

Racing Against the Algorithm: Platform Labor, Human Capital, and Regulatory Trade-offs in China and Beyond

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Abstract. Since 2008, China's food delivery industry has developed rapidly and become one of the country's largest labor markets. These platforms are characterized by algorithmic management to maximize efficiency. However, the highly standardized and time-sensitive nature of platform work as an outcome of algorithmic management has led to a loss of worker welfare, as it inhibits meaningful skill accumulation and upward professional mobility of workers. This essay investigates the specific mechanisms of labor reallocation and erosion of human capital under algorithmic management and the regulatory tradeoff between welfare and efficiency. Drawing on central and local regulations in the current framework, the analysis highlights that China has developed a hybrid model that recalibrates, rather than dismantles, platform efficiency by restricting its harm while retaining flexibility for employment arrangements. These findings contribute to the broader debates on labor reallocation in the rise of the platform economy and provide a reference for future regulation in other countries faced with the same tradeoff.

Keywords: China's food delivery industry, Algorithmic management, Mechanisms and regulatory tradeoff, Hybrid model

1. Introduction

Since the introduction of the delivery platform Ele.me in 2008, the Chinese food delivery industry has expanded rapidly and become one of the country's largest labor markets. By 2024, the sector generated total revenues exceeding 1.7 trillion yuan and employed over 8.4 million platform delivery workers, among whom a huge proportion are rural migrant workers and young urban residents. Such industrial development has profoundly reshaped the labor markets in China.

With technological giants like Meituan and Taobao being the main players of the sector, food delivery platforms have relied heavily on algorithms in their daily operations. The central puzzle of China's food delivery sector is not why workers join these platforms, but the changes in human capital brought by such large-scale labor reallocation under the management of algorithms. Even though the threshold for workers to enter the market is low, the standardized and time-sensitive nature of delivery work restricts long-term skill development of workers and leads to persistent constraints on upward mobility in their professional trajectory. At the aggregate level, such problems eventually cause negative consequences, including structural inequality and a deterioration in social welfare.

Algorithms lie at the core of such transformation, and thus is the focus of such investigation. Delivery platforms widely employ algorithms to distribute orders, establish time restrictions, and monitor the performance of workers. Algorithms play a critical role in the rapid emergence of the delivery sector, optimizing efficiency and reducing operational costs. However, they are also the primary responsibility behind the undermining of the autonomy and welfare of workers. This is because under algorithmic control, workers are forced to comply with the harsh performance requirements placed upon them, even when it makes them more prone to the risks of income instability, safety, and limited career development. Therefore, the tradeoff between efficiency and worker welfare is constantly highlighted, and the regulatory challenge to mitigate the long-term structural consequences of labor reallocation based on algorithms without sacrificing market efficiency of delivery platforms is raised.

China provides a crucial case for understanding this puzzle. As one of the world's largest and most technologically advanced platform labor markets, China offers an unparalleled scale for observing the mechanisms of algorithmic labor reallocation in practice. Furthermore, China's governance model reflects a proactive attempt to recalibrate market efficiency through regulatory interventions aiming to protect labor rights, which exemplifies the tricky balance between efficiency and public welfare.

This essay contributes to the literature that studies platform delivery work as a process of labor reallocation, with fundamental implications for human capital and welfare. It advances three core mechanisms through which such reallocation takes place. Firstly, the essay analyzes the emergence and market landscape of the food delivery industry, providing context for the market condition that algorithmic coordination dominates work, and hence determines who works, where, and under what conditions. Secondly, there is an analysis of the effect of the highly standardized and time-specific nature of work on workers' human capital formation. Finally, there is an analysis of the trade-offs between worker welfare and platform efficiency with regards to regulation and the role of the government in such reallocation. Empirically, the paper draws on the Chinese food-delivery sector to illustrate how these mechanisms play out in practice.

2. Theoretical framework

2.1. Labor reallocation under algorithmic control

Labor reallocation generally refers to the movement of workers from declining or less productive industries to growing or more productive ones. The food delivery industry substantially reflects this process as a huge number of workers are reallocated from traditional sectors including farming, manufacturing, catering, retails and informal employment [1]. Even though the delivery industry itself is an oligopoly, the barrier to entry to become a worker in the industry is extremely low, requiring no formal credentials and minimal training. As a result, the delivery platforms attract low-skilled workers such as migrants, laid-off manufacturing employees, and uneducated youths seeking quick income opportunities. Platform labor also functions as an employment buffer during economic downturns, absorbing labor that would have otherwise become unemployed [2].

Notably, this process of reallocation is a result of the process of technological development, especially the use of algorithmic systems, which, in turn, creates downstream effects on human capital and welfare. The use of algorithms in delivery platforms plays a crucial role in defining critical characteristics of the work of a worker. This change in the nature of the job often includes effects on the manner in which workers reallocate between sectors, the types of skills created or lost by the workers, and the welfare of the workers in the long term.

While workers are drawn into delivery platform jobs because of speed, flexibility, and immediate earnings, algorithmic control reduces autonomy and increases the uncertainty of the work. The allocation system produces highly standardized tasks, compressed time windows, and limited discretion and reduced skill use. Consequently, labor reallocation into platform work can lead to human capital stagnation and welfare risks [2].

As delivery platforms attract labor from all walks of life, they contribute to the emergence of a dual labor-market structure. On the one hand, workers are often pulled out of formal employment by the temptation of immediate income and flexible hours, especially during periods of economic transition or personal instability. On the other hand, they are pushed into platform work by the decline of traditional sectors, which offer stable jobs with benefits, in contrast to delivery jobs. While the platform economy provides a safety net by absorbing short-term unemployed individuals, it typically offers little in terms of skill development or career advancement. Consequently, many workers risk becoming trapped in a cycle of low-skilled, flexible gig work without a clear pathway back to more stable and formal employment.

2.2. Human capital decline

Labor reallocation under algorithmic control thus has downstream consequences for human capital accumulation. Human capital, as a fundamental concept, is generally referring to skills, knowledge, and overall experience that an individual or a given group is able to accumulate, often from a perspective related to costs that a given organization or a given country has to pay over a given level of human capital. According to Huang, "online platform work disrupts conventional routes to skill-building, and this is because the algorithmic control of platform delivery shapes a worker's learning, skill transferability, and even career mobility [3]."

Since the platform's algorithms take over route planning, task sequencing, and time management, assigning tasks that are fragmented, replaceable, and time-pressured [4]. Therefore, workers lose opportunities for judgment-based, experiential skill formation [5]. Instead, workers only gain very narrow forms of spatial familiarity and app-based operational skills. These competencies, while rewarding short-term performance, are hard to certify and transfer to other sectors limiting their usefulness in long-term development [6].

Furthermore, delivery jobs offer few pathways of upward mobility. Most apparently, there are very limited career ladders, with most riders remaining in the same role for years [7]. In addition, high turnover rates among workers decrease the interest of employers to invest in training because they find it unnecessary. This creates a vicious circle where workers are considered an interchangeable labor input, not candidates for more skilled jobs. In general, such dynamics risks trapping workers in low-skilled and informal employment without feasible routes back into more stable and mature labor markets that eventually will perpetuate structural inequality

2.3. Regulatory tradeoffs between efficiency and welfare

Such downstream consequences of platform labor reallocation bind well-designed regulations to safeguard social welfare for workers in the delivery industry. The inevitable large trade-offs in regulating platform efficiency, created by efforts to address the welfare challenges of platform workers, such as income instability, safety risks, and lack of social protection, will always create difficult policy dilemmas. For instance, minimum pay floors, such as those created by regulations, would enhance income stability, but might also reduce the flexibility that is central to the platform's operating model and cost structure. Similarly, demands for algorithmic transparency lower opaque

management practices and increase worker power, but impose costly technical adjustments on platforms that might stifle innovation.

The second essential challenge involves anti-monopoly regulations. While the intervention may be helpful in enhancing workers' bargaining power, the dominant position of the platforms over the competition has been built around speed and lower prices for consumers. Where the major platforms suffer as a result of losing some market advantages following their compliance with some regulations, the capacity of the platforms to absorb the workers' labor would then be influenced, and they would be left with even fewer alternatives. The challenge then revolves around how the needs and well-being of the workers can be catered for without undermining the competitive advantages, such as reliability, associated with the platform economy.

2.4. Synthesis

Overall, the emergence of the platform-based economy has profoundly changed the nature of labor and has become an important factor in labor creation. However, as the nature of labor in a platform-based economy depends on algorithms and aims at achieving efficiency, it can limit human capital accumulation in a substantial way. Such limitations not only affect individual workers' long-term mobility and welfare, but also generate potentially broader risks for the labor market sustainability. These concerns underscore the necessity of regulatory intervention to mitigate adverse outcomes and steer the platform economy toward a more sustainable and equitable model. The following section examines these dynamics in the context of China's food delivery sector.

3. Case study: China's food delivery sector

3.1. Market expansion and price war

The rapid expansion of China's food delivery sector happens in a broader context of urbanization. As life pace becomes faster and demands for digital consumption increase, convenient and time-saving food services have surged especially among younger generations and even turned into an indispensable component of urban lifestyles. During the COVID-19 pandemic, when lockdowns and mobility restrictions were widely imposed, the market expansion of the sector further accelerated and attracted even more investment.

China's food delivery platforms, such as Meituan and Ele.me, run on a high-volume, low-margin business model. Thanks to technically advanced algorithmic optimization and initial government subsidy, these platforms manage to connect millions of customers, restaurants, and delivery riders efficiently. However, such business strategy relying on marginal profit often leads to intense competition which often fostered price wars. Platforms use an enormous amount of subsidies and very low prices to retain more users and capture a bigger market share. This often leads to market instability. While consumers benefit from these low prices in the short term, price war leads to platform losses, worsens service quality and causes market instability in the long term [8].

Such a competitive environment plays a critical role in shaping labor welfare. As platforms grapple to minimize cost and maximize their market share through speed and low price, worker rights become the primary margin of the adjustment. Algorithms are further employed to extract more efficiency from riders through compressing delivery time and raising performance requirements, which directly explains the stagnation of human capital development.

3.2. Worker rights and implications for the labor market

China's food delivery industry has undoubtedly created a large scale of jobs. With low entry barriers and flexible working conditions, it attracts a wide range of workers, including rural migrants, individuals transitioning out of declining industries, and those seeking short-term income flexibility [9]. The sector also accelerates the digital transformation of traditional industries, encouraging companies and restaurants to innovate and optimize resource allocation through online platforms [10].

However, this very efficiency-driven model also creates a major trade-off for the workers. While these platforms provide income, the delivery work itself is designed to be simple, fast, and standardized. Riders are required to strictly follow app-generated instructions with minimal flexibility for independent decision-making, such as routes, pacing or task arrangements. As a result, this algorithmic control constrains opportunities for building new and transferable skills through their current job. Instead, workers become reliant on the algorithm and can get stuck in a cycle of repetitive tasks that limit their promotion in the long run.

From the perspective of the Chinese labor market, such dynamics make platform delivery work a holding zone rather than a steppingstone for professional development. While it absorbs surplus labor during economic downturns, it fails to provide any pathways that allow workers to advance their careers through skill development. Consequently, the labor market will also be segmented and less stable as workers face long-term entrenchment and cycle between low-skilled and precarious jobs.

Worker rights are further deteriorated by institutional disadvantages. Delivery workers are typically classified as independent contractors, not employees, which means they are excluded from benefits like health insurance, pensions, or paid leave. Workers must handle income fluctuations together with safety hazards and unpredictable alterations to algorithmic operational procedures, and their working conditions are entirely controlled by the platform's rules and pay rates. Therefore, while the platform economy successfully reallocates labor into employment, it often traps them into work that offers little future growth or safety net, which further the structural inequality in Chinese society.

3.3. Comparison with western platforms

Chinese online food delivery platforms share some similarities with their Western counterparts, such as Uber Eats, Lyft, and DoorDash, yet they show key differences on worker precarity and human capital erosion. This is because Western platforms operate in a market-oriented environment shaped by regulatory constraints and cultural practices [11].

In the United States, for example, customary tipping practices provide a significant supplement to riders' base earnings, granting them greater agency and stability over their total income. Moreover, the presence of stronger regulatory systems forces these platforms to comply with labor standards such as minimum wage laws and other basic rights. Such regulations ensure a higher level of formalization, resulting in more stable work conditions compared to the current status of gig workers in China, which remain largely unprotected. Consequently, while gig work remains precarious worldwide, the combined effects of cultural practice and regulatory enforcement reduce the severity of welfare erosion experienced by workers on Western platforms.

On the other hand, Chinese platforms undermine human capital and worker welfare to a greater extent. First, a worker's earning is almost entirely dependent on the platform's set payment, with no tip to supplement their income. Second, the pressure of price competition forces the platforms to

reduce labor costs, thus undermining their long-term skill development. Third, the riders are often treated as contractors without formal employment protection or social insurance. The presence of these three factors multiplies the worker's vulnerability and limits their career development.

There are two fundamental reasons behind such differences, both tied to the reasons why the Chinese delivery industry could scale so rapidly: policy support and a large labor supply that offers low labor costs. From this perspective, the Chinese industry's exploitation of labor can be seen as a structural feature underpinning the efficiency of the platform economy. The narrow profit margins and fierce competition make it extremely difficult for platforms to completely abandon this algorithm-driven labor management model, further perpetrating the vicious cycle of low human capital and the low-cost market strategy.

In contrast, the rise of companies like Uber in developed countries is largely due to the labor force freed up by outsourcing and technological advancements. These workers generally have higher average skill levels and alternative occupational options. Many workers have full-time jobs and view delivery work only as a secondary or transitional source of income rather than their primary livelihood. Meanwhile, Western companies rarely resort to aggressive low-price competition to gain market share. Combined with the tipping culture, such differences significantly reduce their working pressure. As a result, the erosion of human capital in the Western labor market is less severe, and workers face fewer long-term risks associated with their platform work, which is remarkably different from the situation in China.

4. Evaluation of Chinese platform regulations

4.1. The context and logic of platform regulation in China

The regulatory framework governing China's platform economy is the product of a co-evolutionary process between the platform firms and the party-state, which reflects China's identity as a developmental state with strong regulatory capacity [12]. Enterprises that run these platforms have never been viewed as purely private market actors, but as instruments for achieving nation-level objectives like economic growth, technological upgrading, and employment. The strategic positioning of platforms explains the initial period of regulatory tolerance, where the state permitted platforms to grow rapidly, transforming them from simple service providers into core economic and social infrastructure.

However, as the industry expands, the social consequences of the transformation have become more and more visible and cannot be neglected. Growing concerns over labor precarity, data security, and social stability, has set the stage for state intervention on platform operation. As a result, regulation in China has developed its regulatory system with a polycentric governance model involving central ministries, sectoral regulators, and local governments. Policy makers and implementers all seek to balance multiple, often competing objectives: protecting employment stability, retaining market efficiency, and ensuring social legitimacy.

Strong platform regulations emerged during 2020 to 2022 because institutional reforms enhanced domain-specific centralization within China's national apparatus [13]. The process of reducing bureaucratic fragmentation created an environment for more direct and cohesive interventions in platform behaviors. In this period, regulatory motivations extended beyond economic risks (such as antitrust concerns) to social concerns including inequality, labor precarity, and public dissatisfaction [14]. This a major shift as this new approach established between organizations became the standard which required platforms to manage their employees during work hours while maintaining security at their facilities. Another groundbreaking innovation during this time was the formal recognition of

algorithms as elements which require regulation. Rather than viewing it as a neutral technology, regulators started to see them as a key instrument of labor control with direct consequences for worker safety and mental health [15].

However, regulatory intensity moderated by late 2022, replaced by a renewed emphasis on market recovery and employment stability due to the post-pandemic economic pressure [16]. Such development highlights the adaptability of Chinese platform regulations among the constraints of macroeconomic challenges, while maintaining their fundamental goal of protecting social welfare.

4.2. The current structure of regulations

Instead of having a single comprehensive labor law, China's platform labor regulations have developed through a series of small-scale governmental interventions that address specific matters. The 2021 MoHRSS Guiding Opinion on New Forms of Employment was a turning point as it formally incorporated platform employment into the public labor protection framework. An intermediate worker category was introduced to identify platform workers who work under labor management systems without fulfilling complete labor criteria. Platforms are required to establish key labor-related rules, including platform access and exit, order distribution, piece rates, commission rates, payment structure, working hours, and disciplinary mechanisms. This established the principle that platforms using outsourcing for cooperative labor arrangements must still bear responsibility for labor rights violations.

Subsequent regulations focus on income security and algorithmic control. The 2021 Joint Guidelines on Protecting Food Delivery Riders require platforms to ensure that riders' earnings meet the local minimum wage standard and to replace the "most stringent algorithm" with "algorithmic averaging" mechanisms to moderate delivery time pressure and performance metrics. Guidelines also link labor protection with public safety governance by mandating traffic safety training and compliance requirements for delivery riders. The 2022 Algorithm Recommendation Management Regulation further clarified work scheduling and task allocation algorithms as elements that require compliance with regulatory guidelines. Algorithmic systems are required to deliver labor dispatch services that enable workers to receive their entitled earnings and their designated work breaks and their permitted work hours. The fundamental shift is that algorithms were formally recognized as instruments of labor management, which provided the foundation for holding platform rules and algorithmic decision-making accountable to labor law standards.

In 2023, regulators shifted their attention towards enforcement. The Guidelines on Labour Relations and Contracts adopted an "actual management intensity" approach to determine a worker's employment status. This approach prevented platforms from automatically treating all workers as independent contractors and required them to formalize arrangements through written agreements that clearly specify rights and obligations regarding working conditions and dispute resolutions, which reinforces the core principle of classifying workers based on the substance of labor control. The 2023 Tripartite Guidelines on Labour Rights Protection further defined algorithmic systems as a form of "labor rules" requiring transparency, disclosure to workers, and channels for worker participation in their development. The guidelines also introduced a new definition of working time that includes hidden overtime and constant availability demanded by platforms. A remuneration floor was established through wage minimum and transparent pricing to stabilize income. These central regulations created various complaint and dispute resolution mechanisms to offer workers accessible and effective legal remedies.

At the local level, cities and provinces have experimented with different regulatory approaches. For example, Nanjing has implemented a classification system to differentiate dedicated and

crowdsourced riders since 2021. This "substance-over-form" approach treats all crowdsourced operators as employees when platform management supports their work activities while granting them distinct work-related injury insurance protections. In 2022, Hunan piloted regulations that assume complete responsibility for labor protection enforcement and shifted from general principles. Algorithm management has been integrated with minimum wage protection to explicitly ban "most stringent algorithms," and labor protections have been embedded into public services such as urban rest stations and vocational training.

4.3. Balance of efficiency and welfare

These regulatory adjustments all tackle the critical trade-off between efficiency and social benefits. Rather than simply sacrificing efficiency for its social consequences, Chinese regulations aim to recalibrate it by restricting the harm while retaining flexibility for employment arrangements. However, the current system of regulations continues to operate with major restrictions and unresolved problems. Enforcement varies widely across regions, and key legal concepts, like the "partial labor relationship," are not well understood. Additionally, platforms retain significant operational authority, which, combined with persistent weaknesses in collective bargaining, prevents workers from opposing platform decisions and creates situations where platforms abuse regulatory loopholes.

Papers using comparative perspectives show that platform labor challenges, including algorithmic opacity, employment misclassification, and insufficient social protection, are globally prevalent [17]. However, regulatory responses differ. EU members like Germany usually require platforms to classify their workers as employees, which provides those workers with enhanced rights to negotiate collectively. In contrast, Chinese authorities developed new regulations which establish a hybrid model with separate worker categories, governed algorithms, and mandates on minimum welfare guarantees, without treating all workers as full employees. It represents a new strategy that prioritizes economic recovery and flexible employment while gradually improving labor protections, as an alternative way to balance short-term efficiency and long-term social welfare.

5. Conclusion

This essay examined how the algorithmic reallocation of labor in China's food delivery platforms reshapes human capital and welfare, and how the regulatory measures aim to achieve a balance between the efficiency of the food delivery platforms and the labor market. It highlights three core mechanisms in this process. First, the coordination of algorithms on delivery platforms fundamentally transforms labor allocation, as it decides who will work, where, and how, thus changing the classical pattern of employment. Second, although this optimization model promotes the sectoral expansion and employment generation, the high degree of standardization and time pressure in delivery work hinders skill accumulation, and thus limits the upward mobility of workers. Third, this situation creates a regulatory trade-off between algorithmic efficiency and the protection of workers' welfare.

By examining the growth of China's delivery industry, this essay shows how such development can undermine human capital in a competitive market setting where low-cost approaches are prevalent. As it is a critical factor in promoting economic growth and protecting employment, the Chinese government aims to rebalance such challenges by adjusting algorithmic management practices to ensure labor protection standards. While enforcement and the labor-capital power imbalance continue to exist, such a hybrid model represents an attempt to balance efficiency and

welfare that could be borrowed by emerging markets where economic growth remains a central concern. As the platform economy becomes trendy in many developing countries, China's experience provides an important reference for their future policymaking.

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