



CROWE Graduate Scholar Series #3

Optionality and Major Choice*

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Executive Summary

- This paper introduces the concept of optionality through the example of college major choice to build intuition, then presents Weitzman's framework as a formal measure and illustrates how this concept arises in a variety of contexts, from a firm developing new technology to a dairy farmer trading options in Chicago's Class III milk market.
- When optionality is taken into account, uncertainty shifts from being a risk to a source of value, because exploration reveals information that creates opportunities and improves decisions. The greater the uncertainty, the more there is to learn, and the higher the potential value of exploration.
- Weitzman's reservation value offers an intuitive yet formal measure of optionality, which we relate to option pricing methods in financial markets, such as the Black–Scholes model.

Introduction

Each fall, students arrive at UW–Madison and face a practical question: which major to pursue. Some have a plan; many are unsure. The decision takes time and effort, and outcomes aren't known up front. Should they pick a major with strong job prospects, follow their interests, or wait and gather more information? This white paper highlights the economics of that choice—how to weigh trade-offs under uncertainty, why testing high-potential options early can help, and when it makes sense to wait for more information before committing.

Choosing a major is more than an academic formality — it is a commitment of time, money, and effort to a path whose rewards and challenges will only become clear over time. Students often face a wide range of possibilities: some majors promise higher earnings, others align more closely with personal interests, and many fall somewhere in between. Deciding among them means weighing uncertain outcomes against the limited time available to complete a degree. In practice, the process unfolds gradually as students progress through the requirements of a major. They declare an intended field, begin taking the required introductory courses, and only later commit fully once they advance into specialized coursework. Along the way, many adjust their trajectory—discovering that an initial plan may not fit their abilities or interests and redirecting their efforts toward another field. Introductory classes provide a chance to test the waters, giving students an early glimpse of what a discipline demands and what rewards it might offer. Those early results often guide the decision to continue investing time in a major or to change direction before the commitment deepens. This process of trying, observing, and then deciding captures the principle of optionality—the value of exploring opportunities without full commitment, and the ability to adjust decisions as new information emerges—a concept central to economics.

This white paper explores how understanding the idea of optionality can guide decision makers toward better choices in uncertain environments, and what lessons can be drawn from both academic research and real-world cases. Our analysis builds on Weitzman (1979), adapting the logic of sequential exploration to the context of higher education, where major choice serves as a central example, and draws on Chade et al. (2014) to illustrate a parallel case from college admissions.

The Challenge of Choosing a Major

For most undergraduates, deciding on a major is the single most consequential academic choice they will make. A major structures course schedules, determines the peers and faculty with whom students spend most of their time, shapes early career opportunities

after graduation, and defines the skills students will develop. Some majors emphasize broadly applicable abilities—like problem-solving or data analysis—while others cultivate more specialized expertise that shines in particular fields. In either case, the decision sets the foundation for much of a student's academic and professional life. The choice, however, is rarely straightforward.

High school students entering college often carry broad impressions about majors: engineers are thought to earn more than artists, and computer science is considered a “safe bet” compared to philosophy — although this too may change in this new AI era. White Paper #2 (Guo et al., 2024) documents how these differences play out at UW–Madison, reporting median estimates of the internal rate of return by major that range from 3.6 for Area/Ethnic/Cultural/Gender Studies to 29.5 for Computer and Information Sciences. These differences highlight the stakes of major choice. But even this across-major view does not capture the full uncertainty students face. Outcomes can vary widely even within the same field. Among UW–Madison graduates, the interquartile range of first-year earnings is about \$21.7k for Engineering compared with \$17.2k for Psychology (in 2020 dollars).[†] This data illustrate how two students with the same degree can still experience very different economic outcomes. This variation often reflects how well a student's abilities fit the demands of the discipline—something that only becomes clear through coursework. Excelling in a field like psychology may open more opportunities than struggling through computer science, even if the latter is often seen as a safer option. Finding the right match between skills and major can therefore matter as much as the choice of major itself.

Weitzman's Insight: The Value of Keeping Options Open

How should students approach decisions when outcomes are uncertain and only revealed gradually? Economist Martin Weitzman (1979) offered a simple but powerful idea. His central insight is that the value of an alternative lies not only in its own expected return, but also in the information it generates when explored. Some choices may not look appealing at first but are worth pursuing because they can uncover unexpectedly high rewards. Others may seem attractive but contribute little additional information even if explored. Weitzman introduced an easily computed index, known as the reservation value, which incorporates both expected returns and the value of optionality.

In our college major choice example, consider a student planning to major in psychology. An introductory family studies course is necessary for progressing in that direction, but it has low optional value. No matter the outcome, the student's trajectory remains largely the same: doing poorly is uncommon and rarely dissuades students from continuing,

[†]Interquartile range of first-year income by major for UW–Madison bachelor's degree recipients, 2016–2018 cohorts. Source: U.S. Census Bureau, Post-Secondary Employment Outcomes (PSEO).

while doing well simply confirms the intended path. By contrast, an introductory computer science course has high optional value. Although it does not by itself prepare a student for a career in programming, the outcome can be decisive: strong performance may reveal an unexpected aptitude and prompt a change of major, while weak performance still leaves the psychology path open, since the credits count toward general requirements.

This is precisely the option value that Weitzman emphasized: exploration is worthwhile because it keeps options open until enough is learned to make a confident commitment. Evaluating alternatives by their optionality also reduces the regret of unexplored paths, since those left aside are precisely the ones with the lowest optional value. For instance, a student might rank computer science above psychology in optionality, and psychology above linguistics. Once computer science is tried, the decision to move further depends on its outcome. If it proves unsuitable, psychology is the next best option. Linguistics, however, will only ever be reached if both computer science and psychology turn out to be poor fits—hence, when linguistics is not attempted, there is no real regret, because the outcomes from earlier majors have already shown they exceed what linguistics could reasonably offer. Weitzman formalized this logic by showing how option value of an alternative—what we call optionality—can be measured and acted upon.

To make his reasoning concrete, Weitzman proposed the analogy of Pandora's box. Each alternative can be imagined as a sealed box that, once opened, reveals what lies inside—but opening a box is costly. The decision maker — Pandora in this story — does not need to keep the reward from the first box she opens. She can continue opening boxes until she is satisfied, at which point she must claim one reward. Some boxes contain only modest prizes, while others may hold something extraordinary. The challenge is deciding the order in which boxes should be opened, and when to stop and claim a reward.

The solution to this dilemma is to give each box an “index” that reflects the optionality it offers, and to open them in descending order. Pandora continues until she finds a box whose contents exceed the index of all the boxes still unopened, at which point she claims that reward.

A simple way to think about these indices is to ask: how much would someone have to offer you to give up the chance to open this box? The harder it is to answer, the greater its optionality. By opening boxes in order of this value, a decision maker avoids wasting opportunities. In education, this means that a major's optionality is not about its average earnings, but about the chance that a student might discover they are among the top performers in that field—something visible only if they try.

A Famous Example: Madonna's Broadway Gamble

The concept of optionality becomes even clearer when seen through a real-world example out of college. In 1978, Madonna left her dance scholarship at the top ranked University of Michigan, where she had been studying modern dance, and moved to New York City with just thirty-five dollars in her pocket. There she worked odd jobs while continuing to train and pursued the dream of a career in performance. At the time, this was an extraordinarily risky choice, since few who entered performance at the time managed to earn a steady living.

To see the weight of that decision, it helps to consider what she gave up. In the late 1970s, graduates in Arts and Letters from Michigan could expect starting salaries of about \$10,386 per year (roughly \$24,525 in 2020 dollars).[‡] While not lavish, such earnings offered stability and the prospect of professional security. By contrast, New York's music and performance scene was far less forgiving: in 1979, about 71% of musicians and composers earned less than \$10,000 a year, barely scraping above the poverty line.[§] Madonna chose this latter risky path, stepping directly into professional performance, where outcomes were far more variable, rather than remaining on the steadier track a degree would have provided.

In other words, her decision was between low uncertainty with limited upside and high uncertainty with the chance of exceptional rewards. Young adults know they should take their risky career choice first, so that they have time to learn from the gamble — i.e. to maximize the optionality value. Framed in Weitzman's terms, this follows the logic of the index rule, where riskier options are explored first because their wider payoff distribution provides greater optionality.

Optionality in College Applications

The logic of optionality extends beyond the choice of major and can also be seen in how students apply to college in the first place. Chade et al. (2014) model the admissions process as a portfolio problem: prospective students face uncertainty about acceptance and must decide how many and which colleges to apply to. Because each application carries a cost, students balance “stretch schools,” which are less likely to admit them but promise higher returns, with “safety schools,” which provide insurance against rejection. The key insight is that once admission to a sufficiently attractive college is secured, applying to lower-ranked institutions adds little value, since those options would never be chosen in practice.

[‡]Michigan State University, Career Services and Placement (1986). Conversion to 2020 dollars based on U.S. Bureau of Labor Statistics CPI-U series.

[§]National Endowment for the Arts (1981), p. 99.

College applications highlight how optionality works in practice. Safety colleges serve as insurance, while stretch colleges hold out the possibility of unusually high returns. In this framework, the marginal benefit of adding another application reflects its option value—whether it contributes something not already covered by existing applications. If a college plays the same fallback role as another—for example, if two colleges both admit nearly everyone and offer similar outcomes—the marginal benefit of adding the second one is close to zero, so applying to both is wasteful.

A simple numerical example illustrates this. Suppose college *A* and college *B* each have an acceptance rate of 90%, and if accepted they provide a return of 1. Applying to either one alone yields an expected return of 0.9. Adding the second application, however, contributes very little:

$$0.9 \times 1 + 2 \times (1 - 0.9) \times 0.9 \times 1 = 0.99.$$

By contrast, pairing an easy-to-enter safety college with a more selective stretch college creates far greater optionality. Consider a college *C* with an acceptance rate of 10% that offers a return of 9. On its own, the expected return is the same as *A* and *B* ($0.1 \times 9 = 0.9$). But combined with a safety school, the portfolio's expected return rises substantially:

$$0.1 \times 9 + (1 - 0.1)(0.9 \times 1) = 1.71.$$

This optionality arises from the combination—the safety college provides insurance, while the stretch college preserves the chance of a much larger return.

In this context, college choices were simultaneous. Optionality is worth even more in a dynamic context. Suppose colleges offer “early decision” before college application season, where they can commit to a college. Where will they apply? Optionality now argues for the riskiest choice first. Not surprisingly, college students tend to apply early for one of their most ambitious stretch colleges.

Beyond Education: Optionality in Policy and Markets

While college majors provide a vivid illustration, the logic of optionality extends far beyond education. At its heart, optionality is about making sequential decisions in uncertain environments, where information arrives gradually and today's choices shape tomorrow's opportunities. Firms deciding which technologies to develop, investors choosing among startups, or policymakers piloting new programs all face problems structurally similar to that of students choosing majors. In each case, the challenge is to balance immediate payoffs with the value of keeping future paths open.

Consider a company choosing between developing a new smartphone model or entering the market for augmented reality headsets. Smartphones are a mature product with

predictable but limited returns, whereas augmented reality is far riskier yet holds the possibility of much greater rewards. Exploring the uncertain option first is often more valuable, since an early breakthrough can determine whether continued investment is worthwhile. Similarly, governments frequently launch pilot programs in education or healthcare before scaling them nationally—treating initial efforts as low-cost opportunities to learn before committing fully. In many domains, it is precisely the high-uncertainty choices that should be explored early. Success on these paths can render safer alternatives unnecessary; meanwhile failure still leaves them available.

Financial options provide a clear economic illustration of how markets assign value to optionality. An option is a contract that grants its holder the right—but not the obligation—to buy or sell an underlying asset at a predetermined price by a future date. A *call option* gives the right to buy the asset at the agreed price by the agreed date, while a *put option* gives the right to sell the asset under the same terms. Unlike forward contracts, which bind both parties to transact at a fixed price, options allow their holders to decide whether to exercise once uncertainty has been resolved. Because only the buyer has the right to make this decision, options provide protection against losses while preserving the opportunity to benefit from favorable outcomes; the option premium represents the market value of optionality itself.

The standard method for valuing these contracts is the Black–Scholes model (Black and Scholes, 1973; Hull, 2018), which expresses an option’s premium as a function of the underlying asset’s current price, the agreed exercise price (known as the strike price), the time to expiration, interest rates, and expected uncertainty. Its central insight is that an option’s value increases with both uncertainty and time: the greater the uncertainty about future outcomes and the longer the time horizon, the more valuable optionality becomes. In spirit, this logic mirrors Weitzman’s framework, though approached from the opposite direction. In Weitzman’s setting, the reservation value acts as a threshold pay-off—analogue to a strike price—that marks the level at which exploring an opportunity becomes just worthwhile for a given cost. Black–Scholes takes the reverse perspective, fixing this threshold (the strike price) and asking how much the right to act at that level is worth today, i.e., the option’s price. Put differently, Weitzman determines the threshold that justifies paying a given price, whereas Black–Scholes determines the price that corresponds to a given threshold. Both frameworks provide complementary ways of quantifying the same principle: that delaying action until uncertainty resolves carries economic value.

This logic is reflected in agricultural commodity markets, such as the Class III milk futures and options markets, which are traded on the Chicago Mercantile Exchange. The Class III markets allow dairy producers to hedge against future price fluctuations and manage

income risk. Class III milk refers to milk used primarily for cheese production, and it plays a central role in Wisconsin's dairy sector (Wolf and Widmar, 2014). Wisconsin is the leading cheese-producing state in the United States, and Class III milk accounts for most of its milk utilization. Prices are highly volatile, reflecting changes in global demand, feed costs, and agricultural policy. Because of its economic importance and price variability, Wisconsin farmers rely heavily on Class III markets to stabilize revenues.

To illustrate how farmers use these markets in practice, suppose the December milk price can end up in one of two states: low (\$17 per cwt) with probability 0.5, or high (\$21 per cwt) with probability 0.5. A farmer expects to sell 20,000 cwt and buys a put option with a \$19 strike price for a \$0.35 premium. Purchasing the option requires an upfront payment of \$7,000 ($0.35 \times 20,000$), which is non-refundable regardless of how prices evolve.

Without the option, expected revenue equals the average price, \$19 per cwt, times 20,000 cwt, or \$380,000. With the option, if the price ends up low, the farmer can exercise the put and receive effectively \$18.65 per cwt (the strike price minus the premium), resulting in \$373,000 in net revenue. If the price ends up high, the option expires unused, and the farmer receives \$20.65 per cwt, net of the premium, resulting in total revenue of \$413,000. The expected price with the hedge is therefore the average of the two net prices, \$19.65 per cwt, which implies expected revenue of about \$393,000. The put option sets a price floor while preserving upside potential, raising expected revenue and reducing downside risk.

Conclusion

Optionality offers a structured way to approach dynamic decisions under uncertainty. Prioritizing alternatives with the greatest uncertainty and potential returns allows decision makers to learn quickly which paths merit further investment and which do not.

This highlights a broader lesson. Uncertainty is not merely a source of risk to be avoided; it is a source of value, since acquiring information creates opportunities for better choices. Whether in education, business, or public policy, decision makers profit by first exploring high variance alternatives, learning from the payoffs to refine choices, and focusing resources where they have the greatest impact.

Financial markets make this logic explicit. Option prices reflect the market's assessment of the value of waiting to act until uncertainty is resolved. The greater the volatility and the longer the time horizon, the more valuable it becomes to hold the option rather than commit immediately. This is precisely the same intuition that underlies Weitzman's framework: preserving the ability to choose later often creates more value than committing too early. Whether through a student testing potential majors, a policymaker piloting new programs,

or a farmer hedging milk prices, optionality provides a unifying economic lens for thinking about dynamic choices under uncertainty.

Appendix: Weitzman's Index

A decision maker can choose among n available projects to replace the current technology with value z (the outside option). Project i ($1 \leq i \leq n$), yields a random payoff X_i with cumulative distribution function F_i ; the payoffs $\{X_i\}_{i=1}^n$ are statistically independent. Developing project i cost c_i and takes t_i units of time; with discount rate $r \geq 0$, $\delta_i := e^{-rt_i}$ denotes the discount factor associated to project i .

Search proceeds sequentially. At each stage, the decision maker either (i) stops and implements the best available technology – $\max\{z, \max_{j \in \mathcal{D}} X_j\}$, where $\mathcal{D}$ is the set of projects already pursued – or (ii) selects an undeveloped project $i \notin \mathcal{D}$ to develop, incurring cost c_i , waiting t_i , and then observing X_i . To quantify a project's optionality, we analyze the single-project case. Given an outside option z , the value of developing project i is:

$$V_i(z) := -c_i + \delta_i \mathbb{E}[\max\{X_i, z\}] = -c_i + \delta_i \left(\int_z^\infty x dF_i(x) + z \int_{-\infty}^z dF_i(x) \right).$$

The *reservation value* (optionality) of project i is the smallest outside option z at which the decision maker is indifferent between developing the project and choosing the outside option z ,

$$z_i := \inf \{z \in \mathbb{R} : V_i(z) \leq z\}.$$

The optimal policy for a decision maker with n projects follows from Weitzman (1979),

- **Selection rule:** A project pursued should be the one with the highest reservation value.
- **Stopping rule:** The process ends whenever the maximum sampled reward $X = \max_{j \in \mathcal{D}} \{X_j\}$ exceeds the reservation values of the available projects $\{z_k\}_{k \notin \mathcal{D}}$, at which point X is implemented.

A numerical example is provided in Figure 1.

Project	A	B	C
F_i	$U[0, 6]$	$U[0, 6]$	$U[2, 4]$
c_i	3/4	4/3	4/3
z_i	3	2	5/3

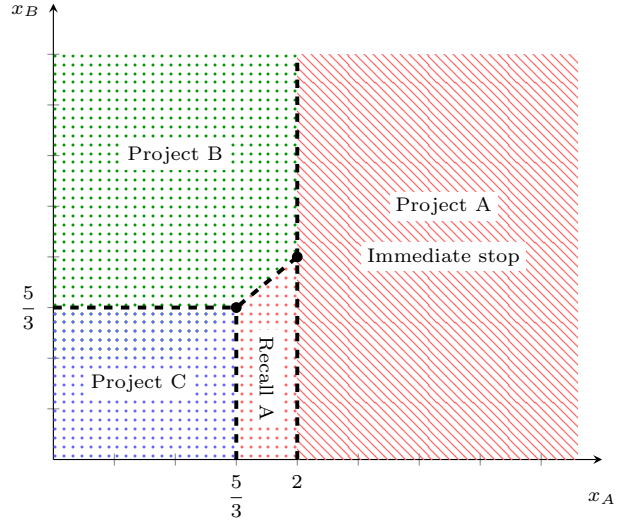


Figure 1: NUMERICAL EXAMPLE WITH THREE OPTIONS: The left table describes three projects: A , B and C ; the last row reports their reservation values z_i . Notice that the index most exceeds the expected payoff with greater variance or lower cost of opening the box — since both raise the optionality value. The optimal research order is as follow: Attempt A first (it has the highest z_i). If the realization is sufficiently high ($x_A \geq 2$), choose A . In the event of a poor outcome ($x_A < 2$), explore B next. The process ends by choosing B if $x_B \geq \max\{z_C, x_A\}$, and recalling A if $x_A \geq \max\{z_C, x_B\}$; otherwise, choose C . See the right panel.

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