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Section 1. Economics of recreation and tourism

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DIGITAL COOPERATION IN ONLINE COMMUNITIES

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Abstract

This paper investigates the mechanisms that sustain cooperation in online communities by examining how reciprocity, signalling, and decentralised enforcement function in the absence of formal governance. Drawing on microeconomic theory, particularly game theory and public goods analysis, the paper challenges the assumption that rationality or trust are prerequisites for sustained cooperation. Instead, it argues that durable interactions and reputational incentives foster self-policing behaviours, enabling users to share digital goods – such as knowledge and information – despite anonymity and the risk of free-riding. Through a case study of Stack Overflow, the paper demonstrates how gift-like exchanges, identity persistence, and gamified reputation systems encourage participation in environments where repeated interaction and indirect reciprocity prevail. The study also explores the structural and cultural limits of cooperation.

Keywords: *Indirect reciprocity, Gift economy, Repeated games, Generalised exchange, Reputation systems, Self-policing mechanisms, Signalling theory, Decentralised governance, Digital cooperation, Trust and trustworthiness*

Introduction

In digital platforms such as Reddit, Stack Exchange, and Discord, users voluntarily contribute information, answer questions, moderate content, and enforce community norms – often without direct compensation or formal authority. These cooperative behaviours occur within anonymous, decentralised environments, raising an important question: what sustains such cooperation in the absence of contracts or external enforcement? Game theoretic models – particularly repeated games – and behavioural concepts such as signalling and generalised exchange explain how communities self-police, motivate participation, and maintain digital public goods.

This paper investigates how cooperation is sustained in online communities by applying concepts from repeated games, signalling theory, and public goods theory. I argue that cooperation in digital spaces arises from strategic incentives structured by reputation systems, persistent identity, and generalised reciprocity. These mechanisms substitute for governance, reduce the risk of defection, and make the supply of digital public goods sustainable. Using examples from major online platforms, I explore both the enabling conditions for cooperation and the structural limits that constrain it.

Results analysis

In a standard one-shot prisoner's dilemma, rational agents defect due to dominant strategy reasoning. However, in infinitely repeated games, players have incentives to cooperate in order to preserve future payoffs (Axelrod, 1984). Thus, for stable cooperation to emerge, players must value future benefits more than payoffs from immediate defection. Furthermore, they must expect interactions to continue indefinitely – there should be no known endpoint to the game. Hence, the cost of terminating a relationship will be higher and therefore more prominent in individual's decision-making process. Players must be able to observe other's actions and respond accordingly. Fast response times would prevent accumulation of defections to such an extent that the victim's provocability is no longer enough to prevent the challenger from having an incentive to defect. It was shown that immediate response to provocation ensures minimal losses for the victim, rendering Tit-for-Tat strategy the best way to foster cooperation (Axelrod, 1984).

Therefore, cooperation mainly depends on durability of relationship rather than trust, which makes anonymous exchanges in digital spaces possible (Axelrod, 1984). There is no definite end to online activity and future benefits may greatly exceed payoffs from exploiting the system – for example, by supplying a good of low quality, an individual risks negative reputation which will pose difficulties during future sales. In terms of provocability, online communities tend to have immediate response to defection because it is very easy to react by posting a negative review or banning the defector. Therefore, the required conditions are maintained in digital spaces which makes stable cooperation possible.

The concept of reciprocity provides a deeper insight into cooperation in online communities, particularly in the absence of formal enforcement mechanisms. In such environments, users often adopt informal strategies drawn from repeated games, rewarding cooperative behaviour while punishing non-cooperation through social sanctions such as downvotes, exclusion, or reputational loss. In this way, reciprocity acts as a decentralised substitute for governance, enabling self-regulation even in large, anonymous networks.

To better understand this mechanism, it is useful to distinguish between gift exchange and commodity exchange. In a gift exchange, a contribution is made with an implicit, delayed expectation of reciprocation, without explicit bargaining or fixed terms. These exchanges foster long-term social bonds and mutual trust, especially when the giver and recipient share a continuing relationship or group membership. By contrast, a commodity exchange is transactional: it involves a clear, immediate equivalence of value, based on the incidence of wants and governed by market logic.

In online communities, content shared voluntarily – such as tutorials, advice, or answers to questions – is a gift in a strict sense (Kollock and Smith, 1999). It is often offered without any guarantee of return, particularly in spaces where the recipient is anonymous or unknown. Yet such digital gift economies flourish because contributors anticipate indirect reciprocity: others may reward them later, or the group as a whole may sustain a culture of helpfulness. This structure allows for network diversification, where social capital and recognition extend beyond direct exchanges. In contrast, commodity exchanges would restrict cooperation only to clear, mutual benefit, undermining the openness that underpins many online platforms. Therefore, digital reciprocity transforms unilateral contributions into socially valuable signals, reinforcing cooperative norms without relying on central enforcement.

Many of the services provided in online communities – answers to questions, shared advice, user moderation – qualify as public goods: they are non-rivalrous and non-excludable. Information posted online is publicly accessible on many platforms, while an individual viewing the information does not diminish the access for other people. However, public goods are prone to underprovision due to the free rider problem: individuals may benefit from others' contributions without reciprocating, reducing the incentive to contribute. Stack Overflow receives 7 million monthly visitors, but there are only 300,534 registered users, demonstrating the extent of contribution inequality (Mamykina et al., 2010).

Digital communities address this dilemma through indirect reciprocity and generalised exchange (Kollock and Smith, 1999). Users help others with the expectation that someone else in the community will eventually return the favour (not necessarily the same individual). Other non-monetary incentives that support this behaviour include:

- Strategic incentives: building a good reputation, increasing one's visibility, or improving access to future help;
- Social incentives: intrinsic satisfaction from helping, status within a group, or moral obligation;
- Psychological incentives: feelings of efficacy, identity alignment with community values, or personal attachment to the platform.

One of the key challenges in digital environments is asymmetric information – users cannot immediately observe others' intentions or trustworthiness. In economic terms, the risk of adverse selection and moral hazard is high: low-quality contributors may flood the community, and once accepted, users may shirk cooperative norms without penalty. To mitigate these risks, platforms implement signalling mechanisms: Reddit uses upvotes and karma scores; Stack Exchange ranks users by reputation points; Discord servers often assign roles based on activity or trust. These signals reduce information asymmetry by making users' past behaviour visible, allowing others to adapt their responses accordingly.

Identity persistence allows players to distinguish between people despite anonymity of online platforms, which makes retaliation strategies possible. Additionally, past interactions are available to players – such as server history or user reviews. Therefore, people who exploit the system and become free riders can be punished by community due to their public activity. Reputation, in this context, becomes a strategic asset. Users invest in cooperative behaviour to build a reputation that yields future benefits, such as access to information, faster help, or social status.

Reputation also functions as an enforcement mechanism on many platforms, punishing defectors by excluding them from future benefits. In comparison to contractual or relational enforcement which are used in real world markets, reputation enforcement mitigates the risks of asymmetric information in the market without hindering the individual's ability to differentiate between trustworthy players and defectors. According to empirical research, reputational enforcement is particularly effective at developing self-perception of trust and trustworthiness (Kuwabara, 2015). Furthermore, reputational knowledge tends to increase the level of cooperation within community highlighting its positive effects on perception of trust (Gallo and Yan, 2015).

Despite their strengths, online communities face structural and cultural limits that constrain cooperation. First, voluntary moderation, that allows platforms like Discord to function, depends on individuals' intrinsic motivation and available time. Without sufficient engagement, norm enforcement breaks down, and communities risk being overrun by spam, misinformation, or toxic behaviour. Stack Overflow has been operating on the basis of achieving minimum response time rather than increasing total number of registered users since it is more important to ensure frequent participation of users (Mamykina et al., 2010).

Second, the scalability of cooperation within small groups is questionable since more complex interactions will have higher implicit costs. Although digital space significantly reduces management and organisation costs for any public good, it may be hard to coordinate between anonymous participants (Kollock and Smith, 1999).

Finally, absence of explicit governance over the space allows for freedom and development of reputational and relational enforcement, but it inevitably leads to higher risk of defection for anyone involved (Kuwabara, 2015). Generalised exchange is riskier because there is no guarantee that fairness would be maintained within community. Contractual enforcement, which is based on contracts rather than reputation, ensures cooperation via rule of law, but makes trustworthiness seem forced. Hence, players fail to learn effective strategies for cooperation, becoming less trusting of transactions that do not involve contracts.

Case study

To support my arguments I look at Stack Overflow as my case study. The platform hosts over 29 million registered users, with more than 24 million questions and 36 million answers as of 2025 (Stack Exchange Inc, 2025). Despite this scale, the platform sustains high rates of cooperation – 92.6% of questions received at least one answer as of 2010, with median first response time around 11 minutes (Mamykina et al., 2010). This demonstrates that large, decentralized communities can still act cooperatively and respond rapidly, aligning with public goods dynamics.

Stack Overflow's gamification system is well-documented: users earn reputation points and badges for contributions such as answering questions and receiving upvotes, which unlock moderation privileges and visible status within the community. Users with reputation over 20,000 are considered "trusted users", leading to real and material implications of high reputation (Osborne et al., 2023). Only 0.05% were considered "trusted" at the time of the study (Osborne et al., 2023). This reflects signalling theory in action: users build visible reputational capital via sustained cooperation.

Empirical work shows that 35.2% of developers answer two or more questions, and only 7.8% answer more than 5 questions (Wang, Lo and Jiang, 2013). This illustrates participation inequality and how reputation incentivises consistent cooperation. Moreover, users experience loss aversion – they react more strongly to downvotes than upvotes – indicating that reputational penalties effectively deter defection (Shankar, 2022). StackOverflow surveys reveal that 25.6% of respondents visit the website to "contribute to a library of information", and 12.4% of respondents say they contribute to open source at least monthly (Stack Overflow Inc, 2019). This suggests reputational rewards create positive feedback loops reinforcing cooperation.

Conclusion

Cooperation in online communities does not arise from altruism alone but is sustained by the strategic logic of repeated interaction, signalling, and reciprocal enforcement. Through identity persistence, reputation systems, and decentralised monitoring, platforms recreate the incentive structures necessary for cooperation to emerge in anonymous, large-scale environments. Game theory thus provides a framework for understanding digital cooperation, illuminating how public goods are provided and sustained without central governance. As online communities continue to shape our social and economic lives, understanding these dynamics is essential to designing more cooperative digital spaces.

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Section 2. Finance, monetary circulation and credit

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STOCHASTIC MODELING AND EFFICIENT SIMULATION OF BRENT CRUDE OPTION PRICES

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Abstract

This study analyzes Brent crude oil call option pricing by integrating the Black–Scholes analytical model with Monte Carlo simulation enhanced by a control variate. Historical daily closing prices of Brent crude from July 2007 to December 2024 (Yahoo! Finance) are used to calibrate asset dynamics. The Black–Scholes formula provides a theoretical option price under the assumption of constant volatility. The Monte Carlo simulation generates numerous stochastic price paths under a Geometric Brownian Motion model, yielding an initial option price estimate of $10.66 (with mean simulated oil price $73.31 and volatility $28.71 at one year). By using the Black–Scholes value ($10.16) as a control variate, the Monte Carlo estimate is adjusted to $10.16, effectively reducing variance. These results demonstrate that combining analytical and numerical methods yields robust option price estimates and better captures market uncertainty.

Keywords: *Option pricing; Black–Scholes model; Monte Carlo simulation; control variate; Brent crude oil*

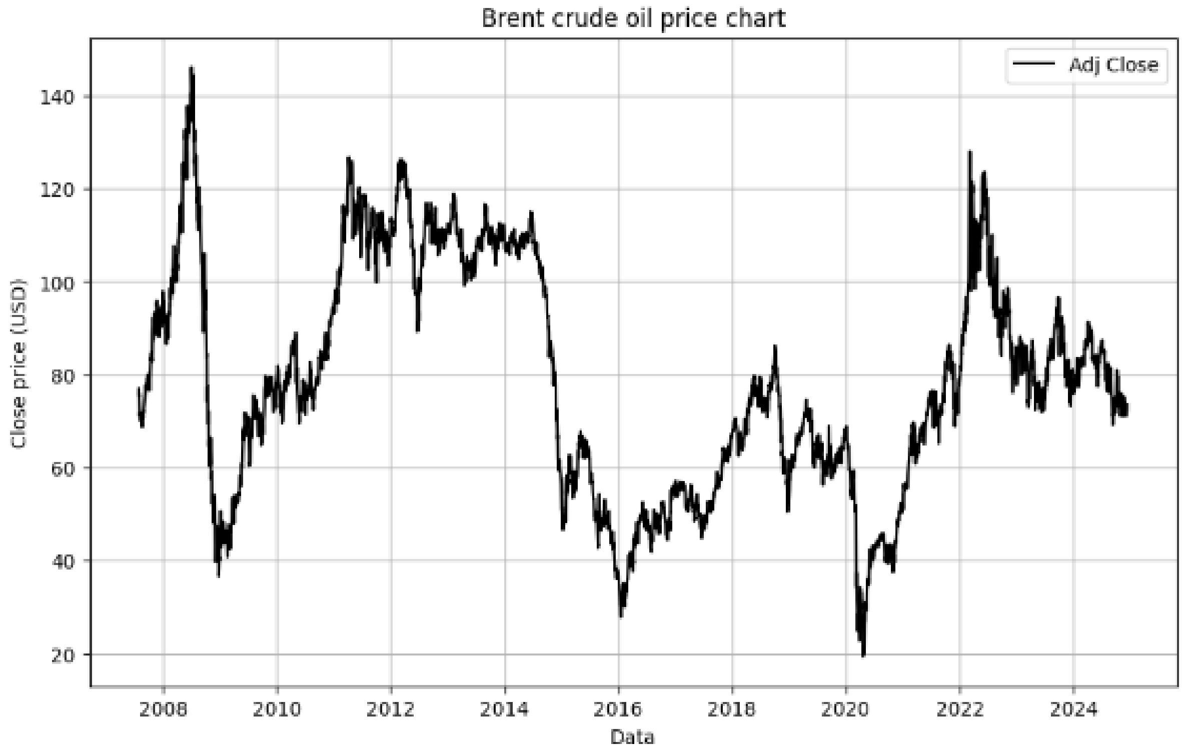
1. Introduction

The price of financial derivatives has formed the basis of modern research in finance in general, especially around volatility models and stochastic modeling concerning the market while pricing derivatives. This work explores the essential concepts and the latest trends in the option pricing area concentrating on the Black-Scholes model, geometric Brownian motion, and Monte Carlo simulation in derivative crude oil pricing. The value of financial derivatives, particularly those of options, has become the most essential pillar of the modern financial market. The call option among all is perhaps one of the most important for hedging purposes, also for speculation and diversification of portfolios. A call option is a contract where the buyer is given the right to buy an underlying asset at a definite strike price within some predetermined period, but the buyer is not obliged to do so. If the buyer does decide upon exercising the option, however, the seller must sell the associated assets. Call options come in two forms, however: European and American. The main distinction between the two is that European options are executable only at expiration, while the latter may be exercised any time before or at expiration, making it more demanding in pricing exercise. Instead, the classical Black-Scholes model provides a mathematical approach for pricing the European options (Gustafsson, 2010).

It brings out the evolution of option pricing research from a historical perspective and implies that these should be dynamic because the nature of modern financial markets requires innovative approaches. The modern way, according to the research proposed here, promises to be stochastic and numerical. This study just might touch both the domains of derivative pricing in theories as well as practice. Although the fusion of classical and cutting-edge techniques in option pricing does resolve the limitation of conventional models, using the control variates in the Monte Carlo simulation improves efficiency. Next, it implies how traditional asset price dynamics will be captured more realistically with geometric Brownian as its between-dollar movement.

The dataset demonstrates how Brent crude prices have undergone dramatic fluctuations over the years. Peaks above $140 per barrel in 2008 sharply contrast with lows near $20 per barrel in 2020.

Figure 1. *Historical data of Brent oil price*



2. Research method

The Black-Scholes model is a widely used analytical approach for pricing European call and put options. It assumes that the price of the underlying asset follows a Geometric Brownian Motion and incorporates assumptions like constant volatility and a risk-free rate.

The formula for a European call option is:

$$C(S_t,t)=S_tN(d_1)-Ke^{-r(T-t)}N(d_2)$$

where S_t – current price of the underlying asset (e.g., Brent crude oil),

K – strike price of the option;

r – risk-free interest rate;

$T-t$ – time to maturity;

σ – volatility of the asset price;

N() – cumulative distribution function of the standard normal distribution.

$$d_1 - \frac{\ln\left(\frac{S_t}{K}\right)+\left(r+\frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}}$$

And in that case, we have the equation:

$$d_2 - d_1 - \sigma\sqrt{T-t}$$

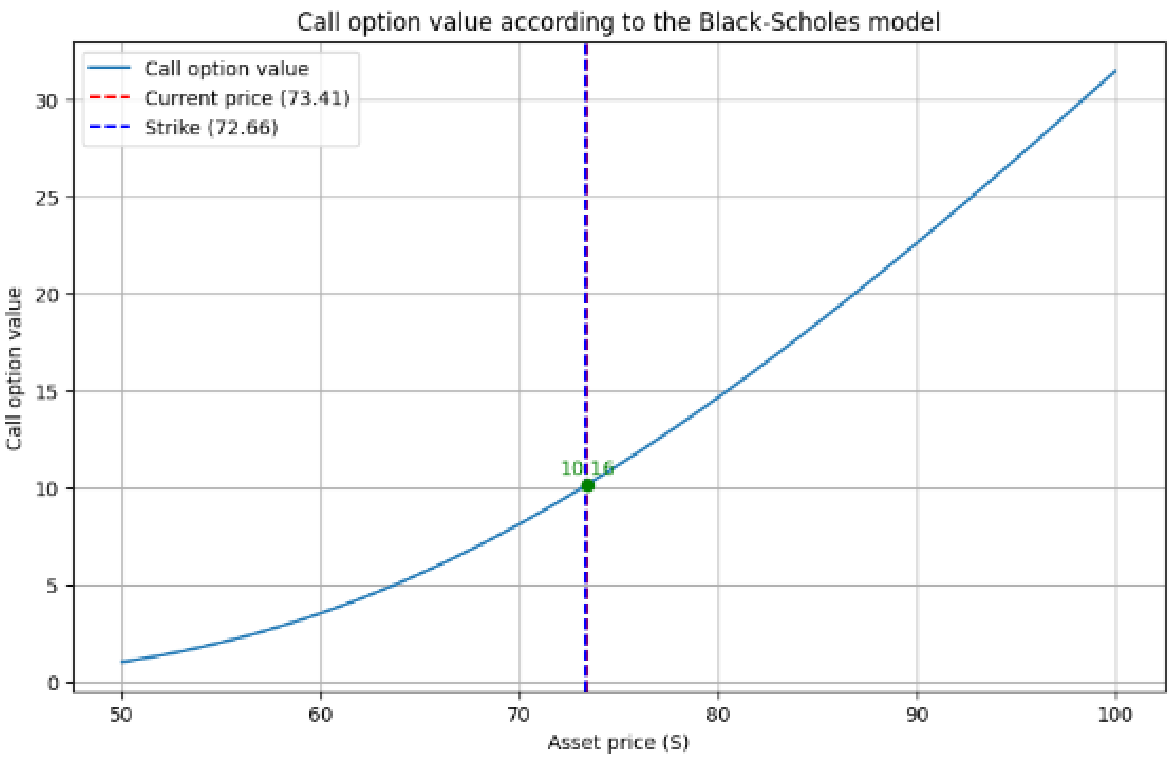
where d_1 – is the volatility-adjusted expected value of the logarithmic expected return on the asset before expiry of the option. This reflects the probability that the asset price will exceed the strike price in the future;

d_2 – is a step closer to the expiration of the option, considering only current conditions and volatility. It relates to the probability that the option will be exercised.

At first glance, it might seem quite inviting to just walk the reader through a sequence of logical steps-buttressing the arguments with the model assumptions and the underlying mathematics. These arguments start with identification of the parameters that determine the option value: the current price of the underlying asset, strike price, the time till expiry of the option, risk-free interest rate, and the volatility of the returns from the underlying asset. These factors represent the economic environment and the characteristics of the option contract. The next thing is to take the calculations of the two main pieces of information which measure how likely it is that an option would be exercised profitably. These measure how much the current price of the underlying asset concerns the strike price, adjusted for time, volatility, and a risk-free rate. The measures themselves are basically the probabilities, under a risk-neutral framework, of ending up in the money at expiration.

After obtaining these variables, their corresponding probabilities under the standard normal distribution are determined. This probability is denoted sometimes with the cumulative distribution values, which reflects the expected likelihood for the specific outcome from the option payoff.

Figure 2. *The value of call option*



Python libraries were utilized for computational efficiency and accurate results. The Black-Scholes model provided a theoretical baseline for pricing options, which we then compared with results derived from simulation methods.

The Geometric Brownian Motion is a stochastic process often used to model the dynamics of financial assets. GBM assumes that the percentage changes in the asset price follow a normal distribution. The mathematical representation of GBM is presented in the formula:

$$dS_t = \mu S_t dt + \sigma S_t dW_t$$

where S_t – price of the asset at time t;

μ – expected return of the asset;

σ – volatility of the asset;

dW_t – increment of a Wiener process (Brownian motion).

We discretized the GBM process for simulation using the following equation:

$$S_{t+\Delta t} = S_t \exp\left(\left(\mu - \frac{\sigma^2}{2}\right)\Delta t + \sigma\sqrt{\Delta t Z}\right)$$

where $Z \sim N(0,1)$ – is a standard normal random variable.

The formula to generate thousands of simulated price paths for Brent crude oil over a one-year time horizon. The resulting graph illustrates the wide range of possible future prices based on GBM, with the expected average price at the end of the simulation being approximately $73.31. This approach effectively captures the stochastic nature of oil price movements.

3. Results analysis

The Monte Carlo simulation provided additional insights into the dynamics and variability of the price forecast over the analyzed period. This stochastic approach modeled thousands of potential price paths, allowing us to assess not only the expected price but also the broader statistical distribution of outcomes. The primary modeled prices from the Monte Carlo simulation yielded the following results:

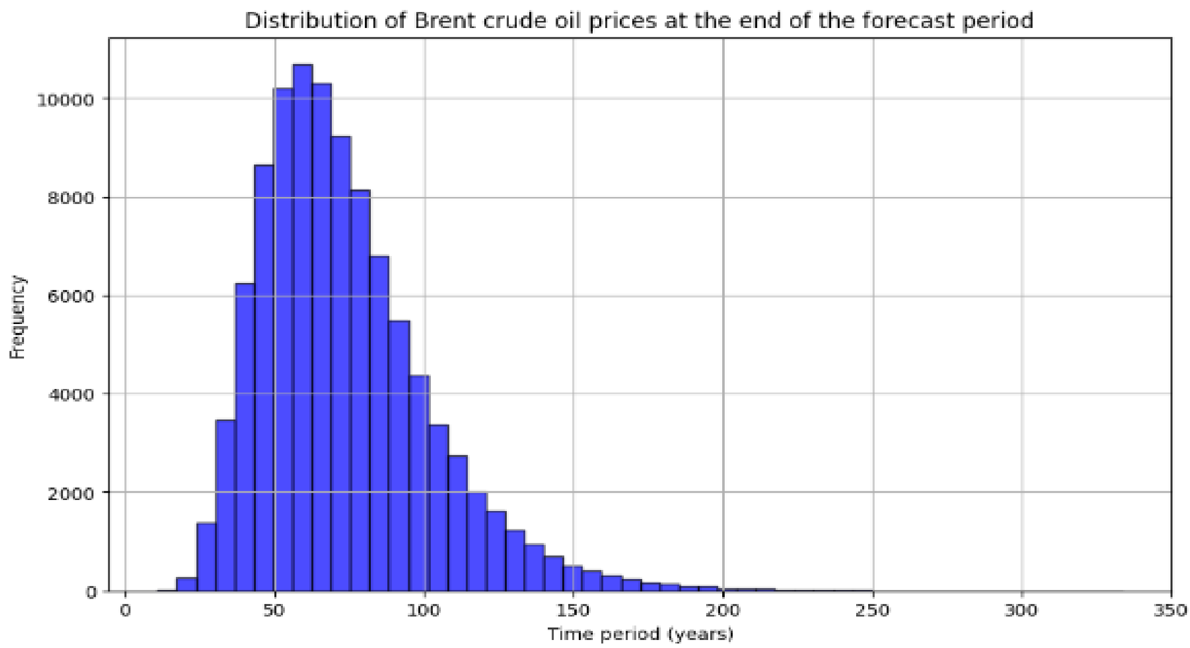
Expected average price at the end of the period: $73.31;

Standard deviation of price at the end of the period: $28.71;

Minimum modeled price: $10.86;

Maximum modeled price: $333.98;

Figure 3. *Final distribution of Brent crude oil prices at the forecast horizon*



Next, with a set price of 10.16, we ran 100,000 simulations using the Monte Carlo model and obtained the following results – the option price using the model is 10.66.

This kind of investigation has fleshed out the complete analysis of option pricing and the underlying dynamics of the market by the application of methodologies and stochastically modeled methods. The fair option price arrived at through advanced mathematical instruments manifestly shows varying economic variables that define the fairness of that option price within the established economic forecasting precision.

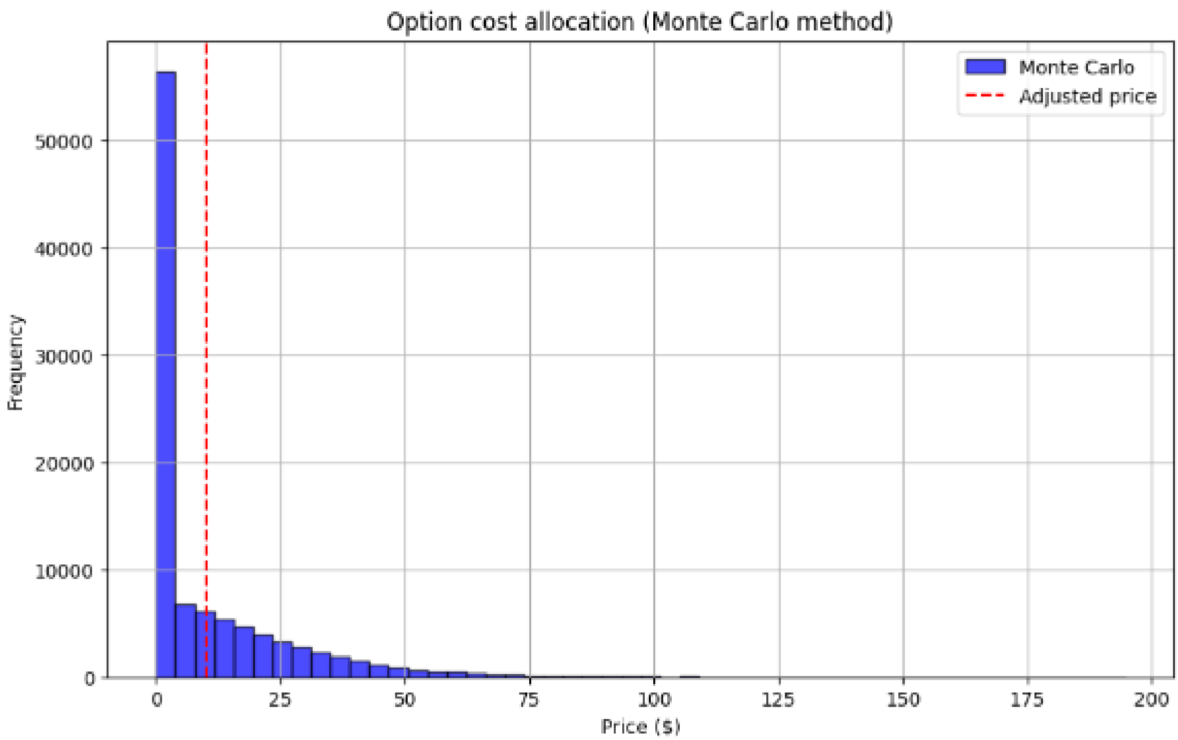
The price movements of an asset are now shown to be highly volatile, as such might bring a greater range in possible extreme prices and reveal their sensitivity when market forecasts become torn with unknown events. Such volatility reinforces the need to develop flexible strategies capable of accommodating favorable as well as adverse market entry. This entire approach-the theoretical precision and the probabilistic exploration-can deepen the understanding of finance. It enables market participants to make informed choices-whether they wish to hedge an adverse price movement, make money off a favorable situation, or construct portfolios based on a risk position and investment goals. The stock price was modeled using the geometric Brownian motion equation, incorporating parameters such as the initial stock price, volatility, risk-free rate, and the expected annual return.

The time horizon was set to one year, divided into 252 trading days, and each random price path was generated step by step using standard normal variables to account for the randomness in price movements.

At each step, the Black-Scholes formula was applied to calculate the theoretical value of a European call option based on the simulated asset prices. This allowed us to track the option's value throughout the year, ultimately providing an average option value at every time point. By the end of the simulation, the Monte Carlo model yielded an estimated option price of 10.66. This result demonstrates the effectiveness of using Monte Carlo simulations to provide a probabilistic estimate for option valuation, complementing analytical methods like the Black-Scholes model.

The graph above visualizes how the average value of the call option evolves over time, showing a gradual upward trend. This progression reflects the combined influence of time decay, volatility, and the risk-free rate on the option's value. Applications of the Monte Carlo simulation method, the Black-Scholes model, and the control variate technique for option pricing are presented within the analysis in Figure 4.

Figure 4. *Control variate*



Each of these methods brings its unique perspective on the problems to be solved, while reflecting the advantages and disadvantages of the numerical and analytical methods.

The option price given by the Monte Carlo simulation is $10.66. In this method, 100,000 possible trajectories are simulated for the price of the asset according to geometric Brownian motion, and then payoffs resulting from these simulated prices are averaged to find the option price. The method is robust, offering solutions to complex cases; however, here the actual number obtained is slightly more than the theoretical number of $10.16 because of left-over numerical error. This «randomness» is statistical variance, due to a finite number of simulations in the model: because other avenues to reduce variance necessitate much computation, many more simulations to reduce this variance using the number would require a large amount of computational power.

However, the Black-Scholes model gives an analytical approximate solution for the price of a European call under certain assumptions: constant volatility, risk-free rate, and no dividends. The price resulting from this theoretical model is benchmarked at $10.16. Since it is a deterministic model, the Black-Scholes formula is free of statistical errors.

4. Conclusion

The results demonstrate the benefits of integrating numerical and analytical techniques for option pricing. Despite its simplifying assumptions, the Black-Scholes model provides a fast closed-form pricing and functions as a useful control variable. In contrast, Monte Carlo simulation can handle complex dynamics and fully captures the stochastic variability of oil prices, but at the expense of sampling error. Utilizing the significant correlation between the two methods, the control variate "anchors" the simulation and lowers variance because the Black-Scholes price is known. This dual strategy has real-world applications. Market players might utilize simulation to evaluate risk and rely on the analytical model for a baseline quote.

The simulated price distribution provides information not available from the static Black-Scholes price, indicating that extreme scenarios (prices below $20 or above $300) are possible. The combined data can be used by traders for speculative or hedging strategies. yielding the accurate value of the option within the assumptions.

The control variate, which has the Black-Scholes price as reference price, was implemented to improve the Monte Carlo estimate. Black-Scholes price is much correlated with the Monte Carlo estimate, and this known theoretical estimate helps us to apply an adjustment to the Monte Carlo result to make it free from statistical error. After applying the control variate, the adjusted Monte Carlo price converged to the theoretical price of $10.16. This shows the power of combining Monte Carlo simulations with control variates for the purpose of winning without much extra computation effort.

To sum up, the Monte Carlo simulation afforded an estimate of $10.66, quite higher than the theoretical reference owing to number error. The exact price was $10.16 due to the Black-Scholes modeling, as a benchmark. After adjusting with the control variate method, the Monte Carlo result now can stand with the analytical value. This analysis shows how numerical methods like Monte Carlo could be improved using control variates to achieve optimal performance, thus providing useful analysis in settings wherein analytical solutions may be absent. These methods are in synergy, painting a wonderful picture between the domination of numerical and analytical approaches to pricing options

Future modifications might use jump-diffusion processes to reflect abrupt shocks to the oil market, American-style exercise, or stochastic volatility (such as the Heston model). Control variates guarantee computational efficiency, and the Monte Carlo simulation offers insightful information even under the fundamental GBM assumption

By combining the Black-Scholes model with Monte Carlo simulation and variance reduction, this research offers an organized method for pricing Brent crude oil options. In order to simulate asset paths, we calibrated a GBM model using historical Brent data (2007–2024). The Monte Carlo estimate's control variate was the analytical Black-Scholes price of $10.16. When the control variate was applied, the estimate converged to $10.16, which is the theoretical value, from the price of $10.66 obtained from the raw Monte Carlo simulation (100,000 paths). The volatility of possible oil prices was also measured by the simulations (with an annual standard deviation of $28.71). These findings show that accurate option pricing that account for market uncertainty can be obtained by combining stochastic and closed-form approaches.

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Section 3. Wold economy

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TRENDS IN THE GLOBAL LABOR MARKET AND HIGH-SKILLED MIGRATION

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Abstract

This paper examines global trends in highly skilled migration, focusing on the role of destination countries' policies in attracting qualified professionals. As labor markets become increasingly globalized, the demand for skilled workers continues to grow. The study outlines historical shifts in skilled migration since the 1950s and analyzes recent data on migration flows to top destination countries. Findings highlight that international students and highly educated migrants are central to talent attraction strategies, with countries like the United States, Canada, and Germany leading globally. The results emphasize the importance of targeted migration policies in shaping global talent mobility.

Keywords: high-skilled migration, talent mobility, temporary work visas, international students, immigration policy, knowledge economy

Introduction

The global labor market has undergone significant transformations in recent decades, with international migration emerging as a key driver of inclusive growth and sustainable development. The United Nations "Transforming Our World: The 2030 Agenda for Sustainable Development" (United Nations, 2015) highlights the positive contribution of migrants, especially highly skilled individuals, in accelerating national and social development through innovation and knowledge exchange.

In recent years, notable shifts have been observed in both the scale and composition of global migration. According to the January 2025 data released by the United Nations Department of Economic and Social Affairs (UN DESA), the number of international migrants reached approximately 304 million in 2024-nearly double the figure in 1990 (United Nations, Department of Economic and Social Affairs, Population Division, 2025). Despite this absolute growth, the share of migrants in the global population remains relatively low, increasing only from 2.9% in 1990 to 3.7% in 2024.

A key dimension of this transformation is the increasing role of highly skilled migrants in shaping global labor dynamics. High-income countries such as the United States, Germany, Canada, and Australia have implemented targeted visa programs and talent attraction strategies, becoming major destinations for specialists in STEM (science, technology, engineering, and mathematics) fields, finance, healthcare, and emerging technologies. This shift reflects the growing international competition for skilled human capital in an increasingly knowledge-based and digitized global economy.

Literature Review

In recent years, there has been a steady increase in scholarly interest in high-skilled migration (HSM) as a key factor in the global redistribution of human capital. According to (Docquier and Rapoport 2012), the international mobility of highly qualified professionals has long transcended the traditional concept of "brain drain" and has become a systemic component of the global knowledge economy. Contemporary studies increasingly interpret HSM as a process influenced by both demand-side (destination countries' policies) and supply-side (individual motivations) factors (Kuptsch, 2020; Boucher & Cerna, 2021).

One of the most actively explored directions in HSM research involves government-led visa programs aimed at attracting qualified labor. For instance, studies by (Avato and Koettl 2019) emphasize that schemes such as the H-1B in the U.S., the EU Blue Card, and Australia's Global Talent Visa are essential instruments not only for addressing labor shortages but also for participating in the global competition for talent. These programs offer clear pathways from temporary employment to long-term immigration, which is a key incentive for many migrants.

Another important focus in the literature is the migration of international students. (Tremblay 2022) and (Della Posta 2023) argue that in countries such as Canada, the United Kingdom, and Australia, international students are increasingly viewed not merely as learners but as prospective high-skilled migrants – especially in contexts where post-study work rights and residency opportunities are available.

Recent work also draws attention to spatial and gender disparities in the distribution of high-skilled migrants. (Bielewska 2021), for example, highlights that women remain underrepresented among internationally mobile professionals, particularly in STEM fields, which underscores the need for more inclusive and targeted migration policies.

Methodology

This study applies a mixed-method approach, combining descriptive statistical analysis with a policy-oriented review of global high-skilled migration (HSM). It uses publicly available data from institutions such as UN DESA, USCIS, and UNESCO to examine trends from 1990 to 2024, with emphasis on the post-2010 period.

The analysis focuses on temporary and selective visa programs (e.g., H-1B, J-1), evaluating their role in shaping talent flows by country of origin, sector, and geopolitical context. Migration patterns are studied by destination income groups using World Bank classifications.

Statistical findings are presented through time-series data and comparative charts, with attention to regional and gender disparities. This framework supports a comprehensive view of how visa regimes influence the global distribution of high-skilled labor.

Result and Discussion

International labor migration, particularly the movement of highly skilled professionals, is closely linked to global changes in the world economy. As labor markets become more globalized, the demand and supply of skilled workers are shaped at the international level. The post–World War II economic system has increased the significance of migration, making it a key factor in economic growth and demographic dynamics. This table analyzes high-skilled migration across four main phases.

At each stage, international political and economic factors – such as scientific and technological progress, globalization, the digital economy, and geopolitical crises – have significantly influenced the demand for skilled labor and the directions of migration flows.

This analysis focuses on highly skilled migrants, primarily including international students and professionals working under non-immigrant (temporary) employment visas. In particular, migration flows under U.S. visa categories such as H-1B, J-1, L-1, and O-1 are examined.

Table 1. *Phases of Global Trends Influencing High-Skilled Migration (1950s-2020s)*

Phase	In-Demand Professionals	Impact on the Global Economy
Phase 1 (1950s-1960s) Scientific-technical revolution; decolonization	Engineers, physicists, rocket scientists, medical doctors	Acceleration of scientific and technological progress; independence of former European colonies
Phase 2 (1970s-1980s) Technological advancement; geopolitical shifts	IT specialists, programmers, academics, researchers	Growth in computing and electronics; US–USSR technological competition; rise of transnational corporations and expansion of global economic networks
Phase 3 (1990s-2010) Globalization and transition to market economies	Software developers, startup founders, business managers, engineers	Collapse of the USSR; development of the Internet and digital technologies; formation of global markets; emergence of innovation-driven economies
Phase 4 (2010-present) Digital economy, AI, pandemics, trade conflicts	AI specialists, data analysts, cybersecurity and fintech experts	Rapid automation and AI integration; US–China trade war; COVID-19 pandemic accelerated global transformations; stricter migration policies

Source: Compiled by the author

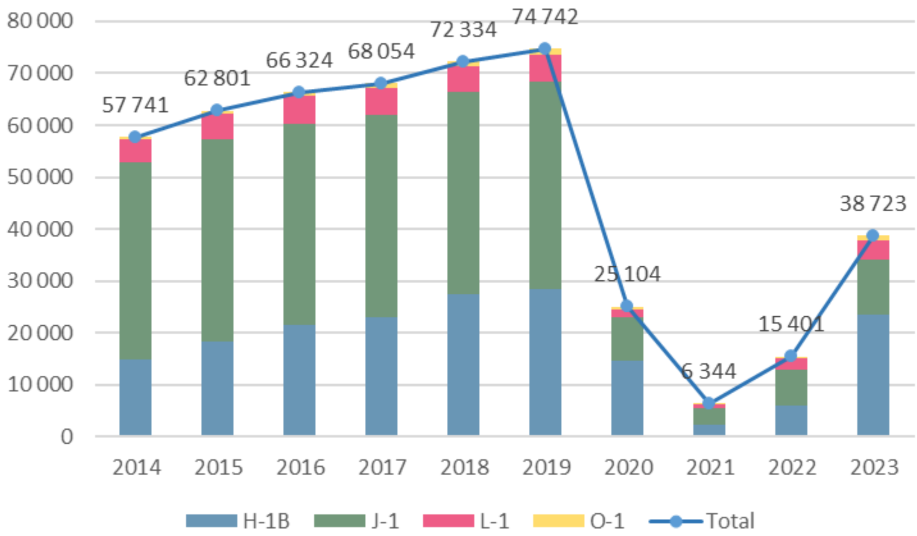
In the United States, highly skilled migrants are primarily admitted under non-immigrant visa categories (see Table 2). According to According to the United States Citizenship and Immigration Services (USCIS) data, the number of such visas reached 636,141 in the 2019 fiscal year and increased to 678,135 by the 2023 fiscal year (U. S. Department of State, 2025; https://travel.state.gov/content/travel/en/legal/visa-law0/visa-statistics/nonimmigrant-visa-statistics.html), following the COVID-19 pandemic.

Table 2. *Types of U. S. Non-Immigrant (Temporary) Employment Visas for Professionals*

Visa Type	Description	Eligible Applicants	Duration
H-1B	Temporary work visa for highly skilled professionals	STEM professionals, specialists in IT, engineering, finance, healthcare, and related fields	Initially 3 years; extendable up to 6 years
J-1	Exchange visitor visa	Students, professors, researchers, physicians, interns, and other exchange participants	6 months to 7 years, depending on the program
L-1	Intra-company transfer visa	Managers, executives, or employees with specialized knowledge transferring within international companies	Initially 1 year (for new offices) or 3 years; extendable up to 7 years
O-1	Visa for individuals with extraordinary ability	Persons with proven achievements in science, arts, sports, business, or education	Initially 3 years; renewable annually

Source: Compiled by the author based on data from the United States Citizenship and Immigration Services (USCIS, 2025)

Figure 1. *Number and Trend of U. S. Non-Immigrant Employment Visas Issued to Chinese Nationals, 2014–2023*

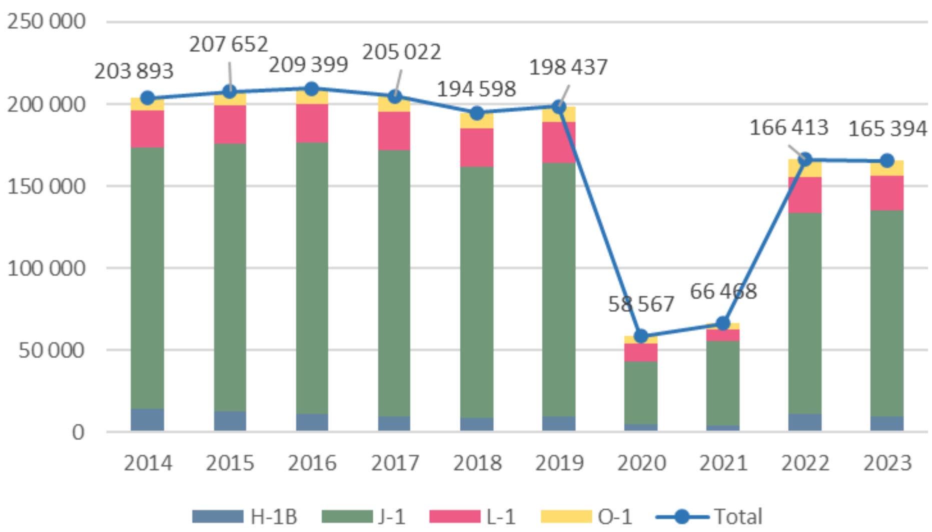


Source: Compiled by the author based on publicly available online sources: https://travel.state.gov/ content/travel/en/legal/visa-law0/visa-statistics/nonimmigrant-visa-statistics.html

The number of non-immigrant employment visas issued to Chinese nationals has averaged around 70,000 per year. The peak was recorded in 2019, with 74,742 visas issued. However, during the COVID-19 pandemic, this number dropped sharply, reaching its lowest point in 2021. Since 2022, the figure has gradually begun to recover, reaching 38,723 visas issued to Chinese nationals in 2023 (see Figure 1).

Before the pandemic, the number of non-immigrant employment visas issued to European nationals remained stable, averaging around 200,000 per year. The peak was reached in 2016, with 209,399 visas issued (see Figure 2).

Figure 2. *Number and Trend of U. S. Non-Immigrant Employment Visas Issued to European Nationals, 2014–2023*



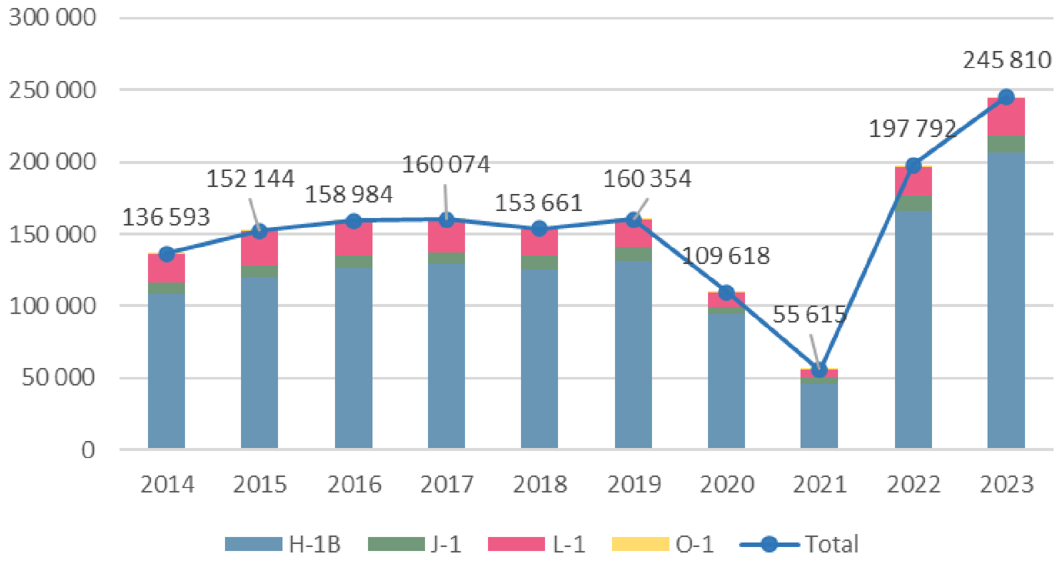
Source: Compiled by the author based on publicly available online sources: https://travel.state.gov/content/travel/en/legal/visa-law0/visa-statistics/nonimmigrant-visa-statistics.html

In contrast, the number of such visas issued to Indian nationals showed steady growth, reaching its highest point in 2019 with 160,354 visas granted (see Figure 3).

During the pandemic, the number of visas issued to Indian nationals declined sharply, reaching only 34.7% of the 2019 level by 2021. However, amid the easing of migration policies in both the United States and India, the figure rose to 197,792 in 2022 and further increased to a new historical high of 245,810 in 2023.

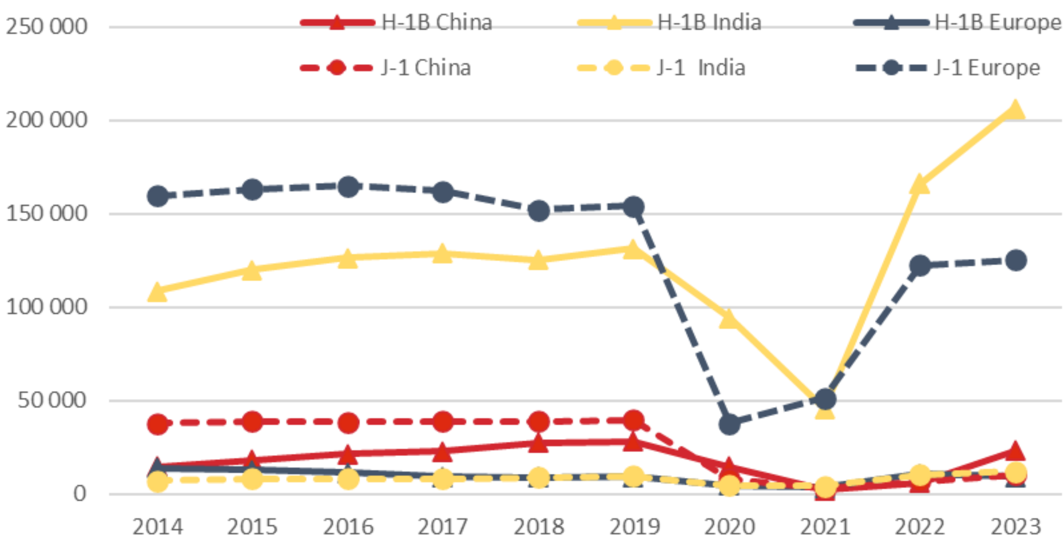
Trends in H-1B and J-1 visa categories vary significantly across countries. India leads in the H-1B segment, with the number of visas increasing from 108,817 in 2014 to 206,591 in 2023. In contrast, the number of H-1B visas issued to Chinese and European nationals remains significantly lower-23,482 for Chinese and only 9,309 for Europeans in 2023.

Figure 3. *Number and Trend of U. S. Non-Immigrant Employment Visas Issued to Indian Nationals, 2014–2023*



Source: Compiled by the author based on publicly available online sources: https://travel.state.gov/content/travel/en/legal/visa-law0/visa-statistics/nonimmigrant-visa-statistics.html

Figure 4. *Trends in H-1B and J-1 Non-Immigrant Employment Visas, 2014–2023*



Source: Compiled by the author based on publicly available online sources

J-1 visas, primarily intended for academic and research exchange, are dominated by European nationals. Between 2014 and 2019, Europeans received over 150,000 J-1 visas annually. Although the numbers dropped sharply during the pandemic, a recovery was observed in 2022–2023, with 125,526 J-1 visas issued to Europeans in 2023. For Chinese and Indian nationals, the annual number of J-1 visas has remained steady at around 10,000 to 12,000.

According to the data, India is the leading source of high-skilled labor to the U.S. under the H-1B program, particularly in the technology and scientific sectors. Europe remains the dominant region under the J-1 visa category. China shows moderate figures in both categories, with J-1 visa levels comparable to India's, but significantly lower H-1B issuance.

Conclusion

The analysis of temporary high-skilled migration to the United States demonstrates that the country actively employs targeted visa programs to attract talent, strengthening its position in the global competition for human capital. The most significant programs include H-1B, J-1, L-1, and O-1 visas, each designed for specific categories of professionals. Notably, J-1 visa holders are predominantly from European countries, likely due to Europe's strong engagement in academic and exchange programs. In contrast, H-1B visa recipients are largely from India, which can be attributed to the country's substantial pool of IT specialists and the strong demand from the U.S. labor market for technology professionals. Overall, the structure of temporary high-skilled migration to the United States reflects both global economic trends and the dynamics of international labor division.

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