analyses and mathematics get much more. Whereas lone authors were once the norm, the most important research these days usually has multiple authors. This last phenomenon is the subject of this chapter and of this book.

This chapter first presents some numerical evidence on the trend in economics toward multiple authors. Then it provides potential explanations for the profession's move from mostly single-author works to mostly multiple-author works. Subsequent sections present a model of the production process for works with multiple authors. The model informs a discussion of why collaboration might be pursued insufficiently, and of ways to secure maximum value from collaborations.

Let me apologize in advance. A number of the arguments in this chapter are speculative, relying on personal assessments of the nature of the collaborative process. They are based on my own heavily collaborative

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research career, on anecdotal evidence from others, and on what might be called back-of-the-envelope empirical investigations, accomplished, for example, by scanning the tables of contents of leading journals. This chapter argues that collaborations, particularly those involving individuals with different backgrounds and training, have great potential, much of which is not realized. This chapter makes the general argument that attempting collaborations provides option value; that is, if collaboration looks promising, it can be repeated. To those who are contemplating their first professional collaboration, in the spirit of this chapter my principal advice is: "Try it; you may like it."

11.1 EVIDENCE OF INCREASING COLLABORATION

In economics, as in most professions, the ordinary seek to emulate the extraordinary. Those who chronicle the profession also look to the high outliers. Recognizing all the biases entailed, I provide evidence of collaborative activity by the winners of the Nobel Memorial Prize in Economics (Nobel Prize) and by the much younger winners of the John Bates Clark Award. My goal is to examine the trend in collaboration over a period of several decades.

Let us begin with Nobel Prize winners, for whom I expect the number of collaborations to increase over time. However, since the Nobel is awarded to individuals of different ages, holding the year of the prize fixed, I expect older winners, who presumably also worked in their younger years, to have fewer collaborations. Note, we refer to collaborations, not to the number of collaborators. Figures 11.1 and 11.2 show the number of collaborations for Nobel Prize winners for their single most cited and for their ten most cited works, respectively. The upward trend is clear in both graphs. Notably, none of the first ten Nobel Prize winners had any collaborators on their single most cited work. The graph for each winner's three most cited works, not shown, gives a very similar impression.

Let c_i represent the number of collaborative works among the i most cited, $i = 1$ and 10 , x_1 the number of years since the first year of the Nobel Prize, and x_2 the Nobelists' ages in the year of the award. The equations giving the number of collaborations are:

$$c_1 = 0.52963 + 0.00682x_1 - 0.00721x_2$$

$$c_{10} = 7.34062 + 0.08931x_1 - 0.08518x_2$$

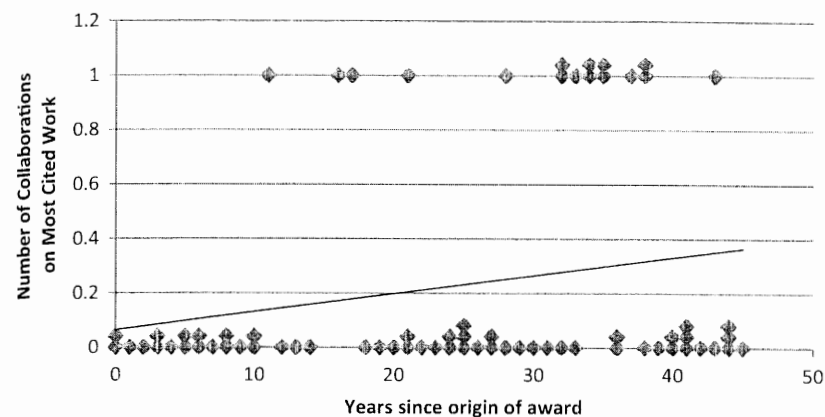


Fig. 11.1 Collaborations on Nobel Prize Winners' Most Cited Work

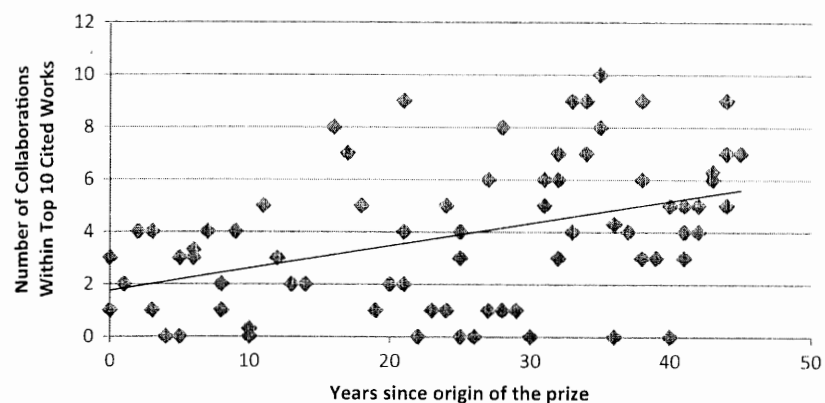


Fig. 11.2 Number of collaborations Within Nobel Prize Winners' Ten Most Cited Works

For c_1 , the number of elapsed years barely misses significance at the 0.05 level ($z = 1.958$); for c_{10} it is significant well beyond the 0.001 level. Age is significant for c_{10} at the 0.05 level, but is not significant for c_1 .¹

For the John Bates Clark Award, the two figures are similar to those for the Nobel Prize (Figs. 11.3 and 11.4).

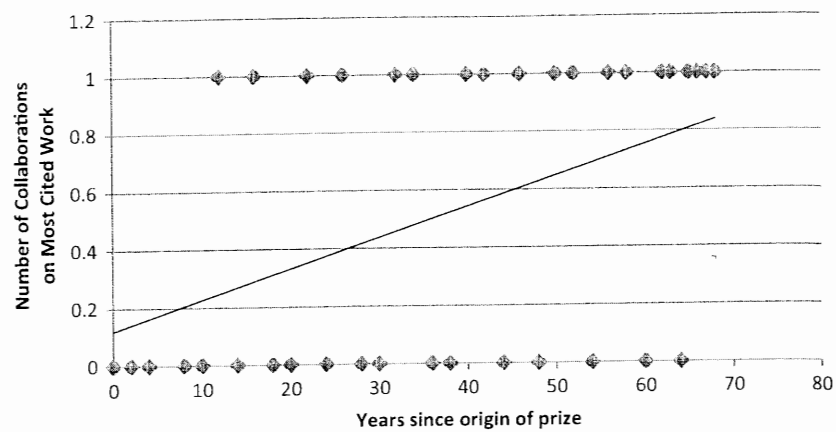


Fig. 11.3 Collaborations on John Bates Clark Award Winners' Most Cited Work

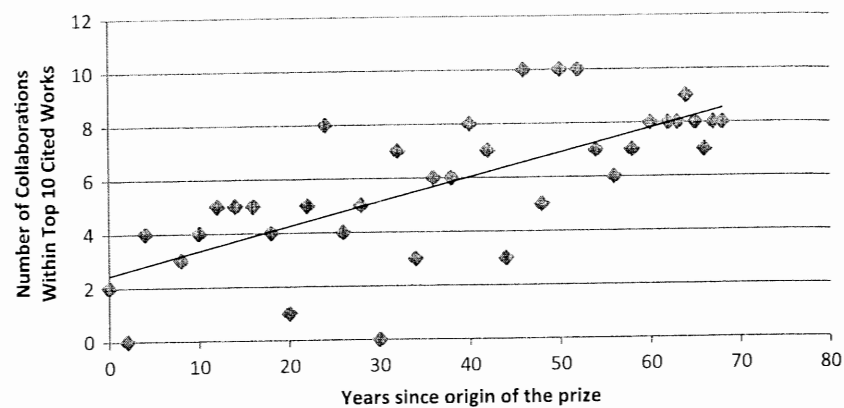


Fig. 11.4 Number of collaborations Within John Bates Clark Award Winners' Ten Most Cited Works

The Clark Award is given to individuals younger than 40; the winners are almost always close to 40 in age. Not surprisingly, age is never a significant explanatory variable; hence x_2 is not included in the regressions below. Let C_i represent the number of collaborative works among the i most cited, $i = 1$ and 10, and x_1 the number of years since the first year

of the John Bates Clark Award. The equations giving the number of collaborations are:

$$C_1 = 0.11995 + 0.01056x_1$$

$$C_{10} = 2.45989 + 0.08918x_1$$

For both C_1 , years are significant at the 0.005 level; for C_{10} , it is significant at well beyond the 0.00001 level.² As we would expect, for both Nobel Prize and John Bates Clark Award winners, the results are much more significant for the ten most cited works, given the greater data available.

Within both these extremely high prestige groups, there has been a strong trend toward increasing collaboration as the years have progressed.³

11.2 EXPLANATIONS FOR INCREASING COLLABORATION

Why has collaboration become much more the norm in economics? I believe that there are many factors. I shall identify just a few.

The need for specialization. The great economists of olden times mastered many disciplines or at least many areas of economics. Samuelson, Arrow, Friedman, Simon, Becker—to identify just a few American pioneers—were all masters of many realms within economics, and indeed often of realms in related disciplines. However, the advance of the field has called for specialization, as it has in so many domains, such as mathematics and medicine. The great emphasis on empirical work today has made it more effective to work in teams. Whereas a Friedman, a Samuelson, an Arrow, a Simon, or a Becker could make his greatest contributions merely by sitting in his office and thinking, most contemporary stars work with large data sets. When Friedman did turn to empirical work, in his *A Monetary History of the United States, 1867–1960*, he teamed up with Anna Schwartz, a data adept (Friedman and Schwartz 1963).

Two of the original American economics prize winners, Kuznets and Leontief, might seem to be exceptions.⁴ They are noted for contributions that led to vast amounts of empirical work. Moreover, both scholars loved delving into real-world numbers. However, their major lasting contributions came from the methods and frameworks they developed individually. Kuznets created a sound basis for national income accounting, and Leontief invented input-output analysis.

Why has economics become both more specialized and more empirical? One possible explanation would be that the problems that are simultaneously important, conceptual, and tractable have disproportionately been solved. A second explanation could be that we now have access to data and the ability to process information in ways that did not exist when our predecessors made their major contributions. This suggests a Says Law of research methodology: when new methods become available, they will be used disproportionately. A third possibility would be that the advent of the personal computer, the Internet, and file sharing has dramatically lowered the cost of collaborative research investigations. When conducting large-scale data-gathering investigations, for example, collaboration is often essential. This has proved particularly true in the burgeoning field of behavioral economics, where data from laboratory and field studies⁵ is the raw ingredient required to produce a successful product. A fourth conjecture is that the nature of advancement in the profession has changed. The pressures to publish or perish have become ever greater. And for getting publications out quickly, many hands make swift work.

I will argue that each of these four proposed explanations helps to explain why economics has become more collaborative. The discussion thus far might suggest that the choice to collaborate is a highly rational process; for example, when A and B are deciding whether to work together or work separately, they simply examine the production and credit functions and pick the mode of organization that yields the most value. An alternative model, leading to much the same conclusion, would be that processes akin to natural selection, with just a little support from careful deliberation, play a role. Thus, skirting rational assessment, some economists simply try out various modes of producing research. Strategies that are more successful get more attention, lead to promotions, and drive out inferior methods. Careful deliberation operates when individuals look consciously to imitate the more successful research methods.

Either of these models might lead to optimal research methods, though the second would encounter some lag. The lag might be a product, for example, of the old-dog-new-tricks impediment. Informal evidence indicates that—reflecting time trends—young scholars are much more collaborative than their older colleagues. Those older colleagues may have more trouble adapting and modifying their work habits.

11.3 SUPERADDITIVITY IN PRODUCTION

We shall talk about researchers with different specialties, that is, different types, below. For now, consider a single type x , for example, a macroeconomist. Let $h(x)$ be what a single researcher can produce alone. Collaboration between two different x 's yields output $g(x,x)$. Our concern is whether collaboration is worthwhile, in other words where it is superadditive. Superadditivity can come from better, not merely more, research, and indeed even from less. Superadditivity would be represented as

$$g(x,x) > 2h(x) \quad (1)$$

If this condition holds, then two macroeconomists working together could produce more than twice the output of one macroeconomist working alone. This condition would apply for some individuals on some projects, but not for other individuals or other projects.

11.4 A MODEL OF COLLABORATION COSTS AND BENEFITS

We shall now allow for a second specialty (type), y , to illustrate an econometrician, and the possibility for a mixed collaboration between an x and a y . When shown as arguments in a production function, either variable represents a single researcher.

The concept of positive cross-partial derivatives drives a great number of phenomena in economics. Thus, for the function $z = f(K,L)$, with derivatives indicated by subscripts, such positivity would imply that $f_{KL} = f_{LK} >> 0$. This concept is particularly relevant in production theory. Thus, labor is more productive where capital is relatively more abundant, and vice versa. The same is true, I will argue, with collaboration in economics, and indeed in many realms. Disparate thinkers produce more when they are brought together.⁶

Think of a likely future economics paper, perhaps on the effect on low-skilled workers when the minimum wage is raised dramatically, a question of contemporary policy interest in the USA. I shall simplify discussion by assuming there are two macroeconomists who could get together and write an excellent paper. So, also, could two econometricians. But I would argue that if the collaborations encompassed different

specialties, with a macroeconomist and an econometrician in each, the prospect of making major contributions would be greater. I would also argue that the single-specialty collaborations would be more likely to emerge. Macroeconomists disproportionately keep company with macroeconomists, and econometricians with econometricians. Collaborating with one's familiars is easier, and probably more fun, at least at the outset. In economists' terms, it is cheaper.

Collaboration costs are certainly relevant. Benefits, however, are the other weight on the balance scale. Posit the following situation. The two types of researchers, x and y , are equally productive. To be crass, let us say they produce as many top-tier journal articles—when working in a single-specialty collaboration. Thus, output $g(x,x) = g(y,y)$.⁷ The output for an x,y collaboration is $f(x,y)$, and we are positing positive cross-partial derivatives, so that

$$f(x,y) \gg g(x,x) = g(y,y) \quad (2)$$

To simplify for now, we will assume that, in any collaboration, the participants share the benefits and costs equally. Any collaboration incurs a transaction cost, as in explaining to a partner one's thinking, or as in just agreeing on how to proceed. All collaboration costs will be measured as the total costs to the partnership. Represent those costs for a single-specialty collaboration as k_p . The collaboration cost for a mixed x,y collaboration is k_m , where we expect $k_m \gg k_p$. Represent the difference as $k_d = k_m - k_p$. Here k_d might represent the costs of explaining to one's collaborator the underpinnings of one's sub-discipline, of writing a joint paper when the styles of the two fields clash, and so on.

The optimal collaboration decision, assuming a one-time collaboration would be

Single-specialty collaboration if

$$f(x,y) - k_d < g(x,x) = g(y,y) \quad (3a)$$

Mixed collaboration if

$$f(x,y) - k_d > g(x,x) = g(y,y) \quad (3b)$$

Why might researchers not follow Eq. (3)? In particular, why might they continue with single-specialty collaboration when (3b) was satisfied? One possible answer, I believe, relates to hyperbolic discounting. The cost k of engaging in the collaboration is borne up front. We know that immediate costs get disproportionate weight relative to those that come later, a concept that we elaborate on in Section 7.

The strength of my argument that we see too few mixed collaborations in economics comes not so much from one-time collaborations, but from the multiple repeat collaborations that never happen. It may well be that for a single collaboration, k_d is large, so (3a) applies. Indeed, it could be that the first mixed collaboration yields negative value, that $f(x,y) - k_m < 0$. However, the initial k should be thought of as a price of entry. For any collaborators, once they have worked together, the cost of future collaborations will decline. Represent the costs of a particular collaboration in round i to be k_{mi} or k_{pi} . Thus,

$$k_{pi+1} < k_{pi} \quad (4a)$$

and

$$k_{mi+1} < k_{mi} \quad (4b)$$

Let us first consider (4a) by itself, and assume that only single-specialty collaborations are possible. Posit the empirical validity of (4a). If hyperbolic discounting leads researchers to assign to the immediate collaboration excessively high costs relative to the future value of collaborations, there will be too few single-specialty collaborations.

I am asserting a second key empirical fact: the costs of a mixed collaboration decrease faster than those of single-specialty collaboration. That implies that $k_{d+1} < k_d$. In short, even when a mixed collaboration might be less attractive than single-specialty collaboration on a one-time-only basis, as represented by (1a), a mixed collaboration might become preferable if there will be repeat collaborations. Of course, there is no reason why a researcher could not pursue both single-specialty and mixed collaborations, though time ultimately does become a constraint, as can timely subject matter.

In short, collaboration should not be thought of as merely a one-time process. Rather, there is the potential for investment in a collaborative partnership. The first trial with a collaborator may produce a net loss,

but as with many investments, it has the potential to pay off over time. Additional factors could reinforce this observation. For example, there could be some equivalent of mutual learning, in which a collaboration yields increasing value over time; that is, $f(x,y)$ or $g(x,x)$ or $g(y,y)$ would increase as the collaboration moves forward. We now turn to another reason why potential long-term collaborations might be worthwhile, though short-term collaborations might not be.

Option value in collaboration. My formulation thus far has ignored uncertainty, a salient feature of research. The potential of collaboration adds a further uncertainty: will coauthors work together effectively? To address this case, I will simplify and talk only about the net value of a unit of the collaboration, v , and will further assume that v stays constant over time, a conservative assumption for the pro-collaboration argument. Here v can be negative and costly or positive and enriching. If v were known, there would be a simple rule: proceed if v is positive. In virtually any real-world partnership, however, v will be unknown. Then, to initiate a collaboration would essentially mean purchasing an option. The implication is that, if the uncertainty regarding v is great, as with any option, it might be worthwhile to proceed even if the expected returns are negative. Uncertainty promotes option value.

Whether one should purchase the option will depend on risk aversion, the potential number of trials, and the discount rate. To simplify, let us assume risk neutrality, two trials, and a zero discount rate. There exists the potential for a collaboration whose payoff is uniform on $[-4, 3]$, implying an expected payoff of $-1/2$ on a single trial. There is a $4/7$ chance that $v < 0$; if so, the researchers will cease collaborating after one period. However, there is a $3/7$ chance that the first trial will reveal that the collaboration is beneficial, that $v > 0$. If so, the average payoff will be $3/2$ in any second trial. Thus, the expected return from the collaboration will be $-1/2 + (3/7)(3/2) = 2/14 = 1/7$. The collaboration will yield positive expected value. If the uncertainty regarding the value of the option is greater, holding its mean payoff fixed, as is true with any option, will increase its value. Thus, if v were uniform on $[-10, 9]$, it would also have an expected payoff of $-1/2$ on a single trial. However, the expected return from two trials together would now be $-1/2 + (9/19)(9/2) = 62/38 = 1\ 12/19$. Of course, if there could be dozens of future trials, the expected value of venturing into collaboration with uncertain payoff would be much greater.⁸ Conversely, a positive discount rate and/or risk aversion on the value of the option would diminish its value.

The real world, as would be expected, is much more complicated. It would presumably have the costs of collaboration declining over time, as modeled above. A single trial would not fully resolve the uncertainty about the period payoff to collaboration. Thus, there would be learning over time about the payoff, implying that it might be worthwhile to persist even if the first trial yielded a negative payoff. However, the central point that emerges from thinking about a potential collaboration in terms of purchasing an option is clear: it may be worth venturing a trial with a negative expected payoff in order to learn whether the payoff from future trials will be positive.

Moreover, leaving aside risk aversion and holding the mean payoff fixed, the greater the uncertainty about the payoff is, the more worthwhile it is to try out a collaboration. Empirically, this would seem to suggest, for a reason quite different from those considered above, that mixed collaborations deserve serious consideration. It is likely that uncertainties about their payoffs are greater than for single-specialty collaborations. Given that the future value of such an option would increase with the number of future trials, young scholars should be particularly eager to try out collaborations. That lesson is reinforced if, as posited above, the costs of collaboration decline with time.

11.5 SUPERADDITIVITY IN CREDIT

Of course, the collaborative authorship approach would only make sense if at least one of the two following conditions existed.

- A. The production process was superadditive. That is condition (1); two individuals working together produce more than twice the value of research of the two individuals working alone. (Note the use of the word "value" and not "quantity.")
- B. The credit process was superadditive. That is, an individual producing nine papers with two coauthors was more richly rewarded than by alone authoring three papers.

A. Credit in Collaborations. The allocation of credit is one of the most troubling issues in collaborative efforts. Perhaps more accurately, the question should be what practices should be employed, such as in the way authors are listed, to convey credit. Different disciplines have different practices. In economics, authors are usually listed alphabetically, unless

there have been disproportionately significant contributions. In psychology, medicine, and many other scientific fields, most collaborative efforts list the principal contributors first and the heads of the labs last, with the heads getting named even if they made no intellectual contribution to that particular project. The disproportionate-contribution principle of economics not infrequently leads to conflict. Collaborator B thinks she has contributed enough more than A to be named first, but A thinks not; he may even think that he has contributed the lion's share. Parceling out credit is particularly difficult if B supplied the theory and A the empirical work, and if, as might seem natural, each rates her/his own realm as more important. Kahneman and Tversky (1979) were listed in that order for "Prospect Theory," but as Tversky and Kahneman (1974) for "Judgment under Uncertainty: Heuristics and Biases." These are their two best-known articles. Richard Zeckhauser, the current author, despite being alphabetically challenged, virtually always lists names on collaborations in alphabetical order. Listing order becomes particularly important when there are many authors on a paper. When A and B write a paper together, usually both authors will be indicated in citations. However, when A, B, C, and D produce a paper, perhaps with authors listed alphabetically, the paper will often be referred to as A et al.

Nevertheless, some highly successful economic teams have now worked out the arrangement of always listing all members alphabetically, even though the contributions of different members may vary considerably from project to project.⁹ This approach has two major benefits: (1) It avoids all conflicts over credit and (2) it announces that listing order does not involve contribution fraction.

Departing from the listing question, why is credit likely to be super-additive? That is, when A and B collaborate, why should both of them end up with, for example, 60% of the credit? The answer lies in a straightforward extension of the phenomenon of egocentric biases in availability and attribution.¹⁰ A significant experimental literature has shown that, when assessing credit for a group project, one's own contributions are more easily available than those of collaborators. Thus, individuals tend to assign to themselves greater credit for a successful group project than do their team members. Now consider credit given to two young collaborators, A and B, a theorist and a development economist, both hoping for promotions. When outside evaluation letters are sent out to theorists asking about A, the respondents will be much more familiar with A and will be

better able to recognize his contributions. Being more available, A will get disproportionate credit from them for the contribution. The same will be true for B. Her development economist respondents will find her more available, and will give her the lion's share of credit.

Let me add a further speculation following this logic: the phenomenon of superadditive credit will be greater the more disparate the collaborators are. Thus, superadditivity will be more extreme for scholars from different universities, who attended different graduate schools, who have different specialties, and so on. That is because the greater the disparity among collaborators is, the greater will be their differences in availability to the various judges. In a collaboration across fields, not merely specialties, I was fortunate to write *The Patron's Payoff: Conspicuous Commissions in Italian Renaissance Art*, with Jonathan Nelson, an art historian (Nelson and Zeckhauser 2014). Jonathan's colleagues did not have the slightest familiarity with me or with economics and gave him 80% of the credit. My fellow economists were equally unfamiliar with Nelson and art history. They gave me most of the credit, though a few might have examined the deep art history in the book and properly assessed my inadequacies.

In short, I am arguing that, holding the size of the contribution fixed, there will be significant superadditivity in credit just because those who are judging A will know A better and those judging B will know B better.¹¹ This phenomenon will be more pronounced on average for mixed collaborations. Let me now leave credit aside, and turn to the productivity of collaborations.

11.6 PRODUCTIVITY IN MIXED COLLABORATIONS IN MUSIC AND IN ECONOMICS

Collaborations in Popular Music. Given the statistics for economics presented above, where the trend has been strongly toward more collaboration, it is likely that the great collaborations in economics mostly lie in our future. That gives me latitude to illustrate my main point—that mixed collaborations have strong potential to be superadditive—by drawing on famous collaborations in the field of popular music.¹² Many extremely famous mixed collaborations arise in the field of popular music. Both music and lyrics are required, and a star at lyrics may not be a star at composition. Yet the two must be blended in tight form. The paired names of Gilbert and Sullivan and of Rogers and Hammerstein almost seem inseparable,

though Rogers and Hammerstein each had successful collaborations with others. The Gilbert and Sullivan collaboration was not only prolific, with Gilbert on lyrics and Sullivan on music, but also often troubled. The two men had personalities that clashed, and quite differing political orientations, the latter a considerable handicap given that their shows satirized central features of British society.

Lennon and McCartney, often Lennon–McCartney, had the basic songwriting responsibilities for the Beatles. However, their songwriting collaboration was far from typical. Both were skilled at composition and lyrics; many of their collaborative songs were primarily, though rarely exclusively, the work of one or the other, though they were always co-listed as creators.

The Lennon–McCartney collaboration, like that of Gilbert and Sullivan, was mixed in terms of personalities. It was also a mingling in approaches to work. Cynthia Lennon, John's first wife, said: "John needed Paul's attention to detail and persistence. ... Paul needed John's anarchic, lateral thinking."¹³

Mixed Collaborations in Economics. The most famous collaborations of economists, I am confident, have involved diversity along a variety of dimensions beyond specialty, including personality and work habits. For example, Milton Friedman was a highly gregarious, eager debater. He had a remarkable propensity for conceptual formulation, a passion for simplification, and great powers of public persuasion. Anna Schwartz, by contrast, exemplified the quiet scholar. She was known for working exceptionally long hours in her office, where she deployed her remarkable skills in assembling, reviewing, and distilling vast amounts of information.¹⁴

Two other collaborations that greatly influenced economics deserve mention as mixtures. Von Neumann–Morgenstern represented the pairing of a brilliant mathematician, one of the great minds of the twentieth century, with a highly capable economist. It is doubtful that their monumental *Theory of Games and Economic Behavior* could have been written without both disciplines and both individuals (von Neumann–Morgenstern 1944). Kahneman and Tversky deserve credit for ushering in the behavioral revolution into economics. Though both were eminent scholars in the same field, their personalities differed substantially. Amos had a quick and playful demeanor; he leapt to insights. His manner reminded me of many a leading economist. Danny has the aura of a deeply reflective soul, of a philosopher. He is well possessed of the virtue of slow thinking. To this outside observer,

he seemed much more inclined to behavioral tendencies than Amos.¹⁵ One might speculate that to identify basic behavioral phenomena to investigate, Danny would make decisions, and he and Amos would then conducted a post mortem.¹⁶ These remarkable psychologists cross-fertilized the formerly walled-off field of economics. They set the stage for the economists who now regularly collaborate with psychologists and neuroscientists to gain insight into how individuals make economic decisions.¹⁷

Collaborators of Uneven Prominence, Experience, and Skill. Much collaboration in economics involves individuals of quite different degrees of prominence, for example, faculty members and students, or full professors and junior professors. Within economics, unlike in many scientific disciplines, this rarely involves the unsavory practice of high-status individuals just attaching their names to the works of more junior people who are beholden to them, perhaps because they are thesis advisors. Collaboration across a hierarchy also may entail greater costs than, for example, having two junior faculty members working together, but it may offer the productivity benefits of a mingling of individuals with quite different perspectives on the world or quite different skill sets. Thus, a senior faculty member might bring a broad-based view of the world and the ability to relate a paper to a range of subjects, whereas the junior faculty member might contribute greater energy and technical skill. Superstars often benefit greatly working with lesser known stars, as did von Neumann and Friedman when they collaborated, respectively, with Morgenstern and Schwartz. To return to our model, collaboration is worthwhile if $f(x,y) > h(x) + h(y)$; and that holds true even if $h(x)$ is extremely large relative to $h(y)$.

Size of Teams. Casual empiricism suggests that the size of teams has grown alongside the frequency of collaboration in economics. Intuitively, the forces that make two heads better than one, are likely to raise the comparative advantage of three heads relative to two, and so on. The limiting factor is that coordination costs probably rise more than linearly with the size of the team. Just as there is an optimal scale for a firm, depending on its product, there is an optimal size for a collaborative team addressing a particular problem. In some disciplines, collaborative teams can be extremely large, a phenomenon not yet apparent in economics. As an extreme example, a May 2015 paper in *Physical Review Letters* reported on findings from the Large Hadron Collider regarding the Higgs boson; it listed 5154 coauthors (Aad et al. 2015).

11.7 SUBOPTIMAL LEVELS AND MODES OF COLLABORATION, SOME BEHAVIORAL EXPLANATIONS

Hyperbolic discounting, mentioned above, is a descriptive concept arguing that, in practice, individuals employ discount rates that decline as they project to a more distant future. One version of this model posits that there is a big discount between current period 1 and period 2; however, after that per-period discount rates are both much lower and constant. Thus, an individual might insist on \$125 in a month in exchange for \$100 today, but for $t > 1$ would exchange \$100 for month t in the future for \$102 in month $t + 1$.¹⁸ There is considerable empirical evidence for such behavior. For example, it represents the underpinning of the propensity to procrastinate on worthwhile projects that incur an up-front cost, since that cost will be "overvalued" relative to future benefits.

Collaboration is just such a worthwhile project entailing up-front costs. For more diverse collaborations, those up-front costs are greater as, for example, the theorist learns to speak the language of the development economist. If the discount factor from today to tomorrow is large enough, a worthwhile collaboration will never happen. One might argue that if one really feels this discount, then the collaboration should not happen. That argument would appeal to those who think that the descriptive (of reality) should necessarily be normative. That is a view that I reject.¹⁹ We have many natural tendencies that we would like to overcome, such as failing to watch the ball in tennis, leaning uphill when skiing, or overspending instead of saving. Often knowledge of such tendencies is sufficient to put one on a path to overcome them. That is the purpose of this section, which seeks to encourage readers to collaborate when they might not otherwise do so.

There is a second behavioral shortcoming, much less documented than hyperbolic discounting, that also leads to inadequate steps into new and, particularly, mixed collaborations. The failure to recognize option value is a costly deficiency in most people's intuitive apparatus. For example, a physician puts a 50-year-old man on a statin drug, expecting on average a 25% reduction in his cholesterol reading. The reduction proves to be 19%. Yet the doctor and patient usually continue with the same drug, although an alternative statin might achieve the 25% reduction. The trial period is brief, the individual will be on the statin for the rest of his life, and there are many slightly different cholesterol-lowering statins available. The option value of trying a second statin is not recognized.

Similarly, the success of collaboration with a new partner is a highly uncertain venture. Maybe the partners will not work well together. Maybe their ideas will clash. Maybe the new partner will prove to be a shirker. But then again, maybe the collaboration will lead to significant success, and then further collaborations can be undertaken with the same partner. Holding the expected payoff fixed, the more uncertain the payoff, the greater the value of the option.²⁰

11.8 CONCLUSION

Economics is moving strongly toward more collaborative production. That is significantly due to the evolving nature of the field, away from seminal achievements by individuals who worked across broad swaths of the field, and toward much more specialized investigations requiring more technical skills, more data gathering, and more heavy lifting requiring teams of investigators. In this regard, economics is following the trajectory of many experimental sciences in which research teams are now the overwhelmingly predominant mode of production.

This chapter provided evidence on this trend toward collaboration by looking at the output of the most celebrated economists, those who won the Nobel Prize and the John Bates Clark Award. It then laid out a conceptual model of the collaboration process. It highlighted various famous collaborations, examined the advantages of mixed collaborations, and identified factors that might inhibit the use of collaborations.

This author's advice, as stated at the outset, is: Collaboration—try it; you may like it.

NOTES

1. The respective standard errors for the coefficients on x_1 and x_2 are 0.00349 and 0.00572 for c_1 , and 0.02094 and 0.03439 for c_{10} .
2. The respective standard errors for the coefficients on x_1 are 0.00365 for c_1 and 0.01507 for c_{10} .
3. A conceivable alternative explanation, of course, is that the award committees previously were much more oriented toward single-author work. However, I have found no evidence to that effect.
4. Of these seven mentioned early pioneers, only Arrow is still among us. Now in his mid-90s, he continues dispensing sought after insights.

5. Field studies oriented toward behavioral explanations are particularly prevalent in development economics. Senior scholars often engage a cluster of junior collaborators to conduct such investigations.
6. See *The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies*, by Scott E. Page (2007), which posits that, because diverse groups of people bring to groups or organizations more or different ways of seeing problems, they produce better ways of solving them. The book pays considerable attention to intellectual problems.
7. Given that research is involved, output should really be thought of in stochastic terms, so these production functions might be expected values. Given the competitive nature of much of research, it might even be that greater uncertainty in output is beneficial. And, of course, the value of output is some function of both quality and quantity. The reader is asked to forgive the simplifications here, which do not obscure the basic argument.
8. A more sophisticated formulation would allow for an error term about v with each trial. Thus, there would be further, but steadily reduced, learning after the first period.
9. For example, James Choi, David Laibson, and Brigitte Madrian had produced 22 joint articles and 11 book chapters as of August 2015, a number in conjunction with other authors. They always employed alphabetical order when it was just the three of them.
10. A pioneering article is “Egocentric Biases in Availability and Attribution,” by Michael Ross and Fiore Sicolu (1979).
11. This will even be true for two people in the same specialty if A is at University C and B is at University D.
12. Of course, the empirical researchers among the readers will object to a selection effect. The individuals would never have gotten famous for collaborating had they not had a successful collaboration.
13. Quoted in “The Power of Two,” by Joshua Wolf Shenk (2014).
14. Milton Friedman also greatly enjoyed engaging with numbers. Private communication with Jan Friedman Martel, Milton’s daughter, August 6, 2015. The nature of his collaboration with Schwartz reflected comparative advantage.
15. Kahneman (2011) remarks on a productive style difference with his within discipline coauthor: “Amos was the more logical thinker,

- with an orientation to theory and an unflinching sense of direction. I was more intuitive and rooted in the psychology of perception, from which we borrowed many ideas.” *Thinking, Fast and Slow*, p. 6.
16. Michael Lewis, who is writing a book on their collaboration, concurred in this speculation.
 17. Richard Thaler (2015), *Misbehaving: The Making of Behavioral Economics*, delightfully recounts much of the story of the penetration of the economics fortress and the subsequent cross-disciplinary collaborations.
 18. David Laibson (1997).
 19. It is disturbing that some bands of behavioral economists argue that what is descriptive should be defined as normative, though—like all behavioral economists—they delight in poking holes in the more traditional economic view that what theory says is normative will also be descriptive; that is, that decision makers are rational.
 20. I am simplifying by leaving aside risk aversion. However, it is not likely to be a major consideration since the participants are not making a major commitment.

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