JOURNAL OF
ECONOMICS
TEACHING

Why Do Supervillains Continue to Emerge? Using Spider-Man to Teach and Unveil the Economics of Crime

This article explores the innovative use of superheroes, specifically Spider-Man, as didactic tools to teach economic concepts, focusing on the economics of crime. Leveraging the global popularity of superhero narratives, this approach makes complex economic principles more engaging and accessible to students. The analysis centers on iconic villains such as Norman Osborn (Green Goblin) and Wilson Fisk (Kingpin), demonstrating how their unique resources and abilities counterbalance the increased probability of apprehension caused by the presence of a superhero. This logic also applies to villains like Dr. Octopus and Vulture, showing that the advanced capabilities of supervillains enable them to sustain illegal activities despite heightened risks. The article compares Spider-Man's presence to increased police presence, offering practical insights into public safety policies. The findings indicate that while a greater police presence effectively deters common criminals, specialized units and advanced technologies are required to combat sophisticated white-collar crimes. This study contributes to existing literature by enriching economic pedagogy with culturally relevant and engaging examples, underscoring the potential of using popular culture in economic education.

Otavio Florentino Detoni†, Michel Candido de Souza‡

†State University of Minas Gerais, ‡Federal University Jequitinhonha and Mucuri Valleys

1. Introduction

In recent years, the teaching of economics has been exploring new methodologies to engage students more effectively. Among these methodologies, using elements from popular culture, such as movies, TV shows, and comic book characters, has proven to be a promising approach. While the global popularity of superheroes provides numerous examples to illustrate economic concepts engagingly and accessible, this article focuses specifically on Spider-Man, one of the most iconic superheroes of our time. By analyzing Spider-Man's stories and characters, we can explore and apply various economic principles, enhancing the educational experience.

Spider-Man, created by Stan Lee and Steve Ditko (1962) first appeared in "Amazing Fantasy" #15 and quickly became one of the world's most popular superheroes. His stories have been adapted into various media, including television and cinema, reaching a global audience. According to the Motion Picture Association of America (2021), superhero-based films have consistently dominated the box office since 2013, and Spider-Man is one of the most lucrative characters with movies grossing billions of dollars worldwide. The popularity of Spider-Man is reflected in events like San Diego Comic-Con, which attracts hundreds of thousands of fans annually. In 2024, approximately 130,000 people were expected to attend the event, as reported by Grupo RBS (2024). These numbers demonstrate not only the cultural relevance of the character but also his ability to engage a diverse audience, including university students.

O'Roark (2017) proposes using superheroes as didactic tools in teaching concepts related to the economics of crime. This article aims to contribute to the existing literature by demonstrating how Spider-Man's villains can be used to teach economic principles, specifically the economics of crime according to Gary Becker's (1968) model. In his seminal work "Crime and Punishment: An Economic Approach", Becker (19968) proposed that criminals make rational decisions based on costs and benefits. Applying this model, we analyze the behavior of villains such as Norman Osborn (Green Goblin) and Wilson Fisk (Kingpin).

While the economics of crime is the backdrop of this article, it also illustrates various other fundamental economic concepts, such as utility, expected utility, risk, risk aversion and preference, production function, and economies of scale. These concepts are explored through the behaviors of Spider-Man's villains, each helping to understand different aspects of Becker's economic model from distinct contexts. Norman Osborn offers a study on financial incentives and corporate power, and Wilson Fisk exemplifies economies of scale in organized crime, showing how the centralization and expansion of criminal operations can increase profits and reduce relative costs.

This article models the expected utility for each of these villains, considering the economic variables that influence their criminal decisions and makes findings about changes in criminal behaviors and strategies with Spider-Man's presence. These characters provide a rich source of study to apply the principles of the economics of crime and demonstrate how these theories can be used to understand complex and multifaceted behaviors. Furthermore, this study serves as a basis for other creative extrapolations in economic pedagogy.

This article's contribution is twofold. First, it offers a detailed analysis of how Spider-Man's villains can be used to teach the economics of crime, enriching economic pedagogy with relevant and engaging examples. Second, it highlights the importance of innovation in teaching techniques for economics, suggesting that integrating popular culture into the curriculum can significantly increase student engagement and knowledge retention.

2. Literature Review

In recent years, the use of popular media as an educational tool has gained considerable traction, primarily due to its potential for engaging students. Becker (2000) argues that actively involving students in the learning process with everyday examples can significantly enhance knowledge retention and student motivation. Utilizing TV shows and movies enables students to see that economic principles permeate all aspects of daily life, making the subject matter more relatable and memorable. Mateer et al. (2016) highlights that using films and TV show clips such as "The Big Bang Theory" and "Seinfeld" to teach economics has proven effective in making abstract concepts more concrete and memorable for students. These resources provide visual and narrative examples that can illustrate economic principles more tangibly than traditional texts. Additionally, Tierney et al. (2016) ," explore how episodes of the series The Big Bang Theory can be used to teach various economic concepts, demonstrating the effectiveness of popular media in economic education.

Wight (2002) uses a fictional narrative to reintroduce the principles of Adam Smith to contemporary readers. In the book, Adam Smith returns to Earth 200 years after his death, tormented by caricatures of his name. His journey of discovery, along with doctoral student Richard Burns, highlights that selfishness is insufficient, rescuing Smith's deeper vision. Moulder (2009) argues that podcasts, literature, and movies can be integrated into the economics curriculum to better connect the technical and existential aspects of the discipline. He emphasizes that economics should not only be about numbers and graphs but also about how these elements affect everyday life and human decisions.

Luccasen and Thomas (2010) discuss how episodes of "The Simpsons" can be used to illustrate various basic economic principles, such as economic reasoning, opportunity cost, incentives, comparative advantage, diminishing marginal utility, elasticity, externalities, free-riding, and game theory. They provide discussion questions and worksheets that instructors can use in their classes, highlighting how these resources can motivate disinterested students and improve instruction. Luccasen, Hammock, and Thomas (2011) expand this approach by using clips from animated shows such as "Beavis and Butthead," "Duck Tales," "Futurama," and "The Simpsons" to teach macroeconomic principles. They use these clips to explain the velocity of money, inflation and long-term monetary policy, interest rates, present and future value, domestic production and the mismeasurement of GDP, and structural unemployment. These examples show how multimedia materials can be powerful yet underutilized tools in teaching economics.

Hall (2005) explores how "The Simpsons" can reveal that economics is everywhere. The book takes readers to Springfield and, by exploring the city of the Simpson family, provides economic tools and insights that guide them at work, home, and the voting booth. With chapters covering individual behavior, money, markets, government, and applied microeconomics topics such as immigration, gambling, and health care, the book is an excellent didactic resource that reinforces fundamental concepts in a fun and culturally relevant way. Deyo and Podemska-Mikluch (2014) also demonstrate the utility of popular series by analyzing how the Harry Potter books illustrate economic principles such as scarcity, opportunity costs, marginal thinking, the power of incentives, and the benefits of trade. They argue that the series' popularity inspires students to adopt economic thinking in a lasting way.

Focusing on the superhero universe, O'Roark (2017) explores how superheroes can be used to illustrate economic concepts in an engaging and contemporary manner. He argues that comic book characters, with their complex plots and detailed development, offer a rich source of economic content. The author discusses how superheroes can be used to teach a variety of economic topics, including scarcity, opportunity costs, specialization, public goods, moral hazard, production functions, and utility. This approach expands the educational tools available to economics teachers, applying not only to primary and secondary education but also to undergraduate courses.

Using characters and narratives from popular culture, such as Spider-Man, to teach economics offers several benefits. Firstly, it helps contextualize economic concepts within stories and characters with which students are already familiar, facilitating understanding and retention. Additionally, these narratives can stimulate discussions about ethics, social justice, and the economic implications of characters' actions. However, there are challenges associated with this approach. Becker (2000) emphasizes that while the use of popular media can increase engagement, it is essential to ensure that economic concepts are conveyed accurately and that students are not just entertained but also educated. Moreover, there is a need to develop appropriate teaching materials and train teachers to use these resources effectively.

Integrating elements of popular culture into the teaching of economics represents a significant innovation in economic pedagogy. Using characters like Spider-Man can make learning more engaging and relevant, helping students better understand economic concepts and their real-world applications. However, it is crucial to balance entertainment and education to maximize the benefits of this approach.

3. The Economic Theory of Crime

Between the 1920s and the 1960s, the dominant disciplines in the scientific social study of crime were psychology and sociology. This trend continued as criminology departments and schools were established in the post-war period (Cook, 2012). During this time, economics had already developed an analytical framework and a set of tools for mathematical formalization that other fields lacked. Consequently, as Conti and Justus (2016, p. 2) indicate, "the economic investigation into criminality emerged in the late 1960s in the United States with Fleisher (1963, 1966), Smigel-Leibowitz (1965), and Ehrlich (1967)."

The seminal workof Becker (1968) marked the beginning of a rigorous, mathematically structured theoretical model for the economic analysis of criminal behavior. In his article, Becker (1968, p. 2) chose not to incorporate the traditional criminological theories, stating that "a useful theory of criminal behavior can dispense with special theories of anomie, psychological inadequacies, or inherited traits and simply extend the economist's analysis of choice." Becker posits that criminals are rational and intentional agents who maximize utility subject to constraints, similar to the standard microeconomic theory.

Becker (1968) applied the concept of expected utility to criminal behavior, suggesting that individuals commit crimes if the expected benefits outweigh the expected costs, including the probability of being caught and the severity of the punishment. This approach revolutionized how crime was analyzed by treating it as a rational economic choice. Becker used mathematics to formalize his theory, creating models that allowed for the prediction of how changes in public policies, such as increased penalties or enhanced police efficiency, could influence crime rates.

Becker's (1968) approach is significant because it introduced a rigorous analytical framework for the study of crime, using mathematical models to understand and predict criminal behavior. His theory enabled economists and policymakers to analyze criminality objectively and quantitatively, considering the costs and benefits associated with criminal behavior.

<u>The Illegal Labor Supply Model</u>

Becker's (1968) economic theory of criminal behavior posits that individuals are rational agents who decide to commit crimes by comparing the expected benefits and costs of this activity with those of legal work. A criminal's decision on how much time to allocate to legal versus illegal work can be modeled using principles of rational choice.

Let us explore the illegal labor supply model (O_i) as a function of key variables: the probability of being caught (p), the penalty (f), and other factors (u):

$$O_i = O(p, f, u).$$

If p increases, the chance of being caught and convicted for a crime increases. This reduces the expected utility of committing the crime, as the probability of facing the penalty f is higher. Consequently, the number of crimes (O_i) will tend to decrease, as the risk of being caught and punished is greater. Similarly, if f increases, the penalty for being convicted becomes more severe. This also reduces the expected utility of committing the crime, as the "price" the criminal pays if caught is higher. Again, the number of crimes (O_i) will tend to decrease, as the cost of being caught is greater. Therefore:

$$dO\,/\,dp < 0; dO\,/\,df < 0.$$

On the other hand, the utility of legal work can be described by the function $U = U(Y_l)$ where utility is a function of income. Since legal work carries no risk of punishment, the utility derived from it is straightforward and based solely on the income earned. In contrast, the utility of illegal work is an expected utility due to the risks associated with being caught and punished. This distinction highlights the fundamental differences in the decision-making processes between legal and illegal activities. The expected utility of illegal work can be expressed as follows:

$$E(U) = pU(Y_i - f) + (1 - p)U(Y_i)$$

where:

- $E(U)$ is the expected utility.
- p is the probability of being caught and convicted.
- Y_i is the income obtained from illegal work.
- f is the penalty (or cost) associated with conviction.

Therefore, when making decisions, a rational individual will compare $U(Y_l)$ with $E(U)$. If the expected utility of illegal work $E(U)$ is greater than the utility of legal work $U(Y_l)$, they may choose to commit the crime. Otherwise, they will opt to remain in legal work.

To illustrate the decision between legal and illegal work, we conducted a detailed numerical analysis considering different probabilities of apprehension and penalties. We demonstrated that the expected utility of illegal work decreases with both an increase in the probability of apprehension (p) and an increase in the severity of the penalty (f). For risk-averse individuals, diminishing marginal utility implies that an increase in the penalty results in a more significant drop in expected utility. However, for risk-taking individuals, increasing marginal utility implies that the drop in expected utility is greater with an increase in the probability of apprehension. For a detailed analysis and specific calculations, see Appendices A and B.

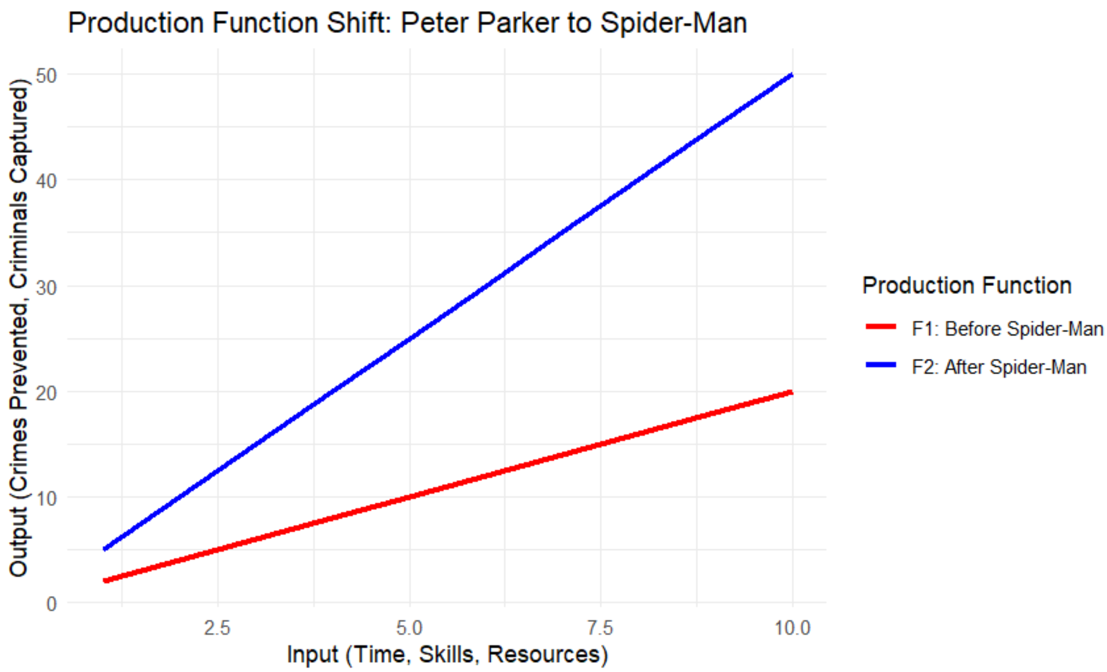
4. The Spider-Man Effect: Modeling the Behavior of Villains (Green Goblin and Kingpin)

Spider-Man's villains are natural risk-takers. They frequently engage in activities that involve high risk and high reward. Their actions indicate a willingness to face significant risks in exchange for potentially substantial gains. For instance, the Green Goblin engages in dangerous confrontations and uses experimental technology, risking his life and sanity. Additionally, many villains seek not only financial rewards but also power and control, often leading them to take extreme risks. They desire status, recognition, and control over the city, which implies a propensity to make risky decisions. For example, Kingpin's quest for total control over New York's underworld drives him to take enormous risks, including confrontations with heroes and other villains.

A brief analysis of the behaviors of Spider-Man's villains reveals a clear tendency to take high risks in exchange for potentially significant rewards. Their actions, repetitive risky behaviors, quest for power, willingness to confront Spider-Man, and use of dangerous technologies support the hypothesis that they are risk-takers. Therefore, it is conjecturable that they possess convex utility functions and thus respond more effectively to changes in probability of apprehension (p) than in penalty severity (f). But what is the impact of the existence of a superhero like Spider-Man in the city?

First, let us understand a bit more about a superhero's abilities. To comprehend the impact of the existence of a superhero like Spider-Man in the city, it is useful to consider the production function in the context of crime fighting. In economics, a production function describes the relationship between the quantity of inputs used and the quantity of output generated. In the case of superheroes, inputs can include time, skills, technology, and other resources, while outputs can be measured by the number of crimes prevented, criminals captured, or the overall increase in public safety.

Table 1



Source: Authors' own elaboration, based on the concept of production functions and the shift in crime-fighting efficiency, adapted from O'Roark, J. (2017).Note: The graph illustrates the shift in Peter Parker's production function from F1 (before becoming Spider-Man) to F2 (after acquiring his powers). The x-axis represents the inputs (such as time, skills, and resources), while the y-axis measures the outputs (such as crimes prevented and criminals captured).

Before becoming a superhero, Peter Parker was just an ordinary teenager with limited abilities to combat crime. His crime-fighting production function (F1) was low, reflecting his normal capabilities. However, after acquiring his Spider-Man powers, his production function (F2) shifted significantly upward (O'Roark, 2017). Now, with the ability to climb walls, super strength, enhanced agility, and spider-sense, he can capture criminals much more efficiently.

With Spider-Man's presence, the probability of apprehension (p) for criminals increases dramatically. This is due to Spider-Man's ability to respond quickly to ongoing crimes, patrol problematic areas more effectively, and use his unique skills to apprehend criminals who would be difficult to capture by traditional methods. For villains, this means that the expected likelihood of being caught is much higher, negatively impacting the expected utility of their criminal activities. Risk-loving villains are particularly sensitive to changes in the probability of frequent negative events, so the increase in p imposed by Spider-Man acts as a strong deterrent to their criminal actions.

On the other hand, an increase in the severity of punishment (f), such as longer sentences or harsher penalties, may have a less significant effect on risk-taking villains. These individuals, as mentioned earlier, tend to be less influenced by increases in the magnitude of punishment due to their willingness to face great risks for substantial rewards. Even knowing they might face severe consequences, they continue to commit crimes because the probability of being caught remains a more powerful determinant for them. In this context, Spider-Man does not affect the severity of punishment. His primary influence lies in increasing the probability of apprehension, which has a more significant impact on these risk-taking villains.

Supervillains

Despite Spider-Man's presence and the resulting increase in the probability of apprehension (p), supervillains continue to emerge. What explains this persistence? A primary reason is that supervillains also possess elevated production functions, often comparable to superheroes. Their superhuman abilities and/or substantial resources enable them to operate efficiently and effectively within the criminal underworld.

The Green Goblin, for instance, has vast financial and technological resources thanks to his company, Oscorp. He utilizes advanced experimental technology, such as his glider and pumpkin bombs, to commit crimes and confront Spider-Man. His resources and scientific knowledge enhance his capacity to plan and execute complex crimes, making him a formidable adversary. The Kingpin, although lacking superpowers, controls an extensive criminal network that benefits from economies of scale. His criminal organization operates on multiple fronts, including drug trafficking, extortion, and corruption. The vast network of informants, henchmen, and financial resources allows the Kingpin to operate on a much larger scale than an ordinary criminal, making his activities highly productive and difficult to combat.

Therefore, although the probability of apprehension significantly increases with Spider-Man's presence, for certain individuals like Norman Osborn and Wilson Fisk, this increase is counterbalanced by their elevated production functions and other factors that ensure their efficiency.

Rational Choice with Spider-Man in Action

Let's now model, based on the theory of the supply of criminal activities, the expected utility functions of Osborn and Fisk. First, with Spider-Man's presence in the city, as already explained, the probability of apprehension (p) increases substantially. Let's call this new probability of apprehension P. Therefore, for a common criminal, the expected utility of working in the illegal market is given by:

$$E(U) = PU(Y_i - f) + (1 - P)U(Y_i).$$

If the probability of apprehension increases, the expected utility decreases. This is because:

$$dE(U)\,/\,dP = U(Y_i - f) - U(Y_i) < 0.$$

Therefore, the higher the probability of apprehension, the lower the expected utility and, consequently, the lower the incentive to switch from legal to illegal work. Spider-Man's presence in the city deters common criminals from engaging in illegal activities, as the higher probability of apprehension reduces the attractiveness of these activities compared to legal work. This is an intuitive result and has been previously discussed.

But let's return to the central question: why do supervillains continue to appear? The answer is: because they are supervillains! Supervillains, like Norman Osborn and Wilson Fisk, operate under a different set of conditions than common criminals. They possess considerable resources, special powers, political influence, and networks of contacts that allow them to mitigate the risks of apprehension and legal consequences. Let's model the expected utility of these supervillains to understand better their decisions.

The Green Goblin: His Resources and Powers

Norman Osborn, also known as the Green Goblin, exemplifies how a supervillain can maintain his criminal activities even in the presence of a vigilante like Spider-Man. The key to this resilience lies in his vast technological and financial resources. Osborn has access to advanced technologies through his company, Oscorp, allowing him to develop weapons, devices, and gadgets that give him a significant advantage over traditional law enforcement and other criminals. Osborn's considerable wealth also enables him to finance large-scale criminal operations, hire henchmen, acquire rare materials, and bribe authorities to avoid capture and punishment. Additionally, as the Green Goblin, Osborn possesses superhuman abilities that enhance his capacity to commit crimes and evade apprehension. His increased strength, agility, and use of advanced technologies, such as the glider and pumpkin bombs, make him a formidable adversary for any security force.

Given this, Norman Osborn's production function is significantly elevated due to these technological and financial resources. This means he can generate much higher returns from his criminal activities than can a common criminal. Osborn's elevated production capacity not only increases his efficiency in the criminal world but also allows him to mitigate the risks associated with the probability of apprehension. Thus, his powers, vast financial and technological resources enable his expected utility to be adjusted to reflect his elevated production capacity in illegal activities (βY_i) and a discount factor on the probability of apprehension (α).

Decision-Making Framework

Norman Osborn's decision-making reflects a trade-off between legal and illegal activities. Osborn's objective is to maximize expected utility by allocating effort (e_c) to illegal activities while balancing constraints on time and resources. The model incorporates his elevated production capacity (β) due to technological and financial resources and his ability to evade law enforcement (α).

$$maxE(U_{\text{Osborn}}) = \alpha PU[\beta Y_c(e_c) - f] + (1 - \alpha P)U[\beta Y_c(e_c) + Y_l(e_l) - C(e_c) - C(e_l)]$$

Where:

- β: the elevated production factor of Norman Osborn($\beta > 1$);
- α: the discount factor on the probability of apprehension due to Osborn's powers and resources $(0 < \alpha < 1)$.
- P: the probability of apprehension, dependent on law enforcement intensity.
- f: penalty incurred upon apprehension, including financial and reputational losses or imprisonment.
- $Y_c(e_c)$: income generated from illegal activities, as a function of effort (e_c).
- $Y_l(e_l)$: income generated from legal activities, as a function of effort (e_l).
- $C(e_c)$: Cost of effort in illegal activities.
- $C(e_l)$: Cost of effort in legal activities.

Osborn's decision-making is subject to two main constraints. First, his total time(T) must be divided between illegal (e_c) and legal (e_l)activities, expressed as

$e_c + e_l \leq T$. Second, his total resources (R) must cover the costs associated with both types of activities, formalized as $R \geq C(e_c) + C(e_l)$, where $C(e_c)$ and $C(e_l)$ represent the costs of effort in illegal and legal activities, respectively. These constraints reflect the finite nature of Osborn's time and resources, shaping his optimal allocation decisions.

The objective function captures the trade-off between the outcomes of being apprehended or evading apprehension. The first term, $\alpha PU[\beta Y_c(e_c) - f]$, represents the utility if apprehended. It is weighted by the probability of apprehension (αP) and incorporates the penalty (f) associated with being caught. The second term, $(1 - \alpha P)U[\beta Y_c(e_c) + Y_l(e_l) - C(e_c) - C(e_l)]$, represents the utility if not apprehended. It is weighted by the probability of evasion $(1 - \alpha P)$ and accounts for the total income and costs associated with legal and illegal activities. Together, these terms reflect the expected utility of Norman Osborn's decision-making process.

To analyze how changes in key parameters (α, β, P, f) influence Norman Osborn's allocation of effort between illegal (e_c) and legal $C(e_l)$ activities, we derive insights from the model's first-order conditions and apply comparative statics principles. We define the Lagrange function as:

$$L = \alpha PU(\beta Y_c(e_c) - f) + (1 - \alpha P)U(\beta Y_c(e_c) + Y_l(e_l) - C(e_c) - C(e_l)) + \lambda(T - e_c + e_l) + \mu(R - C(e_c) - C(e_l))$$

The first-order conditions for maximizing $E(U_{\text{Osborn}})$ with respect to e_c, e_l, λ, μ are:

- $\partial L / (\partial e_c) = \alpha PU'(\beta Y_c(e_c) - f)(\beta Y_c'(e_c) + (1 - \alpha P)U'(\beta Y_c(e_c) + Y_l(e_l) - C(e_c) - C(e_l))(\beta Y_c(e_c) - C'(e_c)) - \lambda - \mu C'(e_c) = 0$
- $\partial L / (\partial e_l) = (1 - \alpha P)U'(\beta Y_c(e_c) + Y_l(e_l) - C(e_c) - C(e_l))((Y_l(e_l) - C'(e_l) - \lambda - \mu C'(e_l) = 0$
- $\partial L / \partial \lambda = T - e_c + e_l = 0$
- $\partial L / \partial \mu = R - C(e_c) - C(e_l) = 0$

These equations balance the marginal utility of effort in illegal and legal activities against their associated costs and risks.

Effect of α (Discount Factor on Apprehension Probability): A decrease in α, which reflects an enhanced ability to evade apprehension, reduces the weight of the apprehension term $(\alpha PU(\beta Y_c(e_c) - f)$ in the objective function. This shift makes apprehension less impactful and increases the attractiveness of illegal activities, raising e_c and reducing e_l.

Effect of β (Elevated Production Factor): an increase in β, reflecting greater productivity in illegal activities, raises the marginal returns to illegal effort $(\beta Y_c(e_c))$ in both utility terms. Consequently, Osborn is incentivized to allocate more effort toward illegal activities.

Effect of P (Probability of Apprehension): a higher P, representing a greater likelihood of being apprehended, increases the weight of the apprehension term $\alpha PU(\beta Y_c(e_c) - f)$. This discourages illegal activities, causing a shift in effort away from e_c toward e_l.

Effect of f (Penalty for Apprehension): an increase in f, the penalty for apprehension, raises the cost of illegal activities in the apprehension term $(\beta Y_c(e_c) - f)$. This discourages illegal efforts (e_c) and reallocates efforts toward legal activities (e_l).

These effects reflect the rational adjustments Osborn would make in response to changes in enforcement parameters or his production capacity, maintaining alignment with Becker's (1968) economic theory of crime.

The Kingpin and Economies of Scale

Economies of scale refer to reducing the average cost of producing a good or service as the quantity produced increases. Given the nature of the Kingpin's, criminal operations and extensive network of illegal activities these economies apply uniquely. Fisk can reduce his operational costs and increase efficiency by coordinating a vast criminal network utilizing infrastructure and resources in an optimized manner.

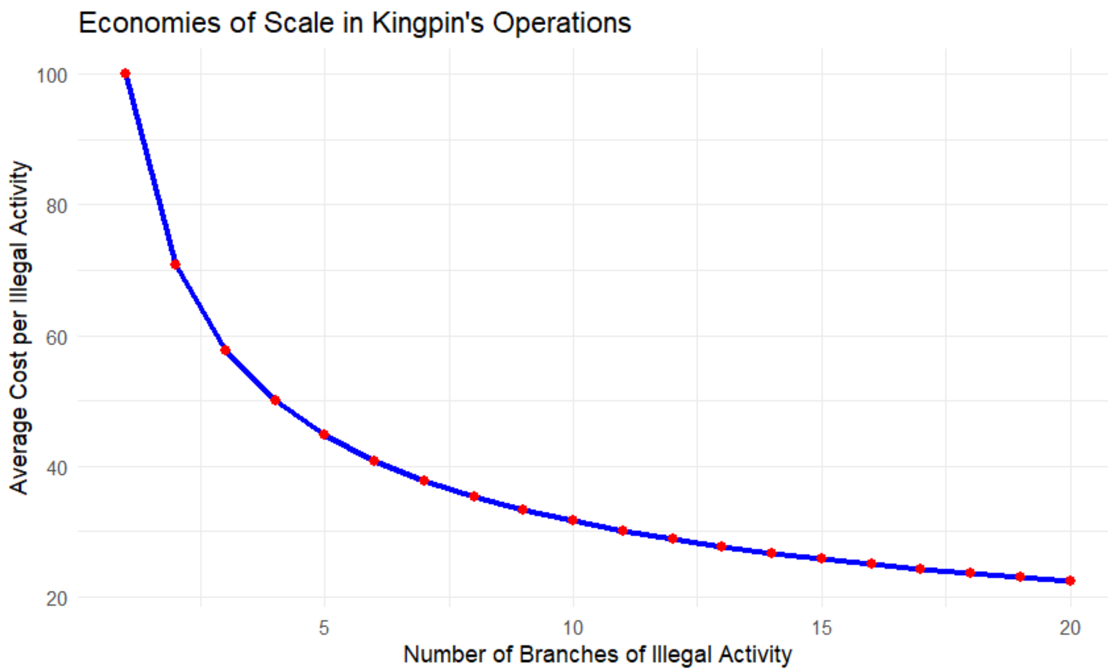
For Fisk, operational efficiency is achieved through centralized coordination and division of labor among specialists in various criminal areas. This reduces redundancies and maximizes operational effectiveness. Additionally, the better utilization of resources is evident in the well-established criminal infrastructure and economies of scope, where multiple types of crimes are carried out using the same resources, thereby reducing costs and increasing efficiency.

Fisk's bargaining power is another crucial factor in economies of scale. His extensive network of contacts allows him to negotiate better prices and terms with suppliers and criminal partners. Furthermore, the intimidation and coercion he can exert ensure favorable conditions, directly reducing costs or forcing third-party cooperation. Practical examples include bulk drug purchases at reduced prices and the efficient use of smuggling and distribution routes.

While economies of scale provide significant advantages, Fisk also faces challenges. Managing an extensive criminal network can become complex, increasing the risk of operational failures. Large-scale operations attract more attention from authorities, raising the risk of investigations and apprehensions. Despite these risks, economies of scale are essential for the efficiency and profitability of Kingpin's criminal operations, allowing him to maintain his dominance in the criminal underworld.

The graph illustrates economies of scale in the context of the Kingpin's operations based on the number of branches of illegal activity. On the x-axis, we have the number of branches of illegal activity, while on the y-axis, we have the average cost per illegal activity.

Table 2



Source: Authors' own elaboration

As the number of branches of illegal activity increases, the average cost per illegal activity decreases, reflecting operational efficiency and better utilization of available resources. The blue line represents the average cost per illegal activity, which falls as the number of activities increases. The dotted red line represents the variable cost per activity, which remains constant.

Therefore, the Kingpin's expected utility can be adjusted with an elevated production factor (β) due to economies of scale and his extensive criminal network, and a discount factor on the severity of punishment (μ) due to his contacts and connections.

Decision-Making Framework

Wilson Fisk's decision-making incorporates economies of scale that significantly influences the operational efficiency of his criminal activities. Fisk allocates resources (R) across multiple branches of illicit operations to maximize his expected utility. The model formalizes how he balances increasing returns, costs, and risks associated with large-scale operations.

$$maxE(U_{\text{Fisk}}) = \alpha PU\beta(N)Y_c(e_c) - \mu f + (1-\alpha P)U\beta(N)Y_c(e_c) + Y_l - C(e_c)$$

Where:

- $\beta(N) > 1$: elevated production factor due to economies of scale, dependent on the number of branches (N).
- α: Discount factor on the probability of apprehension, reflecting additional protection from Fisk's resources and influence $(0 < \alpha < 1)$.

- μ: discount factor on the severity of punishment due to his contacts and connections $(0 < \mu < 1)$.
- P: the probability of apprehension, dependent on law enforcement intensity.
- f: penalty incurred upon apprehension, including financial and reputational losses or imprisonment.
- $Y_c(e_c)$: income generated from illegal activities, as a function of effort (e_c).
- Y_l: fixed income generated from legal activities.
- $C(e_c)$: cost of effort in illegal activities.

Fisk's decision-making is subject to two key constraints. First, his total available resources (R) must be sufficient to cover the costs associated with each branch of illegal activities, expressed as $R \geq \sum_{i=1}^{N} C_i\left(e_c\right)$, where $C(e_c)$ represents the cost of effort in branch i. Second, the production factor $\beta(N)$ increases with the number of branches (N) due to economies of scale $(\beta'(N) > 0)$, but at a diminishing rate$(\beta''(N) > 0)$ reflecting the challenges of managing larger operations efficiently.

Now we can define the Lagrange function as:

$$L = \alpha PU\left[\beta\left(N\right)Y_c\left(e_c\right) - \mu f\right] + \left(1 - \alpha P\right)U\left[\beta\left(N\right)Y_c\left(e_c\right) + Y_l - C\left(e_c\right)\right] + \lambda\left(R - \sum_{i=1}^{N} C_i\left(e_c\right)\right)$$

The first-order conditions for maximizing $E(U_{\text{Fisk}})$ with respect to e_c, N, λ, are:

- $\partial L / (\partial e_c) = \alpha PU'(\beta(N)Y_c(e_c) - \mu f)(\beta(N)Y_c'(e_c) + (1 - \alpha P)U'(\beta(N)Y_c(e_c) + Y_l - C(e_c))[(\beta(N)Y_c'\left(e_c\right) - C'\left(e_c\right)\right] - \lambda \sum_{i=1}^{N} C_i{}'\left(e_c\right)\Big] = 0$
- $\partial L / \partial N = \alpha PU'(\beta(N)Y_c(e_c) - \mu f)Y_c(e_c)\beta'(N) + (1 - \alpha P)U'(\beta(N)Y_c(e_c) + Y_l - C(e_c))Y_c(e_c)\beta'\left(N\right) - \lambda \sum_{i=1}^{N} \frac{\partial C_i(e_c)}{\partial N_i} = 0$
- $\partial \frac{L}{\partial \lambda} = R - \sum_{i=1}^{N} C_i\left(e_c\right) = 0$

Fisk's decision-making process is influenced by key parameters. An increase in the number of branches (N) initially raises the production factor $\beta(N)$, enhancing efficiency and returns from illegal activities. However, diminishing marginal returns $(\beta''(N) < 0)$ and managerial complexities impose limits on the optimal size of N. A higher probability of apprehension (P) reduces the incentive to expand (N) and decreases illegal effort (e_c), redirecting resources toward legal activities. Conversely, a lower discount factor on punishment severity μ - reflecting Fisk's ability to mitigate penalties - encourages an increase in both N and e_c as the potential costs of punishment become less impactful.

Therefore, economies of scale are fundamental to the efficient and profitable operation of the Kingpin. Centralized coordination, optimized resource utilization, and bargaining power allow Wilson Fisk to reduce his operational costs and maximize the efficiency of his vast criminal network. Although he faces challenges such as managerial complexity and increased attention from authorities, Fisk mitigates these risks through his contacts and connections, which reduce the severity of penalties and the probability of apprehension. The adjusted expected utility model for Fisk demonstrates how his ability to operate on a large scale and his resources influence his capacity to maintain and expand his criminal activities, highlighting the importance of economies of scale in his dominance of the criminal underworld.

General Analysis

The presence of Spider-Man in the city increases the probability of apprehension, which reduces the expected utility for common criminals. However, supervillains like Norman Osborn and Wilson Fisk possess unique characteristics (elevated criminal production functions) that counterbalance the "Spider-Man shock." For Osborn, the discount factor (α) on the probability of apprehension due to his powers and resources further mitigates the impact of the increased probability of apprehension. For Fisk, the discount factor (μ) on the severity of punishment due to his contacts and connections also mitigates the impact of the increase from p to P. Therefore, even with a higher probability of apprehension, the high production capacity and advanced resources of the supervillains allow them to continue operating in the illegal market, maintaining their criminal activities as attractive options.

Implications for Public Security Policy

The analogy between Spider-Man's presence and increased police presence highlights key insights into public security policies, particularly regarding the differential impact of enforcement on distinct criminal profiles. Greater policing can be interpreted as an increase in p (the probability of apprehension). For "blue-collar" criminals, who typically lack resources and advanced strategies, such an increase has a significant deterrent effect, as their expected utility from illegal activities diminishes sharply.

Conversely, "white-collar" criminals, like supervillains, possess factors that discount the impact of p. These include access to sophisticated technologies, strategic planning, and connections, which allow them to evade detection or reduce penalties. Thus, while common crimes may decrease with heightened police presence, addressing sophisticated crimes requires targeted interventions such as specialized investigative units and technological investments.

This framework underscores the need for differentiated strategies: increasing visible policing effectively curtails common crimes, while advanced tools and expertise are essential to counteract sophisticated criminal networks. By adopting tailored approaches, public security policies can better address the multifaceted nature of crime.

5. Conclusion

This article has explored the innovative use of superheroes, particularly Spider-Man, as didactic tools for teaching economic concepts, with a special emphasis on the economics of crime. Superheroes provide an engaging and accessible medium to illustrate complex economic principles, leveraging familiar characters and narratives to enhance student understanding. The analysis of iconic villains such as Norman Osborn and Wilson Fisk highlighted how their unique attributes—financial resources, technological capabilities, and extensive networks of contacts—counterbalance the increased probability of apprehension brought about by the presence of superheroes.

Additionally, the article addresses fundamental economic concepts such as utility, risk, expected utility, and economies of scale. Utility is discussed in the context of criminal decisions, where villains weigh the benefits of their actions against the risks involved. The concept of expected utility is used to model the decisions of villains, considering the probability of apprehension and the severity of penalties. Economies of scale are exemplified through the operations of the Kingpin, who uses his vast criminal network to reduce costs and increase the efficiency of his illicit activities. These concepts are explored to demonstrate how economic theories can be applied to fictional contexts, providing a richer and more dynamic learning experience.

In line with Becker's (1968) economic theory of crime, this study adopts a binary choice model between legal and illegal activities, maximizing expected utility. Although the model does not explicitly allow for interaction between legal and illegal activities, such as the possibility of resources from legal work facilitating illegal work, this approach ensures methodological consistency and a focus on the core elements of the theory. This methodological choice seeks to preserve the simplicity and clarity of the model while highlighting the central factors that influence the decision to engage in illegal activities.

The logic that supervillains possess discount factors that mitigate the impact of the increased probability of apprehension can also be applied to other villains in the Spider-Man universe. For example, Dr. Octopus, in addition to his mechanical arms, is a renowned physicist, which gives him a discount factor on the probability of apprehension due to his ability to plan more sophisticated and well-executed crimes (human capital). Similarly, the Vulture, with his advanced use of technology, can also reduce the effectiveness of the "Spider-Man shock," keeping the expected utility of his criminal activities high. These examples show that even with an increased presence of heroes like Spider-Man, the extraordinary resources and abilities of supervillains allow them to continue operating in the illegal market, making their criminal activities attractive and difficult to eradicate completely.

In practical terms, comparing the presence of Spider-Man to an increase in the police force offers valuable insights for formulating public security policies. To combat common criminals, increasing police presence on the streets is an effective strategy. However, to tackle white-collar criminals, who operate with greater sophistication, it is necessary to invest in specialized units and advanced technologies. This study not only contributes to the existing literature but also suggests that innovation in economic teaching techniques, through the integration of popular culture, can significantly enhance student engagement and knowledge retention. The possibilities for examples and analyses are limitless, making this approach a powerful and versatile tool in economic education.

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Appendix A – Choice Between Legal and Illegal Work

We will illustrate the decision-making process of an individual (A) choosing between legal and illegal work using a numerical example. Using generic values: the utility function is given by $U_a = \sqrt{w}$, where w represents income; the income from legal work Y_l is 100; the income from illegal work Y_i is 225; the penalty f associated with illegal work, if caught, is 200; and the probability of being caught and convicted p is 40%, i.e., $p = 0{,}40$. Therefore, we have:

- Utility of legal work: $U = \sqrt{100} = 10$
- Utility of illegal work: $E(U) = 0{,}4\sqrt{(225 - 200)} + 0{,}6\sqrt{225} = 11$

Since the expected utility of illegal work $E(U) = 11$ is greater than the utility of legal work $U(Y_l) = 10$, the individual would choose illegal work. However, what probability of apprehension would change the individual's choice?

$E(U) = p\sqrt{(225 - 200)} + (1 - p)\sqrt{225} = 10$

$p\sqrt{25} + (1 - p)15 - 10 = 0$

$5p + 15 - 15p - 10 = 0$

$-10p + 5 = 0$

$10p = -5$

$p = 1/2 = 0{,}5$

Thus, the probability of apprehension must be at least 50% for the individual to be indifferent between legal and illegal work. Therefore, for any $p > 0{,}5$, the individual would choose legal work.

Now, what if the income from illegal work were $(Y_i = 400)$? Keeping other values for p and f constant:

$E(U) = 0{,}4\sqrt{200} + 0{,}6\sqrt{400} = 17{,}656.$

With illegal income increased to 400, the expected utility of illegal work is 17.656, higher than the utility of legal work at 10. Higher illegal income increases the expected utility of illegal activities.

Appendix B – Response to p or f

Now, if we vary the probability of apprehension to 60% $(p = 0{,}6)$, a 50% increase, we get:

$E(U) = 0{,}6\sqrt{200} + 0{,}4\sqrt{400} = 16{,}485.$

With the probability of apprehension increased to 60%, the expected utility drops to 16.485, a decrease of approximately 6.6% from the previous value. But what about an increase in the penalty, by the same magnitude (50%), i.e., $f = 300$?

$E(U) = 0{,}4\sqrt{100} + 0{,}6\sqrt{400} = 16.$

With the penalty increased to 300, the expected utility drops to 16, a more significant decrease of approximately 9.38%. But what explains the better response to the increase in penalty compared to the increase in the probability of being caught? In other words, what explains the better response to a shock in f rather than p?

The reason can be explained based on the utility function of individual $A(U_a = \sqrt{w})$,, which is concave, indicating risk aversion. Let us analyze this in detail:

The first derivative of the utility function with respect to income w is:

$U_a' = 1/(2\sqrt{w})$.

The second derivative of the utility function with respect to income w is:

$U_a'' = -1/(4w^(3/2)) < 0$

The negative second derivative$(U_a'' < 0)$ indicates that the utility function $U_a = \sqrt{w}$ is concave. Concavity implies that the marginal utility decreases as income www increases. Therefore, individual A is risk-averse.

Now for a risk-loving individual B, whose convex utility function is given by $U_b = w^2$, does the shock in f (severity of punishment) still generate a greater response? Note that it does not. Keeping the values from the previous numerical example for the new utility function, where: $Y_l = 100; Y_i = 400; f = 200; p = 0{,}40$

$E(U) = 0{,}4 * 200^2 + 0{,}6 * 400^2 = 112000.$

Now with a 50% shock in p and subsequently in f:

If p increases by 50% $(p = 0{,}6)$:

$E(U) = 0{,}6 * 200^2 + 0{,}4 * 400^2 = 88000.$

A decrease of approximately 21.4% in expected utility. And the effect of the penalty? Increasing f by 50% $(f = 300)$: :

$E(U) = 0{,}4 * 100^2 + 0{,}6 * 400^2 = 100000.$

A decrease of 10.7% in expected utility is smaller than the increase in the probability of being caught.

Therefore, the increase in the probability of apprehension has a more significant impact on expected utility than the increase in the penalty for risk-loving individuals. This occurs because the convex utility function implies that the marginal utility increases as income increases. Therefore, the expectation of a frequent loss (increase in probability) is perceived as more discouraging than a larger but less probable loss (increase in penalty).

Formally

For risk-loving individuals, the utility function U is convex, implying that the second derivative of U is positive $(U''(Y) > 0)$. This means that the utility function has an increasing rate for higher incomes.

$E(U) = pU(Y_i - f) + (1 - p)U(Y_i)$.

The partial derivatives of $E(U)$ with respect to p and f are:

$dE(U)\,/\,dp = U(Y_i - f) - U(Y_i)$

$dE(U)\,/\,df = -pU'(Y_i - f).$

Since U is convex, $U(Y_i - f) - U(Y_i)$ is greater in magnitude than $-pU'(Y_i - f)$. Therefore, the relative change in expected utility with respect to p is greater than with respect to f for risk-loving individuals. This proves that risk-loving individuals are more sensitive to the probability of apprehension than to the severity of the penalty.

Conversely, for risk-averse individuals, U is concave $(U''(Y) < 0)$); this implies that the magnitude of a variation in f is greater. Therefore, for risk-averse individuals, the severity of the penalty has a more significant impact on the decision to commit a crime than the probability of apprehension.