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Institutional Capacity and Behavioral Outcomes in Educational Correction Organizations: Evidence From China's Special School System

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Abstract

The Special School System in China integrates educational rehabilitation with judicial intervention and has become an important approach to preventing juvenile crime. However, its relationship with juvenile crime has received limited empirical attention. This exploratory study examines the statistical association between institutional capacity of the Special School System and juvenile crime by constructing an Institutional Capacity Index (ICIS) based on institutional supply theory. Using time-series data from Shandong Province (2014–2025), baseline regression and first-difference models were employed. After controlling for educational structure, economic development, urbanization, and time trends, ICIS was significantly negatively associated with juvenile crime (coefficient = −3.950, $p < 0.01$). This association remained robust in the first-difference model (*ΔICIS* coefficient = −4.443, $p < 0.01$). Given the limited sample size, findings should be interpreted as exploratory evidence rather than causal inference. This study provides initial empirical evidence on the role of institutional capacity in China's educational rehabilitation system and offers a quantitative framework for evaluating institutional development in juvenile crime prevention. Future research using larger samples is needed to validate these findings.

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Introduction

Juvenile crime has become an increasingly important concern worldwide, with prevention and rehabilitation emerging as key priorities in contemporary crime governance (Lipsey MW, 2009). Educational alternatives to punitive responses, early intervention, and rehabilitative approaches are increasingly recognized as central strategies for preventing juvenile crime. In recent years, juvenile crime in China has exhibited fluctuating trends and become increasingly characterized by violent offending, cyber-related delinquency, and group-based offending (Supreme PP of China, 2026). In response to these challenges, China's Special School System has evolved into an

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important institutional mechanism that integrates educational rehabilitation with judicial intervention. By emphasizing rehabilitation through education rather than punishment alone, the system embodies China's broader shift toward a prevention-oriented and education-centered approach to juvenile justice.

The 2021 revision of the Law of the People's Republic of China on the Prevention of Juvenile Delinquency further refined China's tiered prevention system by classifying juvenile delinquent behavior into three categories: minor misconduct, serious misconduct, and criminal offending. These categories correspond to a graduated prevention framework comprising primary prevention, secondary intervention, and tertiary rehabilitation (National P PC of China). Under this framework, the Special School System adopts a stratified referral and admission mechanism. Juveniles exhibiting minor misconduct may be admitted to Special Schools upon application by their legal guardians, whereas those exhibiting serious misconduct are subject to compulsory placement by public security authorities (Table 1). This institutional design embodies a governance philosophy that prioritizes education over punishment and emphasizes early intervention in juvenile crime prevention. At the regional level, Shandong Province has established 13 Special Schools, with an additional six currently under construction, reflecting the province's rapid expansion toward province-wide coverage of Special Schools.

Despite the growing policy importance of the Special School System, its effectiveness in preventing juvenile crime has not been systematically evaluated through empirical research (Yuan NN, 2025). Existing studies have primarily examined the influence of mainstream education systems or punitive and rehabilitative interventions on juvenile crime (Hanimoglu E., 2018), while paying limited attention to the Special School System as a distinctive institutional arrangement that integrates educational rehabilitation with judicial intervention. Methodologically, previous research has relied predominantly on descriptive analyses or cross-sectional data (Garduno LS, 2022), providing limited evidence for a long-term relationship between changes in institutional capacity and trends in juvenile crime. From a theoretical perspective, the literature has focused largely on demand-side determinants, such as family environment, school quality, and socioeconomic conditions, whereas the role of institutional capacity as a measurable supply-side factor has received little empirical attention. While related studies have examined community-based prevention (Surong R., et al., 2021), crime prevention education centers (Mo JX, et al., 2020), and compulsory educational rehabilitation programs (Kazakova T, et al., 2021), none has systematically evaluated the effectiveness of educational rehabilitation from the perspective of institutional capacity.

Table 1: Classification of Juvenile Delinquent Behaviors and Corresponding Interventions under China's Legal Framework

Behavior Category	Definition	Representative Behaviors	Corresponding Intervention
Minor Misconduct	Behaviors detrimental to the healthy development of juveniles	Smoking or alcohol consumption; repeated truancy; running away from home; staying away from home overnight without permission; excessive internet use	1. School-based education and behavioral management; 2. Parental supervision; 3. Admission to Special Schools upon application by legal guardians
Serious Misconduct	Violations of public security regulations that do not constitute criminal offenses	Affray; theft; drug use; unlawful possession of controlled instruments	1. Admonition by public security authorities; 2.Compulsory placement in Special Schools
Criminal Offending	Acts constituting criminal offenses under the Criminal Law	Intentional homicide; robbery; rape etc.	Criminal justice proceedings

Meanwhile, as the world's largest developing country, China's institutional experimentation in juvenile crime prevention offers important value for international comparative research. Following rapid social transformation, China has experienced continuous adjustments in social structure, value systems, and behavioral norms, which have increased the risk of delinquent behavior among juveniles (Li, et al., 2010). In this context, how to advance crime prevention through educational rehabilitation not only concerns the improvement of China's juvenile protection system but also provides potential insights for other countries exploring education-based alternatives to punitive responses.

This study addresses the above issues and makes three main contributions. First, it proposes an exploratory measure of institutional enabling capacity of the Special School System and constructs the Institutional Capacity Index of the Special School System (ICIS), transforming it from a qualitative description into a measurable variable. Second, using time-series data from Shandong Province between 2014 and 2025, where Special Schools have expanded rapidly, the study empirically examines the dynamic association between institutional capacity and juvenile crime, thereby providing evidence from China for evaluating the effectiveness of educational rehabilitation systems. Third, building on static model estimation, the study further investigates the association between annual changes in institutional capacity and annual changes in juvenile crime, thereby reducing the risk of spurious correlation due to common time trends and providing provides more preliminary exploratory evidence for the dynamic adjustment of Special School policies.

It should be noted that due to limited availability of official statistical data on Special Schools, the sample size of this study is relatively small (N = 12). Therefore, this research is positioned as an exploratory analysis aimed at generating preliminary evidence and hypotheses for future studies, rather than establishing definitive causal relationships.

Theoretical Background and Literature Review

Existing research has extensively examined the relationship between educational systems and juvenile crime through multiple theoretical perspectives. Among these, self-control theory (Gottfredson & Hirschi, 1990), social bond theory (Hirschi, 1969), and social learning theory (Bandura, 1977) provide the most influential explanatory frameworks. Although these theories emphasize different mechanisms—individual self-regulation, social attachment, and behavioral learning, respectively—they collectively point to education as a key institutional influence on juvenile delinquency.

Early studies primarily focused on the relationship between educational experiences and individual offending. Empirical evidence indicates that limited access to educational resources and early school dropout increase the risk of juvenile crime (Farrington, 2007). Consistent with this view, Kuhnle et al. (2012) reported a positive association between educational experiences during adolescence and the development of self-regulatory capacity. However, subsequent research has also demonstrated that self-control is not determined solely by schooling but is jointly shaped by family environment, peer relationships, and broader sociocultural contexts. This recognition has prompted scholars to look beyond individual educational experiences and examine the social processes through which education may prevent juvenile crime. To better understand alternative pathways for preventing juvenile crime, scholars have increasingly emphasized the importance of social relationships and interpersonal attachment. Wu et al. (2016) argued that strong social connectedness during adolescence facilitates value formation and helps redirect juveniles exhibiting delinquent tendencies. Similarly, Obsuth et al. (2023) found that positive teacher–student relationships significantly reduce the likelihood of delinquent behavior. Taken together, these theoretical perspectives suggest that the relationship between education and juvenile crime operates through multiple complementary mechanisms, providing an important theoretical foundation for examining educational rehabilitation as an institutional approach to juvenile crime prevention.

As empirical research has progressed, scholarly attention has gradually expanded from individual educational experiences to broader dimensions, including years of schooling, school quality, and

rehabilitative educational institutions. At the individual level, Machin et al. (2011) found that educational attainment was associated with both property and violent crime, highlighting the relationships among education, age, and offense type. Hjalmarsson et al. (2015) further demonstrated that additional years of schooling significantly reduced both juvenile offending and the probability of incarceration among young males. These studies provided important evidence on the relationship between education and crime at the individual level; however, their analyses were largely confined to educational attainment and did not address the role of institutional capacity.

Subsequent research shifted attention from individual educational attainment to school-level characteristics. Payne (2008) and Deming (2011) argued that strengthening students' attachment to schools through organizational and institutional improvements could reduce delinquent behavior. Likewise, Wilson et al. 2024, based on a large-scale meta-analysis, identified school-based reforms as one of the most effective intervention strategies for reducing juvenile crime. Although these studies broadened the analytical focus from individual education to school-level characteristics, they remained centered on mainstream education systems and rarely considered rehabilitative educational institutions.

More recently, researchers have begun to examine the broader role of rehabilitative educational institutions in juvenile crime prevention. Badiktsie et al. (2023) reported that residential rehabilitative institutions can generate positive peer effects under certain conditions, while Kazakova et al. (2021) explored the impact of compulsory educational rehabilitation on juveniles involved in delinquent behavior. These studies suggest that educational rehabilitation may influence juvenile offending through institutional mechanisms rather than solely through individual educational experiences. However, existing evidence remains largely case-based or qualitative, with limited attention to the institutional capacity of rehabilitative education systems.

In the Chinese context, the Special School System represents a distinctive institutional arrangement that differs fundamentally from special education schools, which provide compulsory education for children with disabilities. Although both terms contain the word "special" in English, they refer to entirely different educational institutions in terms of target population, legal basis, and institutional function. The Special School System is jointly administered by the education and public security authorities and is designed to provide educational rehabilitation for juveniles exhibiting misconduct before criminal punishment becomes necessary. Despite its increasingly important role in China's juvenile justice system, empirical evidence regarding its effectiveness remains limited.

Overall, the existing literature demonstrates a clear progression from individual educational experiences to school-level characteristics and, more recently, to rehabilitative educational institutions. Nevertheless, an important gap remains between studies focusing on educational experiences and those examining institutional capacity. While educational attainment reflects individual outcomes and school quality represents organizational characteristics, institutional capacity captures the availability, allocation, and implementation of educational resources at the system level. In the context of China's Special School System, little is known about how institutional capacity can be conceptualized, measured, or linked to changes in juvenile crime over time. To address these gaps, this study constructs the Institutional Capacity Index of the Special School System (ICIS) using time-series data from Shandong Province (2014–2025). After controlling for macro-level factors, including economic development and urbanization, we examine the dynamic statistical association between institutional capacity and juvenile crime, thereby providing exploratory empirical evidence on the effectiveness of China's educational rehabilitation system.

Before presenting the research hypotheses, it is necessary to clarify the core concept of institutional capacity within the Special School System. Drawing on institutional supply theory, institutional capacity can be understood as the ability of a public institution to provide resources, organize implementation, and ensure service accessibility. Accordingly, this study conceptualizes institutional capacity through three

complementary dimensions: resource allocation, organizational capacity, and institutional coverage (Furubotn EG, et al., 2010). Based on this framework, the Institutional Capacity Index of the Special School System (ICIS) is constructed using three proxy indicators. Educational expenditure intensity (X_1) represents the resource allocation dimension by reflecting the financial support for educational services (Li MQ, 2025). The teacher-student ratio (X_2) captures organizational capacity by measuring the efficiency of human resource allocation and the potential quality of educational services (Alspaugh JW, 1994 & Frost BN, et al., 2025). Enrollment per 10,000 population (X_3) represents institutional coverage by indicating the accessibility and population reach of educational services (Parvin A., 2025 & Yu, 2023).

It should be noted that official statistics on China's Special School System remain limited. Consequently, the three indicators used in this study are derived from the general education statistical system rather than from institution-specific operational data. This choice reflects the institutional characteristics of the Special School System, which operates as an integral component of the public education system rather than an independent administrative sector. Its financial resources are allocated through local education budgets, staffing is incorporated into the public education personnel system, and student referral relies on the broader educational administration and behavioral monitoring network. Therefore, the ICIS should be interpreted as a proxy measure of institutional capacity, capturing the institutional environment that supports the operation of the Special School System rather than directly measuring its internal organizational performance (Wellner J., 2013).

To further examine the effectiveness of China's educational rehabilitation model in juvenile crime prevention, this study proposes the following hypotheses.

H1: There is a negative statistical association between institutional capacity and juvenile crime levels.

Existing research suggests that institutionalized educational interventions are associated with improvements in educational attitudes, psychological well-being, and academic performance among juveniles, which in turn are negatively related to the likelihood of offending (Huang, et al., 2025). By the end of 2025, the number of Special Schools in China had increased to 430, reflecting policymakers' implicit expectations about their preventive function (Yuan NN, 2025). From a theoretical perspective, stronger institutional capacity implies more effective early identification and diversion mechanisms, enabling at-risk juveniles to be engaged during the stages of minor or serious misconduct before escalation into criminal behavior. However, the realization of such preventive effects depends not only on the expansion of institutional scale but also on the substantive improvement of implementation capacity. As Sun et al. (2023) argue in their analysis of legislative developments, responsive governance requires that the Special School System maintain adaptive capacity in practice.

Nevertheless, a contemporaneous negative association does not necessarily indicate a causal relationship, as it may be driven by shared time trends rather than structural linkage. To address this concern, the study further proposes:

H2: After controlling for time trends and potential confounding factors, there remains a significant negative association between changes in institutional capacity and changes in juvenile crime levels.

Nasu et al. (2025), in their study of the Japanese juvenile justice system, highlight that institutional change and crime trends often exhibit time-lagged and cumulative relationships. Similarly, Zhang (2023) emphasizes that the effectiveness of institutional responses depends more on marginal improvements in institutional capacity than on its absolute level. First-difference models are therefore employed to capture the association between annual changes in institutional capacity and annual changes in juvenile crime (Angrist JD, et al., 2009). Despite growing theoretical attention to rehabilitative education systems, empirical evidence on the dynamic relationship between institutional capacity and juvenile crime remains limited. Existing studies have largely focused on conceptual or theoretical discussions, with relatively few systematic empirical analyses. This study seeks to address this gap by providing exploratory evidence from China's Special School System.

3. Empirical Strategy

Model Specifications

Baseline Model

To examine the statistical association between the institutional capacity of the Special School System and juvenile crime, this study employs a baseline time-series regression model using annual data from Shandong Province for the period 2014–2025. Given the relatively short time span of the data, a linear time trend is incorporated to account for unobserved temporal factors that may jointly influence both institutional capacity and juvenile crime over the study period. The baseline model is specified as follows:

$$Y_t=\beta_0+\beta_1 ICIS_t+\beta_2 X_{it}+\beta_3 Trend_t+\varepsilon_t \quad (1)$$

Where *t* denotes the year; *Yt*represents the level of juvenile crime in Shandong Province; the *ICISt* should be interpreted as a system-level proxy capturing the broader institutional environment that supports the development and operation of the Special School System, rather than a direct measure of internal organizational performance.; *Xt* is a vector of control variables; *Trendt*is a linear time trend (defined as *Trendt=t*); and *εt* is the random error term. The ICIS of the Special School System is constructed from three standardized indicators using Z-score normalization:

$$Z_{it}=\frac{X_{it}-\bar{X}_i}{SD(X_i)} \quad (2)$$

where X_i denotes the original value of each indicator, is the sample mean, and is the corresponding standard deviation. The composite index is calculated as an equally weighted average of the three standardized indicators:

$$ICIS_t=\frac{Z_1+Z_2+Z_3}{3} \quad (3)$$

where Z_1 , Z_2 , and Z_3 represent the standardized values of educational expenditure intensity, the K-12 Teacher- student ratio, and student enrollment per 10,000 population, respectively (Table 2). Equal weighting is adopted to minimize subjective weighting bias while enhancing the comparability and interpretability of the composite index, a widely accepted practice in the construction of composite indicators in public policy research (Carley M., 2025).

Given the limited sample size (N=12), the estimated coefficients should be interpreted as evidence of statistical association rather than definitive causal effects. Accordingly, the empirical results are intended to provide exploratory evidence regarding the relationship between institutional capacity and juvenile crime, thereby informing future studies based on larger datasets.

Table 2: Standardized values of control variables

Year	X1	X2	X3	ZX1	ZX2	ZX3	ICISt
2014	0.0317	0.0671	1256	-1.432	-1.334	-1.042	-1.270
2015	0.0327	0.0673	1260	-1.290	-1.056	-1.062	-1.136
2016	0.0330	0.0681	1261	-1.241	-0.370	-1.042	-0.884
2017	0.0330	0.0687	1282	-1.240	0.151	-0.828	-0.639
2018	0.0395	0.0686	1305	0.268	0.054	-0.589	-0.089
2019	0.0408	0.0692	1330	0.561	0.597	-0.320	0.279
2020	0.0424	0.0699	1349	0.931	1.230	-0.124	0.679
2021	0.0409	0.0705	1387	0.588	1.771	0.271	0.877
2022	0.0425	0.0698	1413	0.945	1.144	0.548	0.879
2023	0.0421	0.0680	1481	0.853	-0.476	1.257	0.544
2024	0.0415	0.0676	1505	0.727	-0.849	1.505	0.461
2025	0.0402	0.0675	1503	0.424	-0.947	1.485	0.321

Extended Model with Control Variables

Broader socioeconomic conditions—such as regional economic development and urbanization—may confound the association between institutional capacity and juvenile crime. To examine whether the estimated association is robust to these macro-level factors, the baseline model is extended by incorporating additional control variables.The extended model is specified as follows:

$$Y_t=\beta_0+\beta_1 ICIS_t+\beta_2 X_{it}+\beta_3 Trend_t+\beta_4 C_{it}+\varepsilon_t \quad (4)$$

where C^{it} denotes a vector of macro-level control variables, including gross domestic product (GDP) (C1) and the urbanization rate C2).

It should be noted that, owing to the limited sample size (N = 12), this study does not estimate interaction terms to formally test moderation effects. Instead, GDP and urbanization are included as additional control variables to evaluate the robustness of the estimated association between institutional capacity and juvenile crime. If the coefficient of ICIS remains stable in magnitude and statistical significance after the inclusion of these controls, the observed relationship is less likely to be attributable to broader socioeconomic trends.

First-Difference Model

Time-series data are susceptible to spurious associations arising from common temporal trends. The augmented Dickey–Fuller (ADF) test is commonly used to assess stationarity; however, its statistical power is limited when applied to very small samples such as the present study (N = 12). Consequently, rather than relying solely on the outcome of the unit-root test, this study employs a first-difference specification as a robustness analysis to examine whether the estimated relationship persists after removing common temporal trends. The first-difference model is specified as follows:

$$\Delta Y_t=\beta_0+\beta_1 \Delta ICIS_t+\beta_2 \Delta X_{it}+\beta_3 \Delta Trend_t+\varepsilon_t \quad (5)$$

where ΔY^t denotes the annual change in juvenile crime, ΔICISt represents the annual change in the ICIS, ΔXt is a vector of annual changes in the control variables, and εt is the random error term. Because the first difference of the linear time trend is a constant (i.e., $\Delta Trendt$=1), the time-trend variable is omitted from the differenced model.

The first-difference specification complements the baseline model by examining whether year-to-year changes in institutional capacity are systematically associated with corresponding changes in juvenile crime. If the coefficient of $\Delta ICISt$ remains significantly negative after first differencing, the baseline findings are less likely to be driven by common temporal trends, thereby providing stronger evidence that the observed statistical association is not merely an artifact of shared temporal trends (Wooldridge JM., 2010).

Data Sources and Descriptive Statistics

The data for the explanatory variables and all control variables, including macro-level indicators, are obtained from the China Statistical Yearbook and the Shandong Statistical Yearbook. To ensure temporal consistency and comparability, the study adopts a unified statistical definition for Shandong Province over the period 2014–2025. Missing values in the dataset are addressed using mean interpolation.

Table 3 reports the descriptive statistics of all variables. Overall, both the Y_t and the ICIS exhibit moderate year-to-year variation without extreme skewness. Specifically, Y_t shows relatively pronounced temporal fluctuations, while ICIS reflects staged adjustments and structural changes, consistent with the phased development of the Special School System in China. All variables have skewness values within ±1, and kurtosis values remain within acceptable ranges, suggesting no severe deviations from normality or the presence of extreme outliers.

Results

Pearson Correlation Analysis

Table 4 presents the Pearson correlation matrix for the major variables included in this study. The results indicate a moderate positive correlation between the ICIS and Y_t, which seems inconsistent with the negative association hypothesized in H_1. This preliminary finding suggests that both variables may be influenced by common temporal trends. Specifically, institutional capacity and juvenile crime both exhibit

Table 3: Descriptive statistics of variables

Variable	Definition	Mean	SD	Min	Max	N
Yt	Juvenile crime index	0	1.044	-1.511	1.735	12
ICIS	Institutional Capacity Index of the Special School System	0.002	0.786	-1.27	0.879	12
X1	Educational expenditure intensity	0.0079	0.9871	-1.432	0.945	12
X2	Teacher- student ratio in K-12 education	-0.0071	1.0099	-1.3343	1.771	12
X3	Student enrollment per 10,000 population	0.0049	0.9942	-1.0619	1.505	12
Trend	Linear time trend (t = 1…12)	4.036	2.24	0.62	7.453	12
GDP	Gross domestic product	0	1.044	-1.365	1.818	12
Urban	Urbanization rate	0	1.044	-1.946	1.486	12
ΔYt	First-differenced juvenile crime index	0.092	1.29	-2.735	1.735	12
ΔICIS	First-differenced institutional capacity index	0.133	0.253	-0.335	0.55	12

upward trajectories during the study period, leading to a positive bivariate association that may reflect concurrent temporal changes rather than reflecting the net relationship between the two variables.

One plausible explanation is that periods characterized by increasing juvenile crime or heightened governance pressure are often accompanied by expanded institutional investment and policy responses. Consequently, improvements in institutional capacity and increases in reported juvenile crime may occur simultaneously, generating a positive correlation at the descriptive level. This interpretation is broadly consistent with previous research suggesting that public policy interventions often intensify in response to worsening social problems rather than precede them (Felson M., 2006). Therefore, the simple Pearson correlation should not be interpreted as evidence against H_1, and further regression analyses controlling for temporal trends are required.

Regarding the relationships among explanatory variables, ICIS exhibits relatively high correlations with X_1, X_3, C_1, and C_2. These correlations are expected because educational investment, regional economic development, and urbanization jointly contribute to the expansion of educational resources and institutional capacity over time. Given the deterministic upward trends among macro-level indicators, highly correlated variables were excluded from the final specification to avoid unstable coefficient estimation under the limited sample condition X1, X3, C1, and C2.By contrast, the X_2 shows comparatively weaker correlations with the other variables, suggesting that it captures additional variation in educational resource allocation beyond the common long-term trends.

Given the strong correlation between several variables and the linear time trend, the observed bivariate relationships may partially reflect shared

Table 4: Pearson correlation matrix

	Yt	*ICISt*	*Trend*	*X1*	*X2*	*X3*	*C1*	*C2*
Yt	1							
ICISt	0.467	1						
Trend	0.358	0.846	1					
X1	0.227	0.963	0.836	1				
X2	0.621	0.656	0.201	0.528	1			
X3	0.252	0.748	0.972	0.759	0.020	1		
C1	0.397	0.698	0.961	0.663	0.029	0.969	1	
C2	0.436	0.862	0.986	0.839	0.285	0.928	0.937	1

Notes: A correlation coefficient ≥ 0.7 indicates a strong linear relationship between variables; a coefficient between 0.3 and 0.7 indicates a significant linear relationship; and a coefficient < 0.3 indicates virtually no linear relationship.

long-term temporal dynamics rather than structural associations (Yang, et al., 2019 & Yu et al., 2022). To address this concern, the empirical strategy explicitly incorporates a time trend in the baseline specification and further employs a first-difference transformation to remove common stochastic trends.

Baseline Regression Results

Table 5 reports the baseline regression results examining the association between the Institutional Capacity Index of the Special School System (ICIS) and juvenile crime (Y_t). Based on theoretical considerations and the preliminary correlation analysis, the baseline specification includes ICIS, the Teacher- student ratio (X_2), and a linear time trend (Trend).

The results indicate that ICIS is significantly negatively associated with juvenile crime (β = -3.950, $p < 0.01$), which is consistent with H_1. This suggests that higher institutional capacity within the Special School System is associated with lower levels of juvenile crime over the study period. In substantive terms, this relationship may reflect improved accessibility of educational rehabilitation resources, more effective early identification and referral mechanisms for at-risk juveniles, and enhanced coordination between educational and judicial institutions.

Higher Teacher- student ratios (X_2) are positively associated with juvenile crime, which may reflect reduced supervisory capacity within the education system or broader resource constraints. This finding is consistent with the interpretation that reduced educational resource availability may weaken supervisory capacity within the education system. The time trend variable is also statistically significant, capturing underlying temporal dynamics

Table 5: Baseline regression results

Variable	Coefficient	Standard Error	t-value	P-value	95% Confidence Interval
Intercept	-4.5979**	1.2473	-3.6862	0.0062	[-7.4743, -1.7215]
ICIS	-3.9500**	1.1379	-3.4728	0.0084	[-6.5728, -1.3271]
X2	2.1468**	0.4813	4.4607	0.0021	[1.0370, 3.2565]
Trend	1.1448**	0.3075	3.7226	0.0058	[0.4356, 1.8539]
N	12				
R^2	0.7773				
Adj-R^2	0.6938				
F-value	9.31			0.0055**	

Notes: Robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

in both institutional development and juvenile crime patterns.

Importantly, the negative association between ICIS and Y_t contrasts with the positive bivariate correlation reported in the Pearson analysis. This divergence suggests that the initial correlation may be driven by shared temporal trends rather than a structural relationship. Once temporal effects are controlled for in the regression framework, the association between institutional capacity and juvenile crime, conditional on time trends, becomes negative. This pattern is consistent with the notion of omitted variable bias in time-series correlations and aligns with the methodological discussion of conditional relationships in Angrist and et al. (2009).

Multicollinearity Diagnostics

To ensure the robustness of the baseline regression results, multicollinearity diagnostics are conducted using the variance inflation factor (VIF). The VIF is defined as:

$$VIF=\frac{1}{1-R^2} \quad (6)$$

where R^2 represents the coefficient of determination obtained from regressing each explanatory variable on all other explanatory variables in the model. A commonly used rule of thumb suggests that VIF values exceeding 10 indicate severe multicollinearity concerns, while values above 5 may signal moderate multicollinearity (O'Brien RM., 2007).

The results show that the mean VIF value of the final specification is 7.79, which falls below the conventional threshold of 10. This indicates that multicollinearity is present at a moderate but acceptable level and is unlikely to bias the estimated coefficients substantially.

These findings support the validity of the model specification adopted in this study. In particular, the reduced model structure—based on theoretical considerations and correlation diagnostics—keeps linear dependence among explanatory variables at an acceptable level. As a result, the estimated coefficients of ICIS and other included covariates can be interpreted as relatively should be interpreted with appropriate caution given the small sample size.

First-Difference Model Results

Table 6 reports the results of the first-difference model used to examine the robustness of the baseline findings. By transforming all variables into year-to-year changes, this specification removes common time trends and time-invariant unobserved factors, allowing for a more direct assessment of the dynamic association between institutional capacity and juvenile crime.

The results indicate that the coefficient of *ΔICIS* is negative and statistically significant (β = -4.443, $p < 0.01$), suggesting that annual increases in the Institutional Capacity Index of the Special School System are associated with corresponding declines in annual changes in juvenile crime. The relatively large

Table 6: First-difference regression results

Variable	Coefficient	Std. Error	t-statistic	p-value	95% CI
Intercept	0.618	0.256	2.408	0.040**	[0.037, 1.199]
ΔX2	2241.451	426.492	5.256	0.001***	[1276.66, 3206.24]
ΔICIS	-4.443	1.244	-3.571	0.006***	[-7.257, -1.629]
R^2	0.756				
Adj-R^2	0.701				
F-statistic	13.915			0.002***	
Observations	12				

Notes: ***, ** denote statistical significance at the 1% and 5% levels, respectively. Δ indicates first-differenced variables. The relatively large coefficient of ΔX_2 results from the use of the original measurement scale of the teacher—student ratio, whereas the dependent variable is a standardized index. Therefore, the coefficient magnitude should be interpreted with caution and does not represent a directly comparable effect size.

coefficient of$\Delta X2$ is attributable to scale differences between the original student–teacher ratio and the standardized juvenile crime index. Therefore, interpretation focuses primarily on the sign, significance, and robustness of the ΔICIS coefficient.

Importantly, the sign and statistical significance of *ΔICIS* remain consistent with the baseline regression results reported in Table 5. This consistency indicates that the observed negative association between institutional capacity and juvenile crime is not driven by shared temporal trends or spurious correlations in the level data.

From a methodological perspective, the first-difference specification addresses a key concern in time-series analysis, namely the potential confounding effect of common trends. By focusing on annual changes rather than levels, the model isolates the relationship between changes in institutional capacity and changes in juvenile crime. The results suggest that the negative association persists even after removing trend components, providing stronger evidence of a stable statistical relationship across different model specifications.

Overall, the findings from both the baseline and first-difference models are consistent in direction and statistical significance, reinforcing the robustness of the estimated association between ICIS and juvenile crime. Minor differences in coefficient magnitude reflect differences in model specification rather than substantive inconsistency. The findings should not be interpreted as demonstrating that expansion of the Special School System directly reduces juvenile crime. Instead, they indicate a statistically observable association that warrants further investigation using larger datasets.

Policy Implications

The empirical findings of this study yield several policy-relevant implications. First, the results suggest that institutional capacity in the Special School System may serve as a structural covariate of juvenile crime within the broader governance context. However, given the exploratory nature of this study and the limited sample size, the results should not be interpreted as establishing causal relationships. Instead, they provide preliminary evidence that may inform future hypothesis development and more rigorous empirical testing.

In this context, policymakers may consider integrating Special School System development into a comprehensive juvenile crime prevention framework. Rather than focusing solely on quantitative expansion, greater attention should be paid to improvements in institutional quality, operational efficiency, and service accessibility. Such a multidimensional approach may help ensure that institutional capacity is translated into more effective educational rehabilitation services for at-risk juveniles.

Second, the findings highlight the importance of distinguishing between statistical variation in recorded crime data and actual changes in delinquent behavior. The positive association between certain control variables and juvenile crime may partly reflect improvements in administrative reporting systems, detection capacity, or changes in classification practices rather than actual increases in delinquent behavior. This underscores the need for caution when interpreting fluctuations in official crime statistics, especially when institutional monitoring systems are continuously evolving.

Finally, the study highlights the limitations of existing data infrastructure for evaluating the Special School System in China. At present, relevant data remain fragmented and regionally inconsistent, which constrains systematic evaluation of institutional effectiveness. Future research and policy practice would benefit from the development of standardized data collection frameworks covering key dimensions such as institutional resources, staffing structure, enrollment in rehabilitation programs, curricular design, and rehabilitation outcomes. Establishing more direct and standardized measures of institutional capacity would also help address limitations of proxy-based measurement approaches used in the present study.

Study Limitations and Future Research Directions

This study is exploratory in nature, and its findings should be interpreted as preliminary rather than definitive. Several limitations should be acknowledged.

First, due to limited data availability, the sample size is small (N = 12). This limitation reduces the statistical power of conventional time-series techniques and restricts the applicability of more advanced econometric methods, such as vector autoregression, structural break tests, or cointegration analysis. Given these constraints, the study does not rely on formal unit root testing (e.g., ADF tests), but instead employs a combination of level specifications and first-difference models as a robustness strategy. While this approach cannot fully substitute for formal stationarity testing, it provides a pragmatic solution under small-sample conditions. Future research would benefit from extending the observation period or constructing multi-province panel datasets to improve statistical power and external validity.

Second, causal identification remains limited. The present study does not exploit exogenous policy shocks or other quasi-experimental variation, and therefore cannot fully rule out reverse causality or omitted variable bias. Accordingly, the estimated relationships should be interpreted as statistical associations rather than causal effects. Future studies could improve identification by leveraging policy implementation discontinuities, institutional reform timelines, or other exogenous variations in the establishment and expansion of Special School Systems.

Third, the Institutional Capacity Index (ICIS) is constructed as a proxy based on general education statistics rather than direct administrative data on Special Schools. This reflects the current lack of systematic micro-level data on Special School operations in China. As a result, ICIS captures the structural supply environment for educational rehabilitation rather than the internal operational quality of Special Schools. Future research should aim to develop more direct and fine-grained indicators as data on staffing, enrollment, institutional resources, and rehabilitative programming become more systematically available.

Finally, the study relies on data from a single province (Shandong Province), which limits the generalizability of the findings. As an economically developed coastal province, Shandong may differ systematically from other regions in terms of educational resources, governance capacity, and juvenile crime patterns. Future research should therefore employ multi-province panel datasets or longer time-series observations to test the robustness and external validity of the observed associations.

Taken together, this study provides exploratory empirical evidence on the statistical relationship between institutional capacity in the Special School System and juvenile crime in China. Given the limitations in sample size and data availability, the findings should be interpreted with caution and further validated in future research

Supporting information

S1 Table. Classification of Juvenile Delinquent Behaviors and Corresponding Interventions under China's Legal Framework.
S2 Table. Standardized values of control variables.
S3 Table. Descriptive statistics of variables.
S4 Table. Pearson correlation matrix.
S5 Table. Baseline regression results.
S6 Table. First-difference regression results.

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Author Contributions

Conceptualization: Bingzhang Li.
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Data Availability Statement

The data used in this study are publicly available from the China Statistical Yearbook and the Shandong Statistical Yearbook. The processed dataset and analytical files used for replication are available from the corresponding author upon reasonable request.

Ethical approval

This study does not involve human participants or animals and therefore did not require ethical approval.

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