Data & Policy (2025), 7: e37
doi:10.1017/dap.2025.12

RESEARCH ARTICLE

Algorithmic regulation at the city level in China

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Received: 19 September 2024; **Revised:** 11 February 2025; **Accepted:** 18 February 2025

Keywords: algorithmic regulation; Chinese social credit system; fairness; interventionism; scoring systems for social governance; transparency

Abstract

On both global and local levels, one can observe a trend toward the adoption of algorithmic regulation in the public sector, with the Chinese social credit system (SCS) serving as a prominent and controversial example of this phenomenon. Within the SCS framework, cities play a pivotal role in its development and implementation, both as evaluators of individuals and enterprises and as subjects of evaluation themselves. This study engages in a comparative analysis of SCS scoring mechanisms for individuals and enterprises across diverse Chinese cities while also scrutinizing the scoring system applied to cities themselves. We investigate the extent of algorithmic regulation exercised through the SCS, elucidating its operational dynamics at the city level in China and assessing its interventionism, especially concerning the involvement of algorithms. Furthermore, we discuss ethical concerns surrounding the SCS's implementation, particularly regarding transparency and fairness. By addressing these issues, this article contributes to two research domains: algorithmic regulation and discourse surrounding the SCS, offering valuable insights into the ongoing utilization of algorithmic regulation to tackle governance and societal challenges.

Policy Significance Statement

This study highlights the growing trend of algorithmic regulation within the public sector, with China's social credit system (SCS) serving as a primary example of this development. By conducting a comparative analysis of SCS scoring mechanisms across various Chinese cities, we shed light on the pivotal role that cities play in both implementing and being subject to algorithmic evaluations. Our analysis examines the extent of algorithmic interventionism within the SCS framework, offering insights into its operational dynamics and broader implications for governance. In addition, the study addresses ethical challenges, particularly concerning transparency and fairness, contributing to the ongoing discourse on algorithmic governance. These findings are crucial for informing future policy decisions regarding the design and implementation of algorithmic systems, ensuring they are both effective and ethically sound in navigating complex governance issues.

1. Introduction

Governments across the globe attempt to implement or have implemented algorithmic regulation in the public sector, labor management, and digital communication. As an increasingly prevalent tool in global social governance, algorithmic regulation is expected to address policy issues more effectively

(Eyert et al., 2022; Veale and Brass, 2019). For example, Estonia has established a national database, including various data from citizens, such as health records or educational qualifications, to facilitate different services, foster transparency, and influence collective behavior (Keen, 2016), which is part of the general ambition to create a European Digital Identity Wallet (see https://e-estonia.com/estonia-the-eid-pioneer-reacts-to-the-european-digital-wallet-plans/). On a global level, different smart city projects exemplify the growing trend of algorithmic regulation, leveraging digital technologies to influence and shape human behavior (Ranchordás, 2020). In 2022, Bologna (Italy) introduced a "Smart Citizen Wallet" application (see https://decentrale.fr/digital-id-in-democracy-to-the-social-credit-system/) that rewards people for "virtuous behavior." A particularly well-known and controversial case of algorithmic regulation is the Chinese social credit system (SCS), which purportedly seeks to increase the "level of trust" in the Chinese society with the help of advanced digital technologies (State Council, 2014). It evaluates the creditworthiness of both individuals and organizations and thereby aims to regulate and change their behaviors in both social and economic domains. In the words of the Chinese government, the SCS functions by "allowing the trustworthy to roam everywhere under heaven while making it hard for the discredited to take a single step" (State Council, 2014). Notably, the SCS is increasingly leveraging an array of digital technologies, including big data analysis, facial recognition, artificial intelligence (AI), and blockchain, to facilitate the aggregation, processing, and analysis of extensive datasets to derive credit scores and behavioral patterns (Engin et al., 2024; State Council, 2022; Zhang, 2020b).

While the recently enacted *EU AI Act* prohibits social scoring systems due to their "unacceptable risk" of violating equality rights (European Commission, 2021), China's State Council just issued the *2024–2025 Action Plan for the Establishment of the Social Credit System* (State Council, 2024) to further promote the development of the SCS. As highlighted in recent research (Chen and Grossklags, 2023), the SCS has steadily matured into an institutionalized entity, making it a compelling subject for studying algorithmic regulation within the public sector. Scholars have previously recognized that there is no universal scoring regime for the SCS at the national level (Liu, 2019; Engelmann et al., 2021; Chen and Grossklags, 2023). In general, there are two branches of the SCS, a commercial branch that is led by several companies, such as Zhima Credit (or Sesame Credit) (Chen and Grossklags, 2020), and a government-run SCS that is constructed at different administrative levels. The government-run SCS has been mostly studied at the national level to explore its reputation mechanism, which is represented by the digital blacklists and redlists, recording "bad" and "good" behaviors, respectively (De Kloet et al., 2019). Moreover, the SCS has garnered significant criticism, predominantly on its opaque nature and its role in extending monitoring and surveillance practices using advanced digital technologies (Suter, 2020; Síthigh and Siems, 2019; Lee, 2019; Liang et al., 2018; Hoffman, 2018).

While the central government devises overarching strategies and policies, cities serve as the primary implementers of the SCS in practical terms and have developed distinct models for executing the SCS. In addition to the SCS blacklists and redlists, city governments also create diverse scoring systems for the local residents and companies, presenting a diversified and more complex picture. In addition, cities not only act as executors but also serve as subjects within the system. They are scored and assessed concerning their execution of the SCS and the business environment they foster. Thus, cities occupy an intriguing position within the SCS where they are both scoring and being scored. The examination of the local implementation of the SCS corresponds with Gerry Stoker's comparative analysis of local governance, highlighting the importance of local-level frameworks in comprehending broader governance dynamics (Stoker, 2011). However, little extant work has been devoted to the SCS at the city level, except for the contributions of Wang et al. (2024) and Li and Kostka (2022), which primarily concentrate on citizens' digital participation and Drinhausen and Brussee (2021), which provides an initial overview of the SCS status as of 2021.

It has been about one decade since the initial launch of the SCS in 2014. Given its rapid evolution and increasing complexity, the system has not undergone sufficient and ongoing examination at the city level. The primary aim of this study is to examine the practical implementation of algorithmic regulation at the city level in China, with a particular focus on its interventionist nature and the ethical considerations of

https://doi.org/10.1017/dap.2025.12 Published online by Cambridge University Press

transparency and fairness. We utilize the framework developed by Síthigh and Siems (2019) as a basis for our analysis. Our study contributes to two distinct bodies of literature: algorithmic regulation and the SCS. More broadly, it offers new insights into the ongoing use of algorithmic regulation to address governance and societal challenges.

2. Algorithmic regulation and the SCS

Algorithmic regulation is widely implemented in the business sector in the form of rating or feedback control mechanisms (Dwoskin, 2018). Drawing on the experiences of big techs like Uber, algorithmic regulation is proposed as a new form of governance to address policy challenges through innovative problem solving rather than relying on traditional top-down law enforcement approaches (O'Reilly, 2013; Eyert et al., 2022). In the realm of public governance, the concepts of algorithmic regulation (Yeung, 2018) and algorithmic governance (König, 2020; Gritsenko and Wood, 2022) have emerged as novel modes of social coordination and control (Ulbricht and Yeung, 2022). These terms refer to the management of societal behavior through automated decision-making systems, frequently utilizing scores or rankings as incentives on a population-wide scale (Cristianini and Scantamburlo, 2020). These scores/rankings are computed on the basis of people's (financial and nonfinancial) behavioral data and are even considered indicative of people's behavioral traits.

Algorithmic regulation can be understood from two perspectives. From the regulatory perspective, it establishes a control loop in which individuals' behaviors are directly associated with rewards or punishments and thus adapt their behavior to maximize their utility (O'Reilly, 2013); from the technical perspective, it emphasizes the utilization of computational algorithms to bolster and streamline the control loop, enabling the monitoring and modification of behavior (Hildebrandt, 2018; Cristianini and Scantamburlo, 2020). According to Yeung (2018, p. 505), "(a)lgorithmic decision-making refers to the use of algorithmically generated knowledge systems to execute or inform decisions, which can vary widely in simplicity and sophistication." Our analysis also showed that the sophistication levels of SCSs vary across cities. Some cities claim to employ highly complex algorithmic models that offer real-time assessments, while others use a simpler calculation model based on point additions and deductions (see Section 6). Moreover, the structure of the SCS serves as a cornerstone for credit-rating-based supervision of market entities, which is under development at the moment. This credit-rating-based supervision represents a significant development in algorithmic regulation within the public sector.

As a prominent example within the global trend of algorithmic regulation, the SCS is part of the global shift of "the focus of public law from constitution and rule of law to analytics and algorithm" (Backer, 2018, p.130). A key issue in this transition is the evolving degree of intervention that algorithmic regulation introduces (Zhang, 2020a; Zuo, 2020). Dai's comprehensive study in 2018 concluded that the SCS represents a predominantly state-centered interventionist model for governing societies (Dai, 2018). Another important theoretical contribution is from Síthigh and Siems, who devised a framework comprising eight factors to evaluate the extent of state intervention across various rating systems, particularly those bolstered by digital technologies, such as the SCS (see Table 1) (Síthigh and Siems, 2019). In their framework, *drafter* refers to the entity—whether a private entity or state authority—that initiates and drafts the system. The factor *user* assesses whether participation in the system is mandatory for individual users. *Aim* inquires whether the scheme has a single, specific objective or encompasses a broader set of objectives across various functions or contexts. *Scoring* examines whether the system utilizes multiple scores or a single score. *Application* investigates whether the system's results are indicative or definitive. *Algorithm* pertains to the transparency of the system. *Enforcement* questions who bears the responsibility for enforcing the system. *Accountability* evaluates the extent to which a separate oversight body monitors the design and operation of the system (Síthigh and Siems, 2019). This framework provides a foundation for better understanding the nature of the SCS within the context of regulatory studies and provides a practical tool for conducting a detailed analysis of various SCS implementations at the city level that we draw on in our research.

https://doi.org/10.1017/dap.2025.12 Published online by Cambridge University Press

Table 1. *Degree of interventionism in rating systems*

	Low	Medium	High	SCSs in pilot cities
Drafter	Private	Co-drafting	State	High
User	Choice	Strong incentive	Mandatory	High
Aim	Specific	Socioeconomic	General	Low
Scoring	Multiple	Main and sub-indicators	Single	High
Application	Flexible	Comply or explain	Uniform	Medium
Algorithm	Transparency	Controlled transparency	Protected	High
Enforcement	Market	Stages of enforcement	State	Medium
Accountability	Oversight body	Review possible	Immunity	Low

Note: This table is developed on the basis of the work of Síthigh and Siems (2019).

The deployment of algorithms in the public sector potentially increases the efficiency and efficacy of public services, such as selecting the optimal policy alternatives and directing interventions toward specific profiles with precision (OECD, 2015). In contrast, such precise interventions also trigger significant concerns, not only regarding their capabilities, processes, and practices (Veale and Brass, 2019), but also ethical considerations over privacy, self-datafication, transparency, fairness, and issues regarding legitimacy and surveillance (Chen et al., 2023b; Veale and Brass, 2019; Gerhard and Hepp, 2018; Dencik et al., 2018; Chen and Cheung, 2017). Existing literature consistently calls for transparency to uncover arbitrary assessments, inaccurate characterizations, and biases within the scoring systems (Zarsky, 2016; Citron and Pasquale, 2014). There are also social initiatives, such as OpenSchufa, demanding more transparency in the credit scoring systems. However, the ideal of transparency remains under debate. Its various limitations are discussed, for example, in the context of privileging seeing over understanding, creating false boundaries, and causing professional boundary work (Ananny and Crawford, 2018). Fairness garners significant attention when algorithms are employed to facilitate decision-making in high-stakes contexts such as hiring (Köchling and Wehner, 2020). This emphasis on fairness becomes even more critical when algorithms are utilized for automated decision-making in social governance. Likewise, the pursuit of fairness should always be assessed together with other factors such as prediction accuracy (Heidari et al., 2018) and group discrimination (Citron and Pasquale, 2014).

Ethical inquiries and critical examination extend to the SCS as well. The existing literature concludes that the system lacks algorithmic transparency (Kobie, 2019; Síthigh and Siems, 2019), offers limited transparency from the perspective of foreign companies (Chen et al., 2023a), and showcases asymmetries in transparency between SCS blacklists and redlists (Engelmann et al., 2019). In these studies, the SCS was typically regarded as a single, overarching system, while its fragmentation and complexity were addressed to a lesser extent (except Liu, 2019; Tsai et al., 2021). This oversight has left a substantial research gap, particularly regarding transparency variations across different SCS implementations at the city level, further compounded by their diverse structures. In contrast to the extensive focus on transparency, investigations into fairness concerns arising from the SCS remain relatively sparse. This research aims to address these gaps by examining the current state of algorithmic regulation development at the city level in China, and by analyzing the transparency of the computational algorithms employed in the SCSs, as well as their societal fairness implications.

3. Methods

Our methodology primarily revolves around policy analysis, a fundamental approach for comprehending the motives and impacts behind Chinese governmental policies concerning the SCS. Policy is not a comprehensively rational, linear process but broadly captures "the interaction of values, interests, and

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resources guided through institutions and mediated through politics" (Davis et al., 1993, p.15). We meticulously scrutinized government guidelines, regulations, and frameworks across diverse administrative tiers, alongside exploring SCS platforms or applications at the local level to gain insights into the city-level implementation of the SCS. Notably, all the documents and platforms/apps we accessed are publicly available, intended for public scrutiny, ensuring transparency and accountability in our analysis.

We acknowledge that reliance on publicly available materials limits the scope of this study. While these documents provide crucial insights, they may not capture nonpublic rules, guidelines, or practices that shape the SCS's design and operation, and remain opaque to both researchers and the public. Indeed, hidden rules play a role in local governance and policy implementation in China. Local governments sometimes selectively implement central government policies to prioritize local economic growth (Oi, 1992), a practice that exemplifies adaptive informal institutions and can even subtly reshape the formal policy landscape over time (Tsai, 2006). Our findings, showing discrepancies in scoring schemes across cities, highlight the potential influence of such nonpublic rules on policy execution at the local level.

Although the SCS is often presented as a public and relatively transparent governance initiative, it functions within a broader system that combines both transparent governance and opaque state strategies (Drinhausen and Brussee, 2021). While local variations in the application of the SCS exist, they are limited by broader national directives and technological advancements that centralize control and reduce opportunities for evasion. The technology underpinning the SCS, with its rigid and relatively transparent mechanisms, makes it more difficult to "game" the system. Thus, while nonpublic rules may shape the SCS at the local level, technological and central government efforts work to mitigate their influence, leading to a more uniform, though still somewhat opaque, system.

Additional qualitative research with stakeholders of the SCS, for example, companies (Chen et al., 2023a), can shed some light on the practical impact of the system and complement our work. However, conducting fieldwork and gathering data in China has become increasingly challenging due to stringent data protection regulations, such as the *Data Security Law* (National People's Congress, 2021a) and the *Personal Information Protection Law* (National People's Congress, 2021b), which impose strict restrictions on data collection, transfer, and use, particularly for foreign researchers. As a result, using publicly available documents becomes a practical alternative for studies under these constraints. The data analyzed in this study were collected between February and May 2024.

Our research is a pioneering effort to explore city-level algorithmic regulation within the framework of the SCS. We focused on a selection of representative cases rather than including all cities in China for two key reasons. First, we examined three components of China's SCS framework: enterprise credit scoring, personal credit scoring, and city credit scoring systems. Please note that prefecture-level cities form the second level of the administrative structure in China, ranking below provinces and above county-level cities. As of 2023, China has 297 prefecture-level cities and 397 county-level cities. (For further details, see https://data.stats.gov.cn/.) As such, a comprehensive analysis of enterprise credit scoring and personal credit scoring for all cities would require examining approximately 1,400 cases, which is impractical for the depth of analysis required. Second, a case study approach allows for a more detailed and nuanced exploration of each system, enabling a clearer and more in-depth understanding of the dynamics at play. We carefully selected representative cases that illustrate the diversity and key characteristics of the systems under study. Given the novelty of this area of study, our investigation of city scores primarily relies on the "city credit monitoring and early warning indicators" (hereafter *City Credit Indicators* for short) (National Center for Public Credit Information, 2022). To complement our analysis, we further draw on information from the national SCS platform (see https://www.creditchina.gov.cn/csxynew/?navPage=12). While it is imperative to acknowledge the limitations of our research, particularly with regard to the scarcity of available sources, it is crucial to emphasize the authoritative nature of the *City Credit Indicators.* Issued by the National Center for Public Credit Information (NCPCI), a body directly affiliated with the National Development and Reform Commission (NDRC), these indicators hold significant weight, providing valuable insights into the city-level implementation of the SCS. A list of different types of policy documents used for this research is summarized in Supplementary Table A5.

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4. The SCS implementation in Chinese cities: an overview

The implementation of the SCS at the city level is driven by the model city program. Selected cities, which are called SCS construction model cities, conduct trials of SCS construction and implementation to accumulate experiences, which are later copied by or promoted to other parts of China (National Development and Reform Commission and People's Bank of China, 2017), manifesting the policy experimentation feature in Chinese public policy (Heffer and Schubert, 2023). Four groups of model cities were selected between 2017 and 2023, resulting in a total of 130 model cities and districts in China (see Credit Zhejiang, https://www.cnfin.com/xy-lb/detail/20230830/3923862_1.html). These cities or districts range from the sub-provincial level (e.g., Hangzhou, Shanghai-Pudong, and Tianjin-Binhai) to the county level (e.g., Yiwu, Jinhua, and Rongcheng). They are distributed unevenly across different provinces. For instance, in Zhejiang province, all 11 prefecture-level cities are designated as SCS model cities, whereas in Qinghai, there is no SCS model city.

From the policy perspective, SCS-related regulations and methods are issued at both the national and local levels. At the highest level, strengthening the SCS is highlighted as a critical part of a unified market that should adhere to high standards in the *14th Five-Year Plan (2021–2025) for National Economic and Social Development* (National Development and Reform Commission, 2021). The State Council has continuously issued national policies about the SCS construction (e.g., State Council, 2014; State Council, 2019; State Council, 2022). Recently, the *2024–2025 Action Plan for the Establishment of the Social Credit System* was issued to guide the development of the system in the next step. These policies serve more as principles for the construction of the SCS. Guided by these policies, Chinese cities and provinces have developed corresponding work plans, regulations, and measures for local SCS implementation (e.g., The People's Government of Suzhou, 2022; Shanghai People's Congress Standing Committee, 2021).

Among the various local SCS policy documents, local social credit regulations hold particular significance, serving as a cornerstone for the implementation of the system in cities. It is noteworthy that documents of *Social Credit Regulation* from various cities and provinces consistently provide similar definitions for "social credit" and "social credit information" (e.g., Shanghai People's Congress Standing Committee, 2021; Tianjin People's Congress Standing Committee, 2021; Guangdong People's Congress Standing Committee, 2021; Hangzhou People's Congress Standing Committee, 2021). It is surprising that these fundamental concepts, which are essential for comprehending the SCS, lack explicit elaboration in the various national SCS policies. This further underscores the importance and necessity of examining the SCS at the city level. "Social credit" refers to "the state in which natural persons, legal persons, and unincorporated organizations with full capacity for civil conduct abide by legal obligations or perform agreed obligations in social and economic activities." "Social credit information" refers to objective data and materials that can be used to identify, analyze, and assess the compliance and performance status of information subjects, including *public credit information* and *market credit information.* Public credit information refers to the social credit information generated or obtained by state organs and organizations authorized by laws and regulations to manage public affairs in the process of providing services in accordance with the law. Market credit information refers to the social credit information generated or obtained by market credit service agencies, credit service industry organizations, other enterprises, public institutions, and social organizations in their production, operation, and social service activities. Thus, while "social credit" emphasizes on the legal and contractual obligations, "social credit information" is collected from almost all perspectives of life.

Cities also exhibit variety in their specific SCS implementation methods. This diversity is evident in, among others, how they administer credit-related rewards and punishments, which are often customized based on the social and economic environment of each city. For example, Hangzhou's rewarding mechanism is characterized by granting priority in policy support and incubation measures to enterprises engaged in innovation and startup activities (Hangzhou People's Congress Standing Committee, 2021). Shenzhen and Nanjing exhibit a relatively lenient approach to implementing punishments. This leniency includes exceptions to the application of penalties in cases where credit subjects promptly rectify minor

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instances of dishonest behavior without causing harm, or when it is their first-time offense and the consequences are minimal (Shenzhen People's Congress Standing Committee, 2022; Nanjing People's Congress Standing Committee, 2020).

At present, all cities in China, irrespective of their designation as model cities, should have integrated the SCS into their governance frameworks. The COVID-19 pandemic played a role in accelerating the adoption and expansion of social credit systems across Chinese cities (Knight and Creemers, 2021; Engelmann et al., 2021). Many cities have tailored credit scoring systems with a distinct focus on evaluating both legal entities and individuals. The subsequent sections delve into the intricate workings of enterprise credit rating systems and personal credit scoring systems using the framework from Síthigh and Siems (2019), offering insights into the implementation of algorithmic regulation across cities. In addition, these sections scrutinize the level of transparency embedded within these systems, aiming to uncover the extent to which these systems reveal their operational mechanisms and criteria.

5. Enterprise credit scoring systems across cities

At the national level, the Chinese enterprise credit rating and scoring systems typically follow a sector-oriented approach. Various government departments have developed distinct methods for rating enterprise credit across sectors such as food and medicine, real estate, intellectual property, taxation, human resources, and environmental protection (e.g., National Development and Reform Commission, 2016; State Taxation Administration, 2014). In the implementation of sector-based scoring systems, enterprises undergo scoring and rating processes consistently across cities within the same sector. Data from various governmental sources are gathered and presented on the National Enterprise Credit Information Publicity System (see https://www.gsxt.gov.cn/index) that is designed as a key national network for market supervision, as well as other platforms such as the national SCS platform—Credit China—at different administrative levels and the departments' websites. Thus, they function as comprehensive repositories of credit-related information.

At the city level, enterprise credit scoring systems are initiated and implemented by local governments, each with its own unique design and approach. All locally registered enterprises are subject to these local systems. Therefore, the degree of interventionism is high from the perspectives of both the *drafter* and the *user*. Figure 1 offers a visual representation depicting the algorithmic regulatory framework designed for public credit scores for enterprises at the local level (this flowchart has been derived through a detailed policy analysis. It serves the purpose of providing a strategic tool for conceptual understanding). Government departments collect and process data regarding locally registered enterprises, and generate scores or ratings within their respective departments. They also place enterprises on SCS blacklists or redlists if they perform any defined "bad" or "good" behaviors, respectively. Evaluation results from this step are directly related to punishments and rewards under the SCS framework. In the next step, a public credit score is automatically calculated. Cities have developed various scoring models, which will be analyzed in detail in the next paragraphs. The enterprise credit score is deemed to reflect an enterprise's overall creditworthiness/trustworthiness and is then linked to supervision at different levels, establishing

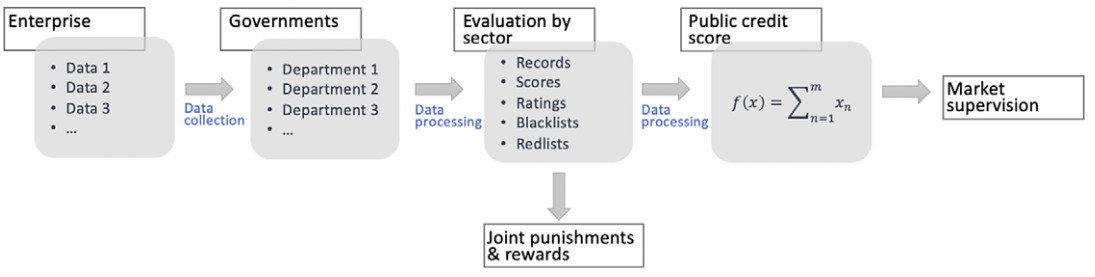

Figure 1. *The algorithmic regulatory framework for enterprises' public credit scores.*

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an advanced approach for governance in the public sector—the credit-rating-based supervision system. In this system, higher ratings for enterprises often facilitate expedited administrative procedures, streamlined access to government procurement opportunities, and reduced regulatory scrutiny. Conversely, lower ratings may result in restrictions on government procurement, reduced access to financial support, and a heightened level of regulatory inspections (Changde Development and Reform Commission, 2022b; Yongzhou Municipal Government Office, 2020).

In general, the enterprise credit system aims to achieve several socio-economic goals across multiple levels simultaneously. At the enterprise level, its objective is to reinforce or alter enterprise compliance and prosocial behavior; at the city level, it aims to promote an overall environment of creditworthiness; and at the regulatory level, the system contributes to a new governance approach based on credit ratings. Thus, the interventionism degree is regarded as a medium from the perspective of *aim* for the enterprise credit scoring systems at the city level.

Guided by SCS policies at the national level, cities have developed various scoring and rating methods for locally registered enterprises. To better illustrate this situation, we present the enterprise credit scoring structures from one province and three cities as an example in Supplementary Table A1. These cases are selected for the following reasons. Zhejiang took the lead by publishing provincial-level scores in 2019 (Zhejiang Development and Reform Commission, 2019), while Guangzhou represents a recent case (Guangzhou Development and Reform Commission, 2023). Yongzhou and Changde provide good examples for a comparison between cities in the same province (Hunan). We analyze the enterprise credit rating systems primarily from four perspectives: score scopes, rating settings, indicators and corresponding weights, and transparency. Supplementary Table A1 presents an overview of the comparative results.

First, in each enterprise credit scoring system, only one credit score is generated, reflecting a high degree of interventionism along the factor *scoring.* However, the scoring ranges are configured differently across various systems, typically spanning from 100 to 1000. Also, some cities set the minimum score above 0, such as Guangzhou.

Second, these scores are transferred to credit ratings that vary in granularity and criteria. Some cities, such as Yongzhou, offer four ratings, while others, such as Guangzhou, provide a more detailed scale with nine ratings. While Zhejiang and Changde share the same score scope of 1000 and both employ 5 ratings, they differ in their rating criteria. In Zhejiang, an enterprise must attain a score of 850 or higher to achieve an "Excellent" rating, whereas in Yongzhou, a score of 800 suffices for the same rating. Therefore, enterprises' scores or ratings are not fully comparable between different regions. Both enterprise credit scores and ratings serve as conclusive assessments of an enterprise's creditworthiness, informing decisions or judgments by governments and/or third parties. However, these scores and ratings undergo periodic revisions based on updated data. In this case, the interventionism degree is regarded as a medium for the *application* factor. While the scores and ratings can serve market purposes, such as facilitating business transactions, the local governments bear the responsibility for ensuring enterprise compliance with the system's rules and regulations. They take decisive action against any violations or noncompliance with the system's requirements. Take Zhejiang province, for example. Administrative enforcement and regulatory departments have utilized the enterprise credit risk model to conduct 220,787 inspections. They further categorize enterprises into three risk levels: highrisk (186,000 enterprises), medium-risk (238,000 enterprises), and low-risk (2,230,000 enterprises) (see Credit Zhejiang at https://credit.zj.gov.cn/art/2022/2/14/art_1229636059_1828.html). For this reason, the interventionism degree is high from the *enforcement* perspective.

Third, all five cities/provinces select a five-dimension model for the enterprises' public credit score calculation, although the content of these dimensions varies slightly (see Supplementary Table A1). Zhejiang and Yongzhou share the same dimensions. "Compliance" and "social responsibility" are included in all scoring models but are defined in slightly different ways across cities. The "compliance" indicator generally evaluates the performance regarding administrative management and judicial records. In Changde (Changde Development and Reform Commission, 2022b), "compliance" also sheds light on records of the SCS redlists, which, however, is included in the "social responsibility" dimension in

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Zhejiang (Zhejiang Development and Reform Commission, 2020) and Yongzhou (Yongzhou Municipal Government Office, 2020). Regarding "social responsibility," Zhejiang focuses more on charity and honor records (Zhejiang Development and Reform Commission, 2020); Guangzhou stresses the payment of social security and tax (Guangzhou Development and Reform Commission, 2023); and Changde and Yongzhou cover both of these perspectives (Changde Development and Reform Commission, 2022b; Yongzhou Municipal Government Office, 2020). Other dimensions cover basic information, finance and taxation, honors and awards/qualifications, supervision risk, governance, and conducting business with integrity. These five dimensions are referred to as the first-level indicators, which are further broken down into second- and third-level subsets, providing detailed interpretations and revealing differences between indicators. Cities have adopted diverse methodologies to assign weights to indicators, including big data technology, the analytic hierarchy process, and the Delphi method (Guangzhou Development and Reform Commission, 2023). Thus, the same indicator may receive different weights across cities. For instance, the indicator of "social responsibility" plays a more important role in the public credit score calculation in Zhejiang (185 out of 1000) than in Changde (120 out of 1000). Despite differences in content, "compliance" always receives the largest weight (over 40%), showcasing its importance for public credit scores.

Enterprises' public credit scores are then translated into ratings, which, in turn, dictate the level of supervision they undergo. While the method for translating scores into ratings is explicitly outlined, the specifics of the supervision measures are not always disclosed to the public. This lack of transparency may pose challenges for enterprises, for instance, in Zhejiang and Guangzhou, to fully comprehend the supervision measures imposed on them. In contrast, the other two cities, Changde and Yongzhou, provided detailed specifications. In Changde, A-level enterprises will be prioritized, under equal conditions, in fiscal funding support and commendation rewards selection, while E-level enterprises are restricted from applying for projects backed by government financial funds and from participating in public resource trading activities (Changde Development and Reform Commission, 2022b). Our case study suggests that the enterprise public credit system in Guangzhou exhibits the lowest level of transparency among the four sample cases. Determining an overall transparency level for the local enterprise public credit scoring systems is challenging due to the considerable variation between cities. In this case, we labeled the interventionism degree as low/medium in the perspective of the *algorithm*.

Finally, at the city level, there is typically no distinct oversight body solely dedicated to monitoring both the design and operation of the system. Instead, responsibility falls to the local branch of the NDRC, which leads, coordinates, and monitors the development of the SCS, indicating that it is not functioning as a separate oversight body. Meanwhile, the system incorporates a mechanism for "objection applications," allowing companies to address inaccuracies or omissions in their data. Consequently, we consider the interventionism degree for *accountability* as the medium.

In parallel with the enterprise public credit scoring systems, there are also credit scoring systems for individuals at the local level. In the next section, we investigate these personal credit scoring systems across Chinese cities.

6. Personal credit scoring systems across cities

The implementation of the SCS in China has accelerated the development of personal credit scoring systems across cities (Li and Kostka, 2022). Aligned with the national *Guidelines on the Construction of a Personal Credit System* (State Council, 2016), cities have introduced unique personal credit scoring systems targeting individuals above 18 years old, who live and work in a given city. Thus, the interventionism degree is categorized as high for both *drafter* and *user* factors. These systems extend beyond traditional financial credit assessments, encompassing a wide spectrum of social, economic, and moral aspects, purportedly seeking to create a comprehensive portrayal of the individuals' creditworthiness to facilitate economic and social activities and, thus, fostering a more trustworthy and reliable society. For this reason, it signifies a moderate level of interventionism from the perspective of the *aim*.

We have identified 56 such systems across China (see Supplementary Table A4), encompassing 55 systems from cities at various administrative levels, such as provincial (e.g., Tianjin), sub-provincial

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Figure 2. *Chinese cities with personal credit scoring systems. (The red spots on the map indicate the presence of personal credit scoring systems in* cities*, while the shades of green represent the number of such systems within specific* provinces*: the darker the shade, the higher the number of systems in that province. Hainan province is assigned a different shade of green, as there is one single personal credit scoring system at the provincial level for all cities. Red spots with blue outlines refer to cities that are analyzed in detail. Additionally, Zhejiang and Hainan provinces are also analyzed in detail in this paper. This map is developed based on data that were collected between February and May 2024.)*

(e.g., Jinan and Xiamen), prefecture (e.g., Wenzhou and Wuxi), and county (e.g., Xintai and Yiwu) levels, along with one system from Hainan province. These systems were launched between 2017 and 2022. As shown in Figure 2, they are particularly prevalent in the eastern part of China. In particular, Zhejiang and Shandong provinces have the most (12 and 10, respectively) personal credit scoring systems, followed by Jiangsu (7) and Henan (5) provinces. In contrast, cities in the western areas usually do not (yet) have a quantified scheme. This uneven geographic distribution broadly aligns with the varying economic development levels across different regions of China, resulting in a higher concentration of SCS personal credit scoring systems in the more economically developed areas.

Cities that have implemented personal scoring systems exhibit varying degrees of development. Advanced systems boast well-defined scoring and rating scales, diverse application scenarios for rewards, and a significant user base, as exemplified by Hangzhou's Qianjiang Score, which boasts over five million registered users. Conversely, some systems are in their initial stages, lacking a clear structure and scoring method, as seen in Hohhot, Anqing, and Xianning. In Supplementary Table A2, we selected four examples to present and compare the current status of personal credit scoring systems across Chinese cities. These cities and provinces span different administrative levels and initiated their personal credit scoring systems in various years. Hainan presents a unique case by constructing a single credit scoring system for all cities in the province. In addition, Hangzhou and Yiwu, both hailing from Zhejiang province, are notable as model cities for the implementation of the SCS. Similar to the analysis of enterprise credit scoring systems, we compared personal credit scoring systems from four perspectives.

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First, cities have adopted very different score scopes. The personal credit scoring systems usually establish a default score as the initial baseline (see Supplementary Table A2), adjusting it based on individual behavior. However, for certain systems, the score scope is not clearly disclosed, as in the case of Hainan province.

Second, rating scales vary from city to city, commonly using five or six ratings. Even among the systems adopting the same score scope, credit ratings might be defined differently, as seen in the contrast between Hangzhou and Changde. Further, similar to enterprise credit scoring systems, individual credit scoring systems in various cities produce a single score as a definitive measure of an individual's trustworthiness. This score is updated continuously and directly utilized in decision-making processes by both government authorities and market participants. For some cities, such as Xiamen, even real-time measurements to offer live and dynamic scores are conducted (see https://port.xm.gov.cn/zmhd/cjwt/202301/t20230113_2714953.html). Local governments are tasked with the enforcement of these scoring systems. Therefore, the interventionism degrees for the factors of *scoring*, *application*, and *enforcement* are high, medium, and high, respectively.

Third, individual credit scores are primarily calculated based on five core dimensions (see Supplementary Table A2). Identical to indicators for enterprise public credit score, "compliance" and "prosocial behavior" are integral components present in all personal credit scoring systems across various cities, albeit the latter might be labeled differently (e.g., public morality, social welfare, and social contribution). Basic and identity information encompasses an individual's educational background, marital status, and profession, among other details. Business credit information includes financial credit records and the fulfillment of economic contracts, while social governance/credit entails administrative records and social welfare information. In this way, the systems endeavor to provide a comprehensive portrayal of people's trustworthiness by incorporating various dimensions beyond financial considerations.

Fourth, the analysis of transparency in personal credit scoring systems reveals a similar structure as that used for enterprises. Among the four sample cities in Supplementary Table A2, they all offered at least some explanation for the first-level indicators, but only half of them disclosed fine-grained indicators as well as corresponding responsible departments. Weights assigned to the indicators remain undisclosed across all sampled cities, rendering it challenging for residents to assess the significance of these indicators. The algorithms used in personal credit systems vary significantly from city to city. Our understanding of the algorithm in Hainan is limited due to scant information disclosure. Among the other three sample cities, two distinct algorithmic models have been identified. Yiwu and Changde employ a straightforward calculation model, providing detailed scoring criteria that specify how points are added or deducted for various actions. For instance, in Changde, donating to charitable causes earns 20 points, while violating public smoking bans results in a 30-point deduction (Changde Development and Reform Commission, 2022a). In contrast, Hangzhou is presumed to use a more complex algorithmic model for its personal credit score. To support this, the city has established a big data laboratory to continuously test and refine the model. However, the specifics of Hangzhou's algorithm remain undisclosed.

In contrast to enterprise public credit scoring systems, which emphasize both punishments and rewards, personal credit scoring systems across cities predominantly focus on rewards. Penalty measures associated with low scores for individuals are often not mentioned. The rewarding measures for personal credit scores are disclosed but in a rather general manner. Typically, they are illustrated by providing a few example scenarios that encompass both public and commercial services. Public services usually cover health care (treatment first and payment afterward), parking (discounts), and library usage (deposit-free), while commercial services may include travel (discounts for admission tickets to scenic spots) and job hunting (system signals verified education and profession background) (see, for example, Qianjiang Score http://qianjiangfen.cn/index.html). Currently, across all cities, efforts are being made to introduce additional score application scenarios to enhance the value of the scoring systems (Liang and Chen, 2022). As shown in Supplementary Table A2, personal credit scoring systems in some cities (e.g., Yiwu and Changde) present a much higher transparency level than those from other cities (e.g., Hangzhou and

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Hainan). Given the variations in algorithmic transparency between cities, we consider the interventionism degree for the *algorithm* as low/medium and for the factor *accountability* as medium.

With the growing prevalence of personal credit scoring systems, local governments are actively exploring the feasibility of establishing a mutual recognition mechanism through information sharing. Under this mechanism, personal credit scores from different cities would be reciprocally acknowledged, allowing residents with high scores to access benefits and privileges across various cities. In 2022, 10 cities signed a strategic cooperation agreement to promote the establishment of such a mechanism (see https://credit.fzgg.tj.gov.cn/detail.do?contentId=70da9420bdc04f45b13184d873e5db80). This trend implies that the future of personal credit scoring systems may continue to evolve in a fragmented manner, albeit with the introduction of common or different mutual recognition mechanisms. The development of a common mechanism would suggest that the objective of implementing algorithmic regulation for social control, particularly focusing on individuals at the national level, could be attained without the necessity of a single unified SCS. While the implementation of such a mechanism aims to enhance the overall efficacy of the SCS, it also faces substantial challenges, particularly in the areas of regulatory frameworks and technical aspects within the realm of algorithmic regulation.

Sections 5 and 6 delved into the establishment and execution of two pivotal components of the SCS across cities. At this stage, there is no clear, unified trend that all cities are following in constructing their SCSs. Instead, cities have developed distinct regulations and established their own unique models. As cities assess the trustworthiness and creditworthiness of their residents and businesses, they similarly undergo scoring and ranking within the framework based on the progress of their SCS development. In the subsequent section, our focus shifts to the city credit scoring system.

7. City credit scoring system

City rankings have evolved into a tool for policymakers to assess urban performance and formulate strategic policies for future development. The Chinese city credit scoring system was introduced under the SCS framework, aligning with the broader pattern observed in numerous national and international city rankings that assess cities based on criteria, such as creativity, innovation, sustainability, and smart city initiatives (Dobbs et al., 2011; Kontokosta and Malik, 2018; Cities of Opportunity, 2016). The city credit scoring system provides a condensed overview of the overall progress in the construction and implementation of the SCS in each city, offering a comparative perspective. This is reflected in the Composite Index of City Credit (CICC), which is issued by the State Information Center and serves as the city's credit score. Despite its significance, the city credit scoring system is largely overlooked in the existing literature on the SCS.

From an implementation perspective, the NCPCI, commissioned by the NDRC, is responsible for evaluating and assessing the performance of Chinese cities in constructing their SCSs. Thus, the state's role as the drafter of this system results in a high level of interventionism in the *drafting* process. Unlike the SCS model cities construction project, which is based on voluntary participation, the city credit scoring system is mandatory for all cities, indicating a high level of interventionism from the perspective of the *user*.

The CICC has a score scope between 0 and 100. Unlike personal and enterprise credit scoring systems discussed in the previous sections, the city credit scores are not converted into credit ratings (e.g., A, B, C, D, or excellent, good, average, and fair) as is commonly done in enterprise and personal credit scoring systems. Instead, cities are ranked monthly based on their numeric scores. Therefore, we consider the degree of interventionism for *scoring* to be high and for *application* to be medium.

The CICC adopts a three-level indicator system. At the first level, there are 8 indicators (see Supplementary Table A3), which are further broken down into 20 second-level and 35 third-level indicators. Based on explanations provided by the *City Credit Monitoring and Early Warning Indicators* (hereafter *City Credit Indicators* for short) (National Center for Public Credit Information, 2022), the eight first-level indicators can be categorized into three groups, focusing on the SCS construction progress, the implementation and application of the SCS results, and creditworthiness/trustworthiness propaganda and

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public opinion. These indicators denote not only the components of city credit but also what the Chinese government cares about and expects regarding SCS implementation.

Indicators 1, 2, and 8 measure the progress of the SCS construction (see Supplementary Table A3). They examine cities' SCS policy implementation, SCS information infrastructure, and the innovation of SCS construction. In particular, Indicator 2, which is about the collection of different types of credit-related data, the accuracy of the data, and data security, receives the highest number of maximum points as an individual indicator, amounting to 28 out of 100. This highlights the substantial reliance of the system on big data. Indicator 8 pertains to the promotion of typical (innovative) experiences at the national level, reflecting a programmatic attitude of exploration in the face of new developments in China's reform progress. Notably, the construction of enterprise and personal credit scoring systems, as discussed in Sections 5 and 6, is not distinctly emphasized within the framework of these indicators that assess the progress of SCS construction across cities.

Indicators 3–5 and 7 evaluate the implementation of the SCS and the application of the SCS results. Together, they constitute the largest share of the CICC, with a maximum number of points of 53 (out of 100). All these four indicators focus on the enterprise SCS. Indicators 3–5 address the utilization of credit reports in administration and public services, public credit-based financing (especially for micro, small, and medium enterprises), and the ratios of trustworthy and untrustworthy enterprises. These three indicators are also reflected in the enterprise public credit scoring system (see Section 5). Indicator 7 evaluates the creditworthiness of local government departments and state-owned enterprises (SOEs), as well as the local government's adherence to implementing the SCS blacklists for market access. Government trustworthiness and creditworthiness are emphasized as one of the four pillars established in the construction of the SCS, as outlined in the *Planning Outline* (State Council, 2014). According to the *City Credit Indicators*, this is assessed through metrics such as the frequency of listings on the SCS blacklist and the occurrence of overdue debts among SOEs.

Finally, Indicator 6 delves into the broader environment of the SCS to assess factors that are more difficult to quantify. It includes factors related to propaganda efforts for creditworthiness, including trustworthiness culture promotion (e.g., see Chen et al., 2022), public opinion dynamics, and major incidents of untrustworthiness in the four pillars of SCS development defined in the *Planning Outline*: government credit, commercial credit, social credit, and judicial credit (State Council, 2014), such as issues related to food security and illegal fundraising. Specifically, big data technology is employed to monitor the specific sub-indicators. In general, these indicators reflect the process of constructing and implementing SCS rather than serving as benchmarks for a superior model.

In addition, eight scenarios will result in severe score deductions (National Center for Public Credit Information, 2022), including falsification of materials, inaccessibility or political compliance issues on the local SCS websites, data security issues, misuse or generalization of credit applications, noncompliance to medium- and long-term coal contracts, unregulated fee collection by industry associations, and bond default by local governments or local SOEs.

Concerning the transparency of the city credit scoring system, detailed explanations, fine-grained indicators, as well as information regarding weights, data source, and scoring details are all provided. Notably, data are sourced not only from government departments, but also from the mainstream digital media platforms, such as official government websites, Tencent News, sina.com, and 163.com. Cities at different administrative levels are scored based on the same criteria but are ranked in two separate groups. One group comprises 36 provincial capitals and cities at the provincial level, while the other includes 261 prefecture-level cities. The scoring and ranking results are presented in the section of "City Credit (城市信用)" on the website of *Credit China* (www.creditchina.gov.cn) and are updated on a monthly basis, providing free public access. However, only the Top 20 and Top 50 cities from each group are featured, denoting a public praising mechanism. In contrast, cities with low scores and poor rankings are conspicuously absent. Based on the data that have been made available, it appears that scores exceeding 90 are seldom achieved, and scores over 80 indicate a very good performance. Full datasets, encompassing scores for all cities, are currently unavailable, and the statistical distribution of the scores remains undisclosed, making it difficult to interpret the scores. Accordingly, for the city credit scoring system, while the scoring

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method is highly transparent, the interpretation of the scores lacks transparency. In addition, there are few clues about whether and how these scores are connected to specific rewards or punishments. Therefore, the degree of interventionism is regarded as a medium from the perspective of the *algorithm.*

The city credit scoring system establishes multilayered, direct, and indirect goals. The above analyzed indicators assess not only the progress and execution of SCS initiatives, but also the effectiveness of cities as centers for economic development, underscoring the critical role of fostering economic growth. This aligns with other city rankings that mostly address one common aspect: attracting wealth generation (Saez et al., 2020). Thus, the city credit scoring system steers Chinese cities into a competition that includes not only SCS construction and implementation, but also attracting wealth generation. In addition, on the "City Credit" website, just below the section for the city credit rankings, there is also a section called "Business Environment (营商环境)," advertising the cities' efforts in promoting a favorable business environment. We assign a medium interventionism label to the factor *aim* for the city credit scoring system.

The degree of interventionism for the city credit scoring system is classified as a medium from the perspective of *enforcement* given the fact that there is not a clear rewarding and sanctioning mechanism associated with city scores. However, there may be a possibility that career prospects of administrators and budgeting are implicitly linked to the scores. In addition, the system is deemed to have a high level of interventionism from the perspective of *accountability*, due to the absence of a supervisory body responsible for overseeing its operations and the lack of a mechanism for handling "objection applications," unlike the other two systems.

8. Discussion and concluding remarks

The act of measuring the behavior of various societal participants (i.e., companies, individuals, and cities) through digital technologies exemplifies algorithmic regulation, as implemented by the SCSs, by transforming abstract values such as trustworthiness or compliance into quantifiable metrics. These metrics enable authorities to monitor, evaluate, and influence behaviors systematically, embedding algorithmic logic into governance processes (Elgert, 2018). However, this process also abstracts complex social realities into simplified indicators, which may fail to fully capture the nuanced and context-specific dimensions of human behavior. As such, while effective for achieving measurable outcomes like economic efficiency, it risks marginalizing broader considerations such as social equity. This section concludes by examining the interventionist nature of the SCSs, addressing the transparency dilemma they present, and delving into the fairness paradox inherent in the system.

8.1. Algorithm-enhanced interventionism

Building upon the framework from Síthigh and Siems (see Section 2) (Síthigh and Siems, 2019), our analysis unveils a heightened level of interventionism across the enterprise, personal, and city credit scoring systems (see Table 2), which partially stands in contrast to the observations made in previous work (Síthigh and Siems, 2019). Our findings align with those presented in Síthigh and Siems (2019) for four of the eight factors—*drafter*, *user*, *scoring*, and *application.* Specifically, the factors *drafter*, *user*, and *scoring* exhibit pronounced levels of interventionism. This characterization stems from the active participation of central or local governments in drafting policies, the compulsory involvement of businesses and citizens, and the adoption of a singular scoring metric at the respective city level. Most individuals and enterprises will have one score in the city where they are based. However, for those who move around or act in different cities, multiple scores by different cities will be available. From the perspective of cities, each one issues only one score for a given individual or enterprise. Therefore, we refer to this as a singular scoring metric. In addition, interventionism is labeled as a medium from the perspective of *application* for all three studied systems. This is due to their provision of definitive results in the form of a concrete number and/or rating, coupled with periodic updates.

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Table 2. *Degrees of interventionism in the SCS*

Factors (low–high)	SCS in pilot cities (Síthigh and Siems, 2019)	Enterprise credit scoring system	Personal credit scoring system	City credit scoring system
Drafter (private–state)	High	High	High	High
User (choice–mandatory)	High	High	High	High
Aim (specific–general)	Low	Medium	Medium	Medium
Scoring (multiple–single)	High	High	High	High
Application (flexible–uniform)	Medium	Medium	Medium	Medium
Algorithm (transparent - protected)	High	Low/Medium	Low/ Medium	Medium
Enforcement (market - state)	Medium	High	High	Medium
Accountability (oversight body - immunity)	Low	Medium	Medium	High

Conversely, our study reveals disparities across the remaining four factors compared to the findings presented in Síthigh and Siems (2019). First, we contend that beyond credit-related objectives, the SCS is designed and executed to fulfill a broader socioeconomic goal of impacting economic and social order (State Council, 2014). Our findings about indicators of different systems show that they cover a wide range of aspects of social and economic behavior, thereby providing empirical evidence supporting the systems' pursuit of socioeconomic objectives. Different socioeconomic goals are also highlighted across SCS-related policies. Second, the degree of interventionism regarding *enforcement* for both enterprise and personal credit scoring systems is high, as the local government institutions take the responsibility to ensure compliance. Third, the transparency of the *algorithms* within enterprise and personal credit scoring systems varies across the sample cities. In half of the investigated cities, it is highly transparent, while in the other half, it is moderately transparent (refer to Sections 5 and 6), indicating a mixed landscape regarding algorithmic transparency. Hence, we designate it as low/medium for these two systems. The city credit scoring system is highly transparent regarding the scoring method but is vague in terms of the incomplete results disclosure and the corresponding rewards and punishments, and is thus labeled as medium. Fourth, there is a lack of a separate oversight body to monitor the three credit scoring systems. However, both the enterprise and personal credit scoring systems at the city level are overseen by the NDRC, as is the city credit scoring system. Therefore, we regard the level of interventionism from the accountability perspective as medium for the enterprise and personal credit scoring systems, but high for the city credit scoring system.

It is instructive to observe how cities in China assume a dual role within the SCS framework, functioning both as the enforcers of the system and as subjects being evaluated. This duality underscores the SCS's pervasive approach to governance that extends its reach to encompass all entities. In a more general sense, the city credit scoring system, like other city rankings, corresponds to the logic of "measurementality" that emerges "from privileging scientific techniques for assessing and measuring the environment as a set of standardized units that are further expressed, reified, and sedimented in policy and discourse" (Turnhout et al., 2014, p.583). It is a manifestation of the trend toward a "metric society" (Mau, 2019; Shore and Wright, 2015).

Within the conceptual framework, the algorithm stands out among the eight factors, exhibiting correlations with factors such as scoring and enforcement. These correlations foster a synergistic effect, amplifying the interventionism degree of the SCS. In fact, different departments, such as the tax bureau,

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score or evaluate enterprises or individuals independently. With a specific algorithmic model, scores or ratings from various departments can be transformed to one single credit score. In enterprise and personal credit scoring systems, computational algorithms enhance the control loop by automatically associating rewards and punishments with scores, thereby facilitating enforcement. In summary, our research concludes that the SCS represents a government-centric, interventionist approach to governing societies, which aligns with Dai's assertion (Dai, 2018). Furthermore, our analysis indicates differences between the three systems: the city credit scoring system exhibits the highest level of interventionism with the state playing a more dominant role, while the degree of interventionism for enterprise and personal credit scoring systems is slightly lower.

8.2. The transparency dilemma raised by the algorithmic regulation

Transparency is commonly viewed as a means to address information asymmetry (Gajewski and Li, 2015; Barth and Schipper, 2008). While a certain degree of transparency is essential to "open up decision-making systems and their inscribed social norms to scrutiny, deliberation, and change" (Katzenbach and Ulbricht, 2019), insufficient transparency poses a barrier, hindering public understanding, trust, and subsequent utilization of the system (Loefflad et al., 2023). However, it is debatable how much transparency is sufficient. Previous research suggests that achieving absolute transparency is not only impractical but also undesirable, as it does not provide a definitive solution to addressing issues related to fairness and power imbalances in algorithmic regulation (Ananny and Crawford, 2018; Mittelstadt et al., 2016). Under specific circumstances, transparency may even pose risks to privacy and might not inherently foster trust-building efforts (Ananny and Crawford, 2018). Moreover, an excessively high level of transparency may inadvertently create misaligned incentives and potentially erode trust (Kizilcec, 2016).

As presented in Sections 5 and 6, in their pursuit of specific local enterprise and personal credit scoring systems, cities make aspects of their systems transparent, yet exhibit significant disparities in the transparency levels embedded within their respective systems. Systems with lower levels of transparency, such as the personal credit scoring systems in Hangzhou and Hainan and the enterprise credit scoring system in Guangdong, are more likely to lead to misunderstandings, potentially resulting in ineffective utilization or a decline in trust. Decreased transparency may leave individuals and companies feeling disempowered, as they have limited insight into and ability to contest the decision-making processes of the system. However, it is possible that cities deliberately engineer a lower level of transparency to bolster the effectiveness of their systems (Engelmann et al., 2019). By keeping the inner workings of the system opaque, individuals and companies may feel compelled to adhere to regulations more strictly, to avoid score reductions. This can lead to more pervasive self-regulation behaviors across various activities.

In comparison, individuals and companies are more informed about highly transparent systems like those from Changde. Thus, they can adjust their behaviors accordingly and make more effective use of the systems. However, very high transparency also increases the risk of reverse engineering. The incorporation of moral behavior and prosocial activities, which constitutes an important share of both the personal and enterprise credit scores, makes the situation more complicated. For instance, Yiwu explicitly discloses the specific scoring methods for charity donations: donations below 3000 RMB (~415 USD) do not earn any points, while contributions between 3000 and 10,000 RMB (~415 USD–1380 USD) earn two points. Donations exceeding 10,000 RMB receive three points (Yiwu Credit Center, 2017). While this scoring plan aims to promote prosocial activities, it serves to quantify and commodify moral behavior. The quantification of moral behavior suggests that "trustworthiness" can be attained through financial contributions, thereby leading to the commodification of moral values. Consequently, individuals may utilize donations to offset poor performance in other areas, such as violating traffic signal instructions, which results in a deduction of one point. As such, very high transparency inadvertently creates opportunities to game the system, ultimately leading to questions about its effectiveness and the value of the signaled creditworthiness or trustworthiness.

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8.3. The fairness paradox of algorithmic regulation

Fairness has been featured in over 80% of the guidelines for AI ethics (Jobin et al., 2019). However, conducting an investigation into the specific differences of the implementation of automated decision-making systems necessitates a thorough analysis of the respective socio-technical contexts (Pfeiffer et al., 2023). In the SCS landscape, fairness concerns arise among individuals, between companies, and between the government and the public. These concerns will be detailed below.

Similar to the situation with other algorithmic scoring systems (Zuboff, 2015), a fundamental and systematic fairness concern raised by the SCS is the power asymmetry between individuals and data controllers, which is further emphasized by the use of big data and other advanced computational algorithms (Rhoen, 2016). Data-based algorithmic regulation strengthens the power of the government that owns the data and selects specific score calculation models for the SCS. Recently, China started paying more attention to data protection matters and issued a series of laws and regulations, such as the *Personal Information Protection Law* and the *Data Security Law.* However, as these laws regulate personal data protection by companies, they exempt the state from these rules in cases where national security is at stake (Zhao and Feng, 2021). While data protection regulations in the European Union (EU) and the United States permit the state to process data for national security purposes, they also ensure the presence of checks and balances to prevent the abuse of these exemptions (Krause et al., 2023). These mechanisms are relatively weak in China, potentially contributing to a form of sovereign power that exacerbates power imbalances (Chen and Grossklags, 2020). This aligns with Zuboff's concerns about the rise of instrumental power and surveillance facilitated by advanced digital technologies (Zuboff, 2015).

As of 2021, ~20% (or 287 million) of the Chinese population remained unbanked, which is 2.85 times higher than the United States (Baltrusaitis, 2021). A primary objective of the SCS is to encompass all entities, including unbanked individuals and small and even microenterprises, and provide them with access to financing and facilitate economic activities (see Section 5). To reach this goal, the SCS incorporates both financial and nonfinancial behaviors (e.g., moral behavior and administrative records) for the assessment of creditworthiness. In this case, the commodification of moral values, which was discussed above, can contribute to inequality between the wealthy and the poor, as affluent individuals and companies can afford to "purchase" scores through donations. Hence, the SCS actually amplifies the existent gap between the rich and the poor by introducing a new dimension where the affluent can enjoy more advantages (Curran and Smart, 2021). This is indirectly corroborated by empirical survey findings: higher levels of approval for SCSs are linked to higher socioeconomic status (Kostka, 2019; Liu, 2022). In other words, individuals with greater income and educational attainment are more inclined to support SCS mechanisms. This connection between higher socioeconomic status and greater approval rates for SCSs can be explained by the strong bias in the SCS benefit schemes, which disproportionately favor urban residents—who typically have higher socioeconomic status—while offering fewer advantages to rural citizens (Kostka, 2019). Therefore, the outcome of the SCS implementation would contradict the system's original goal of promoting economic advancement for underserved communities. Further, the reward and punishment mechanism can potentially lead to social exclusion. Individuals and companies facing financial disadvantages are more prone to being trapped in a vicious cycle: they fail to repay debt and are consequently restricted from accessing financial, as well as other resources, as a penalty, exacerbating their difficulties in recovering from the situation. In fact, a key reason why the *EU AI Act* prohibits social scoring practices is the potential discriminatory outcomes and the exclusion of certain groups (European Commission, 2021).

Different views toward the role of the SCS in the public sector (e.g., EU versus China) raise more interest and attention to studies on the SCS. While our analysis did not identify clear clusters or distinct regimes within the data, we acknowledge that such patterns could emerge in future studies, especially when considering factors like the incentives and the strictness of SCS implementation at the city level, as well as the system's focus on different sectors. These aspects could be closely associated with economic development, as the SCS may vary in its application depending on regional priorities and economic

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contexts. Future research could explore whether these factors lead to different patterns of implementation and impact across cities. It is also imperative for future empirical studies to undertake a comprehensive impact assessment of the SCSs' effects on Chinese society, focusing on its ethical and socioeconomic dimensions, as well as implications for other countries. Such empirical work will contribute valuable insights to the ongoing discourse surrounding algorithmic regulation in the public sector.

Supplementary material. The supplementary material for this article can be found at http://doi.org/10.1017/dap.2025.12

Acknowledgments. We sincerely thank the editors and anonymous reviewers for their valuable comments and constructive feedback.

Data availability statement. All documents and platforms/apps accessed for this research are publicly available and are intended for public scrutiny. A detailed list of the various types of policy papers utilized in this study is provided in a table in the Supplementary Appendix.

Author contribution. Formal analysis: J.G., M.C.; Project administration: J.G.; Supervision: J.G.; Writing – review & editing: J.G., M.C.; Conceptualization: M.C.; Data curation: M.C.; Methodology: M.C.; Resources: M.C.; Writing – original draft: M.C.

Funding statement. This research was conducted without any external funding.

Competing interests. There is no conflict of interest regarding the research, authorship, and publication of this paper.

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Cite this article: Chen M and Grossklags J (2025). Algorithmic regulation at the city level in China. *Data & Policy*, 7: e37. doi:10.1017/dap.2025.12