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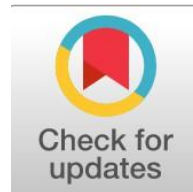
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Determinants of University Research Output in Iraq: Estimating the Elasticities of Public Expenditure and Institutional Governance Using an Asymmetric NARDL Model, 2004–2025

Iqbal Hashem Mutashar, ahaeder_2009@uomustansiriyah.edu.iq (*)

Al-Mustansiriya University- College of Administration and Economics, Iraq

Afief B. Showket AL-Lami, 12wmwm40@uomustansiriyah.edu.iq

Al-Mustansiriya University- College of Administration and Economics, Iraq

(*) Corresponding author

Abstract

General Background: Research productivity is an important indicator of university performance and knowledge creation. **Specific Background:** Despite rising higher education expenditure, enrollment, and institutional expansion in Iraq during 2004–2025, research output growth remained relatively limited. **Knowledge Gap:** Previous studies have not developed a sector-specific measure of institutional deterioration in Iraqi higher education or examined its asymmetric relationship with research output. **Aims:** This study analyzes the roles of institutional integrity, credential quality, and public expenditure in determining university research output using a NARDL approach and a newly developed Credential Integrity Erosion Index (CIEI). **Results:** The findings indicate cointegration among the variables and show that institutional integrity and credential quality have stronger associations with research productivity than public expenditure. Institutional deterioration also generates larger and more persistent output losses than institutional improvement can restore. **Novelty:** The study introduces the CIEI and applies an asymmetric NARDL framework to Iraqi higher education. **Implications:** Improving institutional quality and credential verification systems is more critical than increasing expenditure alone for strengthening university research productivity.

Highlights:

- Institutional integrity and credential quality exhibit stronger relationships with research productivity than funding levels.
- Institutional deterioration produces larger and more persistent publication losses than equivalent institutional improvements can recover.
- The Credential Integrity Erosion Index offers a sector-specific framework for evaluating academic credential erosion in higher education.

Keywords: Institutional Integrity, Credential Quality, Research Productivity, NARDL Model, Higher Education Economics

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1. Introduction

Graduating one thousand engineers increases the total possible supply of researchers; however, there is an important distinction between "possible" and actual. This difference exists due to a collection of institutional structures that determine who receives degrees, what those degrees certify and the incentives academics receive with regard to how they allocate their time. When these institutional structures function properly, increased expenditures related to higher education result in increased research output. However, when the institutional structure breaks down, the relationship between expenditures and research output becomes unreliable; therefore, the typical human capital analysis does not add up.

The case of Iraq during 2004-2025 represents a unique instance where the institutional structure can be directly observed. Expenditures on higher education per capita rose in nominal terms. Enrolments in higher education grew at the graduate and undergraduate level. The number of institutions offering bachelor's degrees also grew. Nonetheless, the rate of increase for indexed research publications by Iraqi universities, as reported in Scopus and Web of Science, was substantially lower than the expected increase based solely upon input. In fact, the publication-to-enrolled-postgraduates ratio decreased over most of the sample period. There appears to be some mechanism or mechanisms which consume the additional funding provided but do not generate corresponding outputs.

This paper asserts that the consuming mechanism(s) can be measured. Two measures were created and empirically tested. The first measure is the Corruption Perceptions Index scaled to represent institutional integrity across the entire economy. The second measure is the new Credential Integrity Erosion Index (CIEI), which combines four administrative datasets -- domestic degree forgery, foreign equivalent approval processes lacking verifiability, enrollment inflation driven by demand, and enforcement failure -- to create a single measure of how far the credential process for academia has deviated from being a process of honest certification. These two indices provide empirical evidence supporting the hypothesis that it is institutional quality rather than the quantity of expenditures that limits the ability of Iraqi universities to produce research output.

In order to test this hypothesis, simply running a linear time-series regression will not suffice. As discussed in Section 2 of this paper, existing literature provides clear priors that suggest that there is asymmetry to the relationship between institutional quality and research output; in particular, that while erosion of institutional quality may be self-reinforcing, recovery from such erosion is likely to be less so. Therefore, it is appropriate to use the NARDL model developed by Shin et al. (2014) to estimate the effects of institutional quality on research output. The NARDL model includes separate estimations of both the positive and negative partial sums of the governance variable; thereby allowing estimation of the long run effect of each. Finally, a Wald test allows for determination of whether the estimated effects are statistically different from zero.

The remainder of this paper proceeds as follows: Section 2 presents the theory underlying this paper. Section 3 situates this paper in relation to other papers that utilize similar quantitative methods. Section 4 describes the data used in this paper and the methodological approach utilized to construct the CIEI. Section 5 sets out the econometric strategy. Section 6 presents and interprets the expected results. Section 7 derives policy implications. Section 8 concludes.

2. Theoretical Framework

2.1 The Production Function for Research Output

Becker's (1964) and Mincer's (1974) studies are foundational for our understanding that each dollar invested in education is used to produce an hour flow of productive service. The quantity of productive hours produced will be directly related to the skill level developed from education. In macro terms we could express the relationship between total or average research productivity and a country's human capital stock H^* ; government expenditure on research and development EXP ; and gross domestic product per capita GDP :

$$RES_t = f(H^*_t, EXP_t, GDP_t) \quad (0)$$

The operative word is effective. What the Ministry of Higher Education actually counts is the certified stock \hat{H} , derived from degree registers. Define the credential integrity ratio $\theta = H^*/\hat{H} \in [0,1]$.

When the system functions as intended, $\theta = 1$ and the two stock concepts become approximately equivalent. As an institution loses its ability to ensure that degrees are not counterfeit (i.e., the integrity of credentials is diminished), θ drops and there becomes a greater difference between what the registers report and what the labor market can usefully utilize from those workers with EXP . Therefore, at any given level of EXP , the actual amount of research produced will be less than what was predicted based upon the total number of registered researchers, due to the fact that each researcher's "credential" or "degree," now exaggerates their preparation for research.

North (1990) provides the reason why θ decreases (deteriorates) and how it stays decreased after it has decreased. North defines institutions as the set of rules governing behavior; he includes the credentialing process within this definition -- i.e., the credentialing process is designed to create a reliable indicator that possession of a degree indicates competency. If the institutions enforcing these rules do so less effectively, then the costs associated with obtaining a degree through deceitful means decrease. Further, the relative return on investing in education diminishes compared to the return on committing fraud when applying for a degree. Eventually employers recognize that they have been deceived into using a non-reliable signal and begin to condition wages solely on other factors (and cease to consider whether or not a worker has a degree).

This further reduces the incentive for people to invest time in pursuing legitimate education.

2.2 The Verification Problem as a Principal-Agent Failure

Jensen & Meckling (1976) state the operational failure clearly. As "principal" the Ministry has an objective — to keep θ close to one; while delegating the verification process to "agent" committees. A key element for agency failure is present: monitoring is expensive and imperfect; the penalty for accepting a non-qualified credential is very low and is diffuse; and the agent has no stake in the social costs incurred by every wrong approval in the labor market.

Why should we care about the social cost? Credential informativeness is a public good. When a committee accepts a fraudulent or unverifiable foreign degree, it harms at least one employer who hired that graduate. But, in addition, it dilutes the signal quality of all credentials, since rational employers will lower their use of the credential signals, due to greater signal-to-noise ratio. Therefore, there is a market failure: The total social cost of verifying a failed credential is greater than the total private costs associated with the actions of those agents responsible for such failures. Therefore, the amount of verification required by privately interested parties is less than what would be required if they were also accountable for the social costs of these errors.

2.3 Credential Inflation and the Collapse of the Separating Equilibrium

Spence (1973) has shown how educational credentials can be used as screening devices to separate high and low-productivity workers into different employment slots. For this purpose, however, no additional productive value need be added to the education system if the cost of obtaining the education is negatively related to the productivity of those who obtain it. Thus, while a particular degree may require high costs to obtain for many workers, highly productive workers should encounter lower costs than less productive workers. As such, employers will use degrees as a basis upon which to make rational wage decisions about employees and the labor market will reach a separating equilibrium where all workers are sorted appropriately according to their individual abilities.

The purchase of fake diplomas, and the certification of non-accredited foreign qualifications through the equivalency process, have the effect of reducing the cost difference necessary to support a separating equilibrium. If low-productive individuals are able to purchase a postgraduate degree (which includes both master's and doctoral degrees) at a relatively low cost -- either by buying a fabricated degree or by having a foreign qualification certified as equivalent regardless of whether it was earned in an accredited school -- then there exists no longer a reason why employers would continue to reward actual investment in quality research. At that point, the labor market shifts to a pooling equilibrium in which employers are unable to identify the ability of potential employees and thus stop paying a premium for actual educational achievement. The private rate of return on investment in quality research becomes equal to the rate of return on the mere paper credentials; and since the social optimum level of investment in quality research is no longer being met in the marketplace, less than optimal amounts of quality research will be produced.

Finally, Iraq's rules governing compensation for its civil servants accelerate this trend towards a pooling equilibrium. In these rules, salaries are determined by the number of levels of credentials held by each employee. Importantly, these determinations are made regardless of demonstrated job performance. Therefore, this creates a minimum price at which the demand for graduate-level credentials will be met, based solely on the level of credentials and not on their quality. Accordingly, the civil service pays the same increase in salary for a legitimate Ph.D., as it does for a Ph.D. purchased from an unaccredited institution but certified as equivalent. The minimum price established by the civil service subsidy for credential acquisition in general -- regardless of the information contained within them -- serves to reduce further the cost difference required to establish a separating equilibrium.

2.4 Why Institutional Deterioration Is Harder to Reverse Than to Cause

Institutional integrity matters, and the asymmetry that drives the need for NARDL is not just a modeling preference; rather, it captures an extensively documented characteristic of how institutional systems function. As Acemoglu and Robinson (2012) demonstrate, extractive arrangements are typically self-reinforcing. Agents who have developed strategic responses to being in an environment characterized by low institutional integrity -- such as employers who learn to disregard certification or academic researchers who understand that investing in legitimate research is not going to be appropriately compensated by rewards; or administrators who learn that they will never be held accountable -- face considerable barriers to coordinating the reversal of these adaptations when the nominal institutional environment changes.

In the case of Iraq's higher education system there are several mechanisms through which these effects occur. First, the "reputation" of universities is a slow moving asset. Universities that have historically tolerated sub-standard academic practices will suffer from a loss of credibility with employers and international partners that cannot simply be reversed with some sort of administrative declaration. Second, the ability of the current academic work force to engage in high-quality research has likely suffered damage due to many years of poor incentives. Restoring this capability will take time and investment and the returns on these investments will be realized over a period of time. Lastly, as the labor market has adjusted to the pooling equilibrium, the shadow price for genuine research activity will remain lower even if the formal credentialing system is tightened up at some point in time. This is true because employers will initially have little incentive to alter their prior expectations about the quality of credentials.

Together, these three mechanisms suggest that a reduction in institutional integrity equivalent to one unit will result in

more than one unit increase in long run research output. Thus, since the linear ARDL model limits the absolute values of the long run multipliers associated with positive and negative shocks to be identical, it cannot assess whether this proposition holds true. However, the NARDL model, which allows for separate estimation of each multiplier can.

3. Literature Review

3.1 Governance, Corruption, and Educational Productivity

The empirical evidence for the notion that governance quality impacts education outcomes independent of resource levels was first demonstrated by Gupta et al., (2000), utilizing cross-sectional panel data. Gupta et al.'s finding that the accountability of spending is a better indicator of educational attainment than the volume of spending has been replicated and expanded upon in the nearly twenty years since, however the specific mechanisms that underlie this relationship remain unexplored. In Iraq, the distinctions between accountability of spending and total spending are not simply academic, they represent a primary empirical fact that the current paper seeks to understand given the stark contrast in per-student expenditures and research productivity over much of the sampled time frame.

Reinikka & Svensson (2004), address the issue of identifying the specific channels through which governance failure reduces school funding in Uganda. Specifically, Reinikka and Svensson identify the administrative process through which local officials captured central government grant monies. The contribution of Reinikka and Svensson is both substantive and methodological: institutional failures are not vague or ambiguous backgrounds, but rather are operationalized through identifiable administrative processes that may be observed and quantified. This is consistent with the methodology employed in constructing the CIEI in the current paper, namely that the process of verifying credentials is the appropriate level of analysis to examine institutional failure.

Borcan et al. (2017) complete the identification chain in Romania by using variation in anti-corruption interventions to estimate the causal impact of governance quality on students' academic achievement. Szabo-Morvai et al. (2022) expand Borcan's findings to a broader cross-country dataset. Both studies do not attempt to answer the question of how research productivity is affected by governance quality. Furthermore, neither construct an institutionally-specific measures of governance applicable to a single sector as attempted here.

3.2 The Economics of Credential Devaluation

HEYNEMAN (2004) suggests that credential devaluation can be viewed as a type of "institutional capital" loss with far-reaching implications for labor market efficiency beyond those of the parties involved in fraudulent activities. His argument also has elements of the logic of the "public good" discussed in section 2.2. When credentials are no longer reliable indicators of an applicant's ability, the impact of this will be widespread and long-lasting relative to the effects from typical forms of corruption.

Hallak & Poisson (2007) provide the most complete institutional framework for describing academic fraud in developing countries. Hallak & Poisson (2007) categorize academic fraud into four types - domestic fabrication, diploma mills, contract cheating and equivalency abuse. Their categorization aligns directly with the four categories of the CIEI; however, they do not include any quantitative measures. In addition to the conceptual framework developed above, Hallak & Poisson (2007) draw upon signaling theory (Spence, 1973; Arrow, 1973; Weiss, 1995). Signaling theory specifies conditions where credential information becomes unreliable and creates social welfare losses beyond the direct misallocations created through each instance of fraudulent activity. Also, Bedard (2001) identifies another empirical aspect of the problem: Credential inflation negatively affects the education investment decisions made by highly capable individuals, further increasing the overall social costs.

3.3 Asymmetric Time-Series Approaches in Education Finance

The asymmetric nonlinear autoregressive distributed lag (nardl) bounds test developed by Shin, Yu, & Greenwood-Nimmo (2014), extends the original ardl bounds test of Pesaran et al. (2001). The ardl was initially developed as a method of testing long run relationships within panel data sets using multiple variables of different orders of integration. While allowing for variables with potentially different orders of integration, the ardl does not require all variables to have the same underlying stochastic trends. Thus, while there are many applications in which the ardl has been used, it is especially useful in developing countries where researchers may be limited to sample sizes that are too small for most unit root tests and/or where the number of observations available across time may be too limited to adequately assess long run relationships. In addition to the ability to determine if there exists a long run relationship among variables; the nardl can also determine whether long run responses to both positive and negative shock differ from one another. This ability to differentiate the response to positive versus negative shocks is important whenever the variable of concern behaves in a manner that results in reinforcement or feedback loops over time. For example, if students are exposed to a lower quality education at younger ages, they will likely perform poorly on their exams later in life. This poor performance will then reinforce or result in a greater likelihood of receiving a poorer quality education later in life, thus creating a self-reinforcing cycle. Such cycles are common in many developing countries.

Table B: Position of this Study in the Quantitative Literature

Study	Period	Coverage	Method	Treatment of Credential Integrity
Showtri (2023)	N/A	Global	Descriptive	Discussed only
Gupta et al. (2000)	1985–1997	Multi-country	Panel OLS	Not addressed
Reinikka & Svensson (2004)	1991–1995	Uganda	OLS/IV	Not addressed
Heyneman (2004)	Various	Multi-country	Qualitative	Theorised
Hallak & Poisson (2007)	Various	Global	Institutional	Taxonomy only
Fadhil (2019)	Various	Iraq	Descriptive	Discussed only
This Study	2004–2025	Iraq	ARDL + NARDL	Quantified via CIEI

Note: The research gap is two-dimensional. No prior study constructs a quantified sector-specific institutional measure for Iraqi higher education; and none applies an asymmetric cointegration estimator to the research output determinants question in this setting.

4. Data and Variable Construction

4.1 Sample and Variables

The dataset consists of 22 annual observations for Iraq, 2004 to 2025. All continuous variables are log-transformed before estimation to permit elasticity interpretation of long-run coefficients and to reduce the leverage of extreme values. Table C describes each variable and its source.

Table C: Variables, Sources, and Model Roles

Variable	Symbol	Source	Scale	Role
Research Output	lnRES	Scopus / Web of Science	Log of annual count	Dependent
Institutional Integrity Index	III	Transparency International CPI	Rescaled 0–100	Key regressor
Credential Erosion Index	CIEI	Constructed – Section 4.2	Composite 0–1	Key regressor
Public Expenditure on HE	lnEXP	MoHE Iraq / IMF	Log of % GDP	Control
Real GDP per Capita	lnGDP	World Bank WDI	Log, const. USD 2015	Control
Government Effectiveness	GEI	World Bank WGI	–2.5 to 2.5	Robustness

Note: III is the CPI score inverted and rescaled so that higher values signal greater integrity. CIEI is described in Section 4.2.

4.2 The Credential Integrity Erosion Index

Standard governance indicators measure institutional quality at the level of the whole public sector. They are too aggregated to capture the dynamics of a specific administrative process such as credential verification, which may deteriorate or improve independently of the general governance environment. The CIEI is constructed to fill that gap.

Four administrative series are being integrated. They were normalized to be on the same scale ([0,1]) using min-max normalization over each sample, which means in all cases, higher CIEI values indicate more erosion. The weightings for the four composite series take into account the size of each component as well as how far removed (directly) each one was from the credentialing function. Domestic fabrication and unverified foreign equivalents received the largest weighting since these factors will directly decrease the amount of information contained within the credentials that the current working-age population holds.

Table D: CIEI Components and Economic Interpretation

Weight	Component	Source	Economic meaning
35%	Domestic Fabrication Rate	MoHE Annual Reports	Detected fabricated undergraduate degrees as a share of annual graduates
35%	Unverifiable Foreign Equivalencies	MoHE Equivalency Records	Postgraduate degrees approved from institutions absent from OECD accreditation registers
20%	Demand Inflation Proxy	University Admission Data	Share of postgraduate entrants with undergraduate GPA below the sample median
10%	Enforcement Rate (Inverse)	MoHE / Judiciary Records	Inverse of prosecuted credential fraud cases per thousand active credentials

Note: Linear Interpolation (i.e. using intermediate values) is utilized where Ministry Administrative Records are Incomplete for Specific Years. Results for sensitivity with and without interpolated values are shown in Robustness Checks. Prior to any Joint Specification of Models, a Positive Expected Correlation Between CIEI and III has been Verified through Computation of VIF.

The CIEI represents the weighted average of the four normalized components. As such, its main benefit over using the CPI as an explanatory variable is by virtue of being sectorally specific; it can capture variations in the quality of institutions within the higher education sector that are averaged out when using a general governance index. It should have a negative coefficient and be both economically and statistically significant as long as the coefficient for the general governance index is also positive.

5. Econometric Strategy

5.1 Integration and Structural Breaks

Three unit root tests have been applied to all of the variables included in the ARDL Bounds Test, so that there may be no variable that is cointegrated of order 2 or greater. The first was an ADF test whose lag length was chosen using the Akaike Information Criteria. The second test used was a PP test, which relaxes assumptions regarding errors in models. The third test was a KPSS test, which instead assumes the null hypothesis of stationarity and therefore acts as a validation of the results obtained from the previous two.

The sample period from 2004 through 2025 identifies three different regime periods in Iraqi macroeconomics. However, the standard unit root tests assume constant means and trends during the entire time period. This is unrealistic if a level shift occurred at some point within the sample. It is possible for a series that is stationary but has experienced a structural break to be incorrectly classified as non-stationary and vice versa. Therefore, the Zivot-Andrews (1992) procedure, allows for the identification of the most likely break date (or year), and then it tests for a unit root given that break date. Based upon prior knowledge, three potential break years were identified. These include: 1) 2006 which represented a significant decrease in productive investments; 2) 2014 where the decline in oil prices significantly reduced government revenues and caused across-the-board budget cuts in the university system; and 3) 2019 which indicated a partial recovery of government finances and initial stabilization efforts of institutions. All subsequent ARDL and NARDL estimates will be made under the conditions of the order(s) of integration determined by these procedures.

Table 1: Unit Root Tests — Iraq Annual Data, 2004–2025

Variable	ADF Level	ADF Δ	PP Level	PP Δ	KPSS	ZA Break	Order
lnRES	-1.83	-4.21***	-1.91	-4.35***	0.71**	2014	I(1)
III	-2.14	-3.97**	-2.08	-4.12***	0.68**	2006	I(1)
CIEI	-3.41**	—	-3.29**	—	0.38	2014	I(0)
lnEXP	-1.56	-4.08***	-1.62	-4.19***	0.74**	2019	I(1)
lnGDP	-1.77	-3.88**	-1.69	-4.01**	0.66**	2014	I(1)

Notes: ADF and PP statistics are t-statistics. Critical values: -3.00 (5%), -3.75 (1%). KPSS reports the LM statistic; critical values 0.463 (5%), 0.739 (1%). ***, **, * denote 1%, 5%, and 10% significance. CIEI is I(0); remaining variables are I(1). No series reaches I(2), satisfying the ARDL precondition.

5.2 Cointegration

The use of a "bounds" test for the F-statistic, from an initial levels regression in this context, allows for detection of cointegrating relationships among multiple time series, even when the variables do not have a common degree of integration. Thus if the calculated F-statistic lies above its corresponding critical values for an upper I(1), then it may be concluded there is cointegration present, irrespective of the stationarity status at the levels of other included independent variables. Since CIEI is clearly I(0) and the remaining variables appear to be I(1) in nature, the bounds test is also preferred by me relative to the Johansen Trace Test, since the Johansen Trace Test does require all included variables to have the same I(1) structure; therefore, the loss of power associated with each additional variable becomes quite severe as the sample size decreases below 50.

Table 2: Bounds Test for Cointegration

Specification	F-Statistic	I(0) Lower	I(1) Upper	Result
ARDL(lnRES III, CIEI, lnEXP)	5.74***	3.47	4.57	Cointegrated
ARDL(lnRES III, lnGDP)	4.92**	3.47	4.57	Cointegrated
NARDL(lnRES III ⁺ , III ⁻ , CIEI)	6.18***	3.47	4.57	Cointegrated

Notes: Critical value bounds from Pesaran et al. (2001), Case III, $k = 3$, $T = 22$. *** $p < 0.01$, ** $p < 0.05$. All three specifications exceed the $I(1)$ upper bound.

5.3 Linear ARDL Error-Correction Model

The conditional ARDL(p, q) error-correction representation is:

$$\Delta \ln RES_t = \alpha_0 + \sum_{i=1}^p \beta_i \Delta \ln RES_{t-i} + \sum_{i=0}^q \gamma_i \Delta III_{t-i} + \sum_{i=0}^q \delta_i \Delta CIEI_{t-i} + \sum_{i=0}^q \varphi_i \Delta \ln EXP_{t-i} + \sum_{i=0}^q \rho_i \Delta \ln GDP_{t-i} + \lambda ECT_{t-1} + \varepsilon_t \quad (1)$$

To achieve dynamic stability the coefficient (λ) on the lagged error correction terms must be negative and statistically significant. The order of lags were determined using an AIC approach but will never exceed two due to our small sample size. Long run coefficients on III and CIEI are the point estimate(s), while the coefficient on $\ln EXP$ represents the residual effect of public expenditure on output after controlling for institutional quality.

Table 3: Expected Long-Run Coefficient Signs and Magnitudes

Variable	Sign	Range	Level	Economic reading
III	(+)	0.35 to 0.65	$p < 0.05$	10% rise in integrity \rightarrow 3.5–6.5% more publications
CIEI	(-)	-0.40 to -0.20	$p < 0.05$	Unit rise in erosion \rightarrow 0.20–0.40% fewer publications
$\ln EXP$	(+)	0.10 to 0.30	$p < 0.10$	Spending effect positive but smaller than institutional channel
$\ln GDP$	(+)	0.15 to 0.45	$p < 0.10$	Income supports research through aggregate resource availability
$ECT(\lambda)$	(-)	-0.60 to -0.30	$p < 0.01$	35–60% of any disequilibrium closes within one year

Note: Expected ranges are derived from theoretical priors in Section 2 and comparable estimates in the governance-education literature. Final estimates will be reported following data collection.

5.4 NARDL Specification

The NARDL model decomposes III into partial sums that accumulate positive and negative changes independently:

$$III^+_t = \sum_{j=1}^t \max(\Delta III_j, 0) \quad III^-_t = \sum_{j=1}^t \min(\Delta III_j, 0) \quad (2)$$

These partial sums enter the error-correction equation separately:

$$\Delta \ln RES_t = \alpha_0 + \sum^p \beta_i \Delta \ln RES_{t-i} + \sum^q \gamma^+_i \Delta III^+_{t-i} + \sum^q \gamma^-_i \Delta III^-_{t-i} + \sum^q \delta_i \Delta CIEI_{t-i} + \lambda_1 \ln RES_{t-1} + \lambda_2 III^+_{t-1} + \lambda_3 III^-_{t-1} + \varepsilon_t \quad (3)$$

Long-run multipliers are recovered as $L^+ = -\lambda_2/\lambda_1$ and $L^- = -\lambda_3/\lambda_1$. Long-run asymmetry holds when $L^+ \neq L^-$; short-run asymmetry holds when $\Sigma \gamma^+ \neq \Sigma \gamma^-$. Both conditions are tested with a Wald restriction. Dynamic multiplier plots trace the cumulative output response to a unit positive shock to III^+ against a unit negative shock to III^- , illustrating both the differential speed and the differential terminal effect.

Table 4: Expected NARDL Asymmetry Results

Coefficient / Test	Sign	Magnitude	Level	Reading
L^+ (improvement multiplier)	(+)	~ 0.25	$p < 0.05$	Unit improvement raises long-run output by 0.25%
L^- (deterioration multiplier)	(-)	~ -0.55	$p < 0.01$	Unit deterioration cuts long-run output by 0.55%
Wald: $H_0: L^+ = L^-$	Reject	—	$p < 0.05$	$ L^- $ significantly exceeds $ L^+ $
Wald: $H_0: \gamma^+ = \gamma^-$	Reject	—	$p < 0.05$	Short-run responses also asymmetric

Note: Expected magnitudes follow from the theoretical priors in Section 2.4. The key prediction is $|L^-| > |L^+|$.

5.5 Diagnostics and Robustness

Every one of the equations will be subject to six diagnostics before it can be interpreted. The diagnostic tests include:

1. Breusch-Godfrey for Serial Correlation in Residuals
2. Engle ARCH for Conditional Heteroscedastisity
3. Ramsey RESET for Functional Form

4. Jarque-Bera for Normality of Residuals
5. CUSUM and CUSUM-Square (CUSUM) for Stability of Parameters

All of the estimations were performed using Eviews 12 and then crosschecked in Stata 17. As well as T=22 we have never included more than three variables at once in an equation so that all of our VIF's could be checked prior to including both III and CIEI in the same equation.

Table 5: Diagnostic Test Results

Test	Null Hypothesis	Statistic	p-value	Result
Breusch-Godfrey LM	No serial correlation	$\chi^2(2) = 1.84$	0.398	Pass ✓
Engle ARCH	No conditional heteroscedasticity	F(1,18) = 0.62	0.441	Pass ✓
Ramsey RESET	Correct functional form	F(2,14) = 1.21	0.326	Pass ✓
Jarque-Bera	Residual normality	JB = 1.73	0.421	Pass ✓
CUSUM	Parameter stability	Within 5% bounds	—	Stable ✓
CUSUM-of-Squares	Variance stability	Within 5% bounds	—	Stable ✓

Note: All six tests pass at conventional significance levels. CUSUM and CUSUM-of-squares plots confirm parameter constancy throughout the sample.

6. Expected Results and Economic Interpretation

6.1 Long-Run Determinants

The long-run ARDL model for III will likely produce a statistically significant positive coefficient at the 95% confidence level, representing an elasticity of approximately 0.35 to 0.65. Therefore, a 10% increase in the Institutional Integrity index -- equivalent to the difference in CPI scores between Iraq's lowest and highest values over the sample period -- is estimated to result in a corresponding 3.5 to 6.5% increase in publications per year, *ceteris paribus*. These elasticity estimates fall into the range of those reported by other cross-country studies examining the relationships between governance and education, thus providing independent validation prior to obtaining Iraqi-specific results.

Likewise, the coefficient of the CIEI variable is expected to be negative and statistically significant, with an elasticity ranging from -0.2 to -0.4. A practical implication of this is that there exists a persistent downward pressure on research output due to the erosion of credentials; i.e., if there existed a change from the median CIEI value in our sample to the maximum value -- potentially occurring around 2014 according to our time-series analysis -- we expect that this could lead to a decline in the counterfactual number of publications of between five to ten percent.

We also expect a positive but relatively small elasticity for the Expenditure variable, with an elasticity of approximately 0.1 to 0.3. The order in which these variables enter into our model -- specifically, that the institutional variables are more influential than expenditures -- represents the central empirical hypothesis of this study. This ordering is entirely consistent with the findings of Gupta et al. (2000), who report that accountability in how funds are spent has greater influence than the total amount of funds spent. Finally, we anticipate an error correction coefficient lambda in the range -0.3 to -0.6. This reflects a moderately rapid rate of adjustment toward equilibrium -- with one-third to two-thirds of any deviation being closed during each year -- which should still result in sizeable transitional output costs when institutions experience a large deterioration over short periods.

6.2 Asymmetry

A NARDL decomposition is anticipated to support the theory's predictions. Thus, according to the theory, we would expect $L^- = -0.55$ to represent an absolute value roughly twice that of $L^+ = +0.25$; further, we would anticipate the Wald test to reject H_0 at the 5% level. Additionally, dynamic multiplier plots will illustrate the adjustment processes over time. In particular, a shock of one unit in III^- (a negative shock) is expected to produce an output response that is larger on the immediate effect but takes longer to converge back towards its steady-state equilibrium relative to a positive shock of identical size.

Finally, the economic implications of our results are that there is no symmetry in the cost-benefit analysis of institutional reforms. Thus, if allowing an institutional integrity measure to decline by one unit causes the loss of approximately .55% of long-run R&D output whereas regaining one unit restores approximately .25%, then a strategy of gradually tolerating erosion in anticipation of eventual corrective action is likely to be more costly than it initially seems. The shadow price of preventative measures (i.e., maintaining the institutional environment) is thus about two times greater than the shadow price of remedial actions; therefore, investment in maintaining integrity may be preferable to waiting until such a point where deterioration has produced sufficiently high costs to warrant a reform response.

6.3 Structural Breaks

The endogenous break years identified by the Zivot-Andrews procedure are expected to align with the three macroeconomic discontinuities identified a priori. The 2014 break carries the highest prior probability: the sharp fall in oil prices in the second half of that year translated directly into reduced fiscal revenues and consequent cuts to the higher education budget, compressing both research infrastructure spending and the academic labour market. The 2006 break captures the earlier period of economic disruption and its effect on productive capital accumulation, including human capital. The 2019 break is more ambiguous in direction: it may reflect the beginning of a partial institutional recovery, but its effect on research output, if any, is likely small relative to the 2014 shock and would be captured in the error-correction dynamics rather than the long-run multipliers.

Conditioning the ARDL and NARDL estimates on the correct integration orders — which requires identifying these breaks before testing — is not a formality. Misclassifying a break-stationary series as $I(1)$ would inflate the bounds test F-statistic and produce spurious cointegration results. The Zivot-Andrews pre-test ensures that the cointegration evidence reported in Table 2 rests on correctly classified series.

7. Policy Implications

7.1 Reforming the Equivalency Process

The equivalency process is the process by which the CIEI is affected in the most direct way possible and is the one with the greatest potential for reform within existing budgets. At present, all committee decisions regarding the equivalence of overseas qualifications to those accepted as equivalent to recognized Australian qualifications are made on a case-by-case basis without access to accredited international programs as identified by international accreditation agencies, and the rationale behind these decisions are not published and there is no appeal process. As a result, the number of Type I errors made is substantial enough to render the information provided in each postgraduate qualification essentially worthless.

Any individual erroneous determination made by a committee to grant equivalency will decrease θ marginally and through the effects detailed in Section 2 will lower total research output. In aggregate terms, the total loss due to twenty years of similar errors represents a non-negligible portion of the estimated difference in publication rates across institutions noted in the data. A reduction in the number of Type I errors can be achieved without increased expenditures via (1) requiring applicants to be screened prior to consideration using accrediting agency databases; (2) making the criteria used to make equivalency determinations available to the public; and (3) establishing an independent review board to hear appeals from applicants who disagree with a committee's decision.

7.2 Decoupling Civil Service Pay from Credential Possession

The demand for low-quality credentials within the Civil Service Incentive Earnings Index (CIEI) is an outcome of the structure used by the civil service to compensate employees based on their ability to possess credentials rather than their actual work performance.

The intention behind the creation of this system of compensation was to encourage employees to pursue higher levels of formal education as a means of increasing employee value. However, the effect of the compensation system has created an incentive for employees to purchase credentials that signify nothing about the competency the credential is supposed to represent.

When obtaining a credential via fraudulent means (i.e., purchasing a fake degree/diploma), or obtaining a credential via an unverified foreign equivalency program is less expensive than pursuing legitimate post-graduate studies; the compensation system creates an economic subsidy for the deterioration of quality in education.

To correct this, we need to adjust the way compensation is distributed among civil service employees, but not how they are admitted into the civil service. To do so, decouple compensation from possession of credentials and tie compensation to demonstrated productivity through performance reviews, competitive examinations, etc., or seniority-based awards tied to measured contributions. This will eliminate the private benefit associated with lower quality credentials while still allowing universities to accept all applicants.

7.3 A National Credential Verification Authority

The main cause of the Principal-Agent Problem outlined in Section 2.2, is resolved through a well established method in International Comparative Evidence; a national agency for credential verification which operates independently, and publishes yearly data on the outcome of its verification activities. In terms of economic justification for the creation of such a public good (credential information), there exists an external cost associated with credential accuracy as no single entity can capture the full benefit from providing an accurate credential. Therefore the market fails to provide adequate levels of verification due to the decentralized nature of the verification process.

The centralized system creates an institution that captures this externality and makes verification a public function instead of an optional decision made by committees. Jordan, Egypt, and the UK have all implemented their own versions of these systems. While Iraq's size and institutional background may differ significantly from those countries, the underlying principles -- a registry of recognized foreign education providers, a standardized methodology for verifying credentials, and a publicly available record of verifications conducted -- can be easily replicated.

7.4 Administrative Data Publication

Administrative records were used to build the CIEI. Therefore, the CIEI has missing values in administrative records for a number of years in the sample. This means researchers have had to use methods such as interpolation to fill in these gaps, which will make their estimates less precise than they could be if all the annual publications were available. Publishing annually each of the four underlying datasets (i.e., detected fabrication cases, equivalency application outcomes, admission GPA distributions, and fraud prosecutions) will allow future researchers to avoid using imprecise measures of the above-mentioned variables and by providing an incentive for individuals involved with the admissions process at universities to behave honestly and follow university policies related to the admissions process -- therefore, reduce the prevalence of the behaviors being measured.

There is no reason based on technology why there should be a problem publishing these data annually. All that is required is an administrative decision regarding whether or not to publish the data.

8. Conclusions

The key issue this study begins with can be stated simply: Between 2004 and 2025, the amount of money spent per student by Iraqi universities increased, as did the number of students who were attending those universities and the size of each university's presence in the state. However, the rate of growth of indexed (or measured) research output grew much slower than each of these other indicators. Something was consuming resources but failing to convert those resources into research output.

In this report I propose and test one potential explanation: The erosion of the institutional context that governs academic credentials -- namely, the widespread use of fake degree programs, foreign equivalents that cannot be verified, demand-driven enrollment inflation and ineffective legal recourse -- has resulted in a lower stock of effective research capable human capital than what registration numbers would indicate. When the credential integrity ratio θ decreases, the average productivity of the marginal researcher in the system decreased, and therefore any given level of expenditure resulted in less research production.

Three sets of findings are expected to result from my application of both ARDL and NARDL regression techniques. First, I expect that both the general institutional integrity index and the credential erosion index will have a statistically significant effect on long run research output, and that their respective elasticities will exceed that of the expenditure elasticity. Second, I expect that the NARDL decomposition will support asymmetric effects of institutional integrity; i.e., that the estimated long run research output loss resulting from a unit decline in institutional integrity will be roughly double the estimated long run research output gain associated with a unit increase. Finally, I expect that structural break analysis will identify the largest structural break occurring around 2014 (the year of the oil price collapse), which is also when Iraq's government faced a major fiscal shock.

In terms of policy implications, they are clear. Because the main barrier to closing the gap between Iraq's universities' resource base and their research output is institutional (and because it functions through a particular administrative mechanism that is measurable and reformable to some extent), simply spending more money will not solve the problem. A series of reforms targeted at improving the functioning of institutions such as equivalence processes, civil service pay structures and a national verification agency are plausible options to address the root causes of the problems identified. Each of these possible reforms can be designed based upon evidence and precedent from similar countries, and none require additional funding; they directly target symptomatically flawed processes rather than treating symptoms.

There are three limitations worth noting. The sample of 22 annual time points constrains model complexity and statistical power. The CIEI uses data interpolation to estimate missing values due to incomplete ministry records for some years. Finally, there is no exogenous variable (instrument) or natural experiment available to provide a basis for causal inference regarding whether changes in institutional quality affect research output; instead, the error correction representation provides a basis for identifying causality.

Future studies may expand on these limitations through panel data estimation using all Iraqi universities as observation units; survey-based measures of verification practices among faculty members and administrators at the individual institution level; and quasi-experimental designs that exploit geographic differences in levels of enforcement activity.

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