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Is Statutory Renewable Portfolio Standard Stringency Robustly Associated with Real Gross State Product? The case of New Mexico.

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Abstract:

Renewable portfolio standards (RPS) are state-level measures designed to accelerate the adoption of renewable electricity, but the overall economic effects of these standards remain unclear. Because energy affordability, economic growth, infrastructure development, and efforts to address climate change must be considered together, assessing RPS is relevant to the United Nations Sustainable Development Goals (SDGs) 7, 8, 9, and 13. This study examines the relationship between the stringency of statutory RPS and New Mexico's real gross state product (RGSP), using 28 annual observations from 1997 to 2024. The approach combines an autoregressive distributed lag (ARDL) model that accounts for the U.S. business cycle with a complementary Toda-Yamamoto lag-augmented vector autoregression. The ARDL (1,0,1,1,1,1) model, selected based on the AIC and estimated for the period 1998 to 2024, has a negative adjustment coefficient of -0.4187 ($p = 0.018$). The reported long-run RPS coefficient is negative and only marginally significant at -0.0155 ($p = 0.092$). However, the finite-sample bounds test is not conclusive at the 10% level and does not reject the null hypothesis of no level relationship at either the 5% or 1% level ($F = 3.601$; $t = -2.647$). The Toda-Yamamoto tests also fail to reject the null of no causality in either direction. The preferred ARDL model satisfies the residual and stability tests reported. Consequently, there is no robust long-run or predictive relationship between aggregate output in this small, single-state sample. RGSP alone cannot measure RPS's contribution to clean energy, inclusive growth, resilient infrastructure, and climate action.

Keywords: Renewable Portfolio Standards, New Mexico, Real Gross State Product, ARDL, Bounds Testing, Toda- Yamamoto, Energy Policy
JEL classifications: C22; O40; Q42; Q48

1. Introduction

Renewable Portfolio Standards are among the most significant state-level tools employed in the United States to alter the mix of electricity supplied by requiring covered electricity suppliers to acquire a minimum proportion of their electricity from qualifying renewable resources. Such RPS schemes generate regulatory demand for renewable power production. Nevertheless, the way these programs are designed varies considerably from state to state in terms of the stringency of their targets, eligible technologies, compliance rules, cost-recovery arrangements, geographical restrictions, and implementation schedules. For this reason, the mere adoption of a policy does not constitute a complete indication of the intensity of that policy (Carley, 2009; Carley et al., 2018; Yin & Powers, 2009). It is therefore necessary to examine whether the stringency of New Mexico's statutory RPS is linked to changes in real gross state product if one is to determine whether renewable-energy requirements have an effect on the broader economic performance of the state, rather than merely on changes in electricity generation or investment (Mamkhezri et al., 2021). Furthermore, overall state-level RGSP may mask considerable spatial redistribution, as alternative RPS designs can have significant county-level effects even if their statewide economic impacts are not statistically distinguishable. Hence, the connection between RPS stringency and aggregate economic

growth in New Mexico should be interpreted with caution, since statewide RGSP may mask local gains and losses and the delayed adjustment processes that occur across different regions. Sustainable development offers a more comprehensive basis for understanding these economic effects. The RPS policy contributes to the move toward affordable and clean energy under SDG 7 and promotes climate action under SDG 13. Moreover, the policy's impact on employment, productive activity, and the need for grid investments is linked to SDG 8 and SDG 9 (United Nations, 2015). This study does not directly assess the attainment of the SDGs. Rather, it examines whether a single overall economic outcome, RGSP, captures a detectable share of the policy's broader sustainability effects.

It is not clear, from a theoretical perspective, how a stricter RPS will affect a state's overall economic performance. On the one hand, investment in renewables can lead to increased construction activity, greater capital formation, stronger local supply chains, more learning, and higher levels of employment. On the other hand, the costs associated with meeting compliance requirements, transmission, integration, and balancing can affect both retail electricity prices and production costs. Empirical studies have shown that the effects of RPS policies vary by outcome and may occur with a delay or even cross state borders (Deschênes et al., 2023; Hollingsworth & Rudik, 2018; Upton & Snyder, 2017). As a result, the fact that RPS policies increase renewable capacity or generation does not necessarily mean they have a measurable impact on total state output. New Mexico is a suitable example because it has substantial conventional energy use alongside significant wind and solar resources and a long record of developing renewable energy policies. The Renewable Energy Act established a public utility obligation that increased from 5 percent in 2006 to 10 percent by 2011, 15 percent by 2015, and 20 percent by 2020; the 2019 Energy Transition Act introduced higher future targets. The historical RPS figure used in this study refers to the statutory requirement for public and investor-owned utilities and must not be understood as reflecting the historical compliance levels of every cooperative or municipal utility (Renewable Energy Act, Senate Bill 43, 46th Legislature, Second Session, 2004; Energy Transition Act, Senate Bill 489, 54th Legislature, First Session, 2019).

The main empirical issue is identification. Because New Mexico is subject to the national business cycle, the state's RGSP may move with US output regardless of the RPS policy. Moreover, the RPS series is a legislated step function rather than a typical stochastic macroeconomic process. The small annual data set from a single state also reduces statistical power. To address these points, this study directly controls for US real GDP in the preferred ARDL model, treats the RPS as a deterministic policy intensity when interpreting the results, and corroborates the ARDL findings with a simple Toda-Yamamoto lag-augmented VAR. The contribution is therefore intentionally more limited than a causal policy evaluation. The study seeks to determine whether there is a long-run relationship between the observed history of statutory RPS stringency and New Mexico's aggregate real output, and whether RPS has predictive power for state output after accounting for national economic conditions. This ex-post time-series inquiry complements the simulation and cross-state studies without asserting that a single-state ARDL can identify a treatment effect.

2. Research gap

Although many cross-sectional and panel studies have examined the effectiveness of RPS mandates for renewable capacity, the results remain empirically inconsistent and often fail to account for the considerable heterogeneity in how state-level policies are designed (Siddiqui et al., 2015). Moreover, the current body of literature frequently conflates investment in renewable energy with actual capacity or production, failing to distinguish between the financial obligations required by policy and the real economic outputs generated (Pata et al., 2023). Furthermore, the literature often fails to consider the temporal aspects of the diffusion

process and does not examine whether structural breaks—such as the 2008 financial crisis—have fundamentally changed how economic growth responds to renewable energy mandates (Basher et al., 2014). Additionally, earlier research has mainly focused on the direct effect of mandates on capacity deployment and has largely ignored the possibility of bidirectional feedback loops in which socio-economic objectives impose fundamental constraints on both the design and the subsequent evaluation of these policies (Pahle et al., 2016).

There were three reasons for carrying out the study. The first of these is that much of the literature on RPS tends to focus on renewable energy deployment, electricity prices, emissions, or average treatment effects across states rather than on historical relationships among aggregate output within a single state.

Second, studies specific to New Mexico have examined alternative RPS scenarios and their distributional consequences. Yet there has been less attention, from a post-hoc standpoint, on the actual statutory policy path and the observed overall RGSP.

The final point is that time-series data at the state level pose problems for national projections and can lead to overidentification or overanalysis of a deterministic policy plan; hence, this study makes good use of adjustments for business-cycle effects, finite-sample ARDL methods, robustness checks on predictive causality, and sets a clear limit on the causal description.

2.1 Research Objectives and questions:

The study examines whether the stringency of New Mexico's statutory RPS was linked to the state's economic performance between 1997 and 2024, accounting for several important state variables and the U.S. business cycle. It separates out the short-run dynamics from any evidence of a long-run level relationship and examines whether the stringency of the RPS has predictive power for New Mexico's real output by using a lag-augmented VAR. Another aim of the study is to interpret its results in the context of SDG 7, SDG 8, SDG 9, and SDG 13, and to explain why aggregate RGSP should be evaluated alongside indicators of affordability, employment, energy infrastructure, renewable energy deployment, and emissions.

The research questions, the relevant empirical tests, and the criteria for interpretation are given in Table 1.

Table 1: Research questions and empirical interpretation

Research Question	Empirical test	Interpretive standard
1 Is statutory RPS stringency associated with New Mexico real RGSP in a dynamic model?	Preferred ARDL levels/ECM representation	Association, not structural causality
2 Is there evidence of a stable long-run level relationship?	Pesaran-Shin-Smith bounds test with finite-sample critical values	Reject only if bounds criteria support a level relationship
3 Does RPS predict New Mexico real output after national-cycle control?	Toda-Yamamoto modified Wald test	Granger predictive precedence, not treatment effect
4 Are results econometrically well behaved?	Breusch Godfrey, Breusch Pagan, Normality, RESET, CUSUM, VAR stability/ Lagrange Multiplier Checks	Diagnostic adequacy and sensitivity

2.2 A review of the literature and a conceptual framework:

Viewing the issue through the lens of the Sustainable Development Goals broadens the criteria used to assess renewable portfolio standards. RPS policies directly contribute to the shift toward affordable and clean energy as called for by SDG 7 and to action on climate change as required by SDG 13; employment and productivity aspects are connected with SDG 8, while transmission, storage, and grid integration are linked to SDG 9 (United Nations, 2015). Thus, the existing literature suggests that an RPS's insignificant effect on aggregate output alone is not sufficient to determine whether it contributes to sustainable development; macroeconomic, environmental, infrastructure, affordability, and distributional outcomes all have to be taken into account.

Research carried out in the past has demonstrated that the design and the degree of stringency of the RPS can affect the use of renewable energy and the results of the electricity market (Carley et al., 2018; Upton & Snyder, 2017). The present analysis raises a different question: is New Mexico's actual statutory RPS pathway linked to a steady aggregate real-output relationship? Yet the annual series performs only moderately well.

The RPS has not been designed using macroeconomic indicators across time periods, and earlier research has shown that its effectiveness depends on policy design rather than on adoption alone. Carley (2009) examined the varying effectiveness of state renewable energy policies, while Yin and Powers (2009) found that more stringent standards are associated with higher levels of renewable energy production within the state. Shrimali and Kniefel (2011) found that different policy instruments vary in their ability to promote the deployment of renewable electricity. Carley and others (2018) developed a more comprehensive measure of RPS stringency and found positive relationships with renewable energy, solar generation, and renewable capacity. More recent causal evidence has highlighted the role of heterogeneity and dynamic adjustment, rather than a single uniform policy effect (Deschênes et al., 2023). RPS policies can affect the economy through the electricity market.

As Upton and Snyder (2017) point out, RPS policies have measurable effects on the electricity market, with evidence that retail prices are higher and demand is lower in states that have adopted the policies than in their synthetic control groups, indicating a cost-based transmission mechanism. Yet, as Barbose et al. (2015) summarize, the full impact of these programs encompasses multiple aspects, including both costs and benefits that cannot be captured by a single-dimensional account. The ability of renewable-energy credits to be traded between states, as noted by Hollingsworth and Rudik (2018), also means that the policy's effects are not limited to the areas where it is implemented, thus casting doubt on any purely local interpretation. More generally, Lyon (2016) emphasizes that the economic effects of RPS depend on policy design, existing market conditions, and the specific outcome variable examined, thereby supporting the need for a context-sensitive evaluation.

Moreover, the latest literature still shows that the effects are heterogeneous and context-dependent, rather than indicating a uniform outcome regarding RPS. A 2023 evaluation of state climate-policy commitments shows that RPS policies tend to increase renewable generation capacity, though there remains limited evidence that states adopting such policies achieve a greater share of renewable energy in their overall energy mix (Bergquist & Warshaw, 2023). In line with this caveat, more recent empirical studies find that the estimated relationship between state RPS policies and renewable generating capacity varies with data refinement and model specification (Mullen & Dong, 2021). Newer causal evidence points to delayed and technology-specific effects, showing an increase in wind capacity but no statistically significant impact on solar investment (Deschênes et al., 2023). These results indicate that policy stringency might affect the timing and make-up of energy investment without producing a stable or easily identifiable effect on overall economic output. They also underscore the importance of distinguishing between the intensity of statutory policy and its actual

deployment, and of examining state-specific time-series dynamics rather than viewing RPS adoption as a uniform national intervention.

(Mamkhezri et al., 2021) use an integrated modeling framework that combines econometrics, geographic information systems, input-output analysis, and system dynamics to highlight New Mexico evidence that is directly relevant. They conduct a scenario analysis and find that the statewide economic impacts under market mechanisms need not differ significantly across the various RPS scenarios, even when both county-level and environmental effects are taken into account. The current study is complementary in that it does not simulate alternative future scenarios but rather assesses the historical association that has actually occurred between the stringency of statutory policy and total state output.

This study addresses the gap between simulation-based forecasts and empirical ex-post evaluations of state-level climate legislation (Bergquist & Warshaw, 2023) by adopting a longitudinal approach that reduces reliance on static cross-sectional observations, which typically fail to capture the temporal dynamics of policy development. It also enables the analysis to distinguish between immediate adjustments and those that occur later, which is especially important because the effects of increasing renewable capacity may not appear until several years after the RPS is put in place (Deschênes et al., 2023). However, the use of a single-state design still leaves the results vulnerable to national trends, serial correlation, and other contemporaneous shocks, so it is necessary to include explicit controls for business cycle fluctuations and to interpret the findings with care rather than drawing a definite causal conclusion (French & Heagerty, 2008).

The theoretical framework encompasses both positive and negative pathways. A more rigorous Renewable Portfolio Standard could lead to greater investment in renewable energy and construction, promote learning and advances in the supply chain, and reduce exposure to fluctuations in fuel prices. At the same time, the costs of meeting regulatory requirements and integrating into the grid might cause electricity prices to rise or alter the financial position of energy-intensive manufacturing. The overall RGSP thus reflects the net effect of these channels, the national economic situation, the sectoral structure, migration, productivity, and a number of other factors. Therefore, the direction of the RPS coefficient is not predetermined. Although computable general equilibrium models show that the impacts of RPS are often negatively correlated with shocks to natural gas prices—thus offering a kind of partial economic insurance—the overall net effect on state output remains empirically unclear (Hannum, 2023). The wider RPS literature indicates that conclusions regarding economic growth depend greatly on distinguishing gross activity from net economic effects: input–output models include direct, indirect, and induced impacts but are generally unable to account for changes in electricity prices, whereas econometric and computable general equilibrium models are better suited to assessing wide-ranging economic outcomes (Heeter et al., 2014). A review of 31 state- and utility-level assessments reveals a high degree of uncertainty, even though most of the studies predict only modest cost effects, with 70% estimating that increases in retail electricity prices will not exceed 1%; the estimated gains in employment also vary considerably depending on assumptions about technology selection, in-state development, manufacturing, and the effects on electricity bills (Chen et al., 2008). The body of literature specific to New Mexico highlights these interpretive challenges: an integrated scenario model that compares 10%, 20%, and 100% renewable energy standards finds no statistically significant difference in the state-level market-based economic impacts, while showing considerable county-level effects and possibly larger benefits in certain targeted areas when environmental benefits are taken into account (Mamkhezri et al., 2021). Further evidence from New Mexico's experience with renewable-energy employment also warns that claims about job creation depend on measurement choices and on the distinction between temporary construction jobs and more persistent, economy-wide labor-market effects (Hadjilambrinos, 2019). Altogether, these

reviews and case studies show that New Mexico’s RPS could influence economic growth via investment, electricity costs, employment, environmental benefits, and uneven spatial development, but they do not prove a uniform overall output effect, meaning that an ex-post longitudinal evaluation of actual state output remains an important empirical contribution.

3. Data, Variables, and Data Structure

The study employs annual time-series data for New Mexico from 1997 to 2024, before accounting for dynamic lags; the audited workbook includes data for consecutive years with no missing values. The preferred ARDL model is based on 27 observations, as one observation is lost due to lagging. This period captures the transition through several business cycles while retaining the degrees of freedom required for robust estimation within an ARDL framework (Zehri, 2025).

Actual real state output and real U.S. GDP are reported in chained 2017 dollars; employment is reported in thousands; the price of electricity is reported in cents per kilowatt-hour; inflation is measured by the annual CPI-U inflation rate; and the level of stringency of the RPS is based on the statutory renewable percentage. The RPS series reflects the intensity of the legal policy rather than the actual amount of renewable generation or compliance.

Table 2 summarizes the variables used in the empirical analysis, including their functions, the transformations applied, the units of measurement, and the main data sources.

Table 2. Variables, roles, units, and sources

Variable	Role	Unit/transformation	Primary source
Real Gross State Product (RGSP)	Dependent variable	Millions, chained 2017 dollars; ln	BEA/FRED (NMRGSP)
RPS stringency	Key policy variable	Statutory required renewable share (%)	New Mexico statute, NMSA §62-16-4
Employment	Control	Thousands; ln	BLS/FRED
Electricity price	Control/cost channel	Cents/kWh; ln	U.S. EIA state electricity data
Inflation	Control	Annual CPI-U inflation (%)	BLS
U.S. real GDP	National-cycle control	Billions, chained 2017 dollars; ln	BEA/FRED (GDPCA)
Population	Candidate control	Thousands; ln	Census/FRED
Renewable generation	Mechanism variable	MWh; ln	U.S. EIA generation by fuel
NM/U.S. real-GDP share	Robustness outcome	Percent; ln	Derived from BEA/FRED series

Although population and renewable generation are included in the audited dataset, they are not mechanically incorporated into the preferred ARDL. Renewable generation, in a way, serves as a means by which the RPS functions, and the more complete static specification exhibited severe collinearity.

The descriptive statistics for the variables over the study period from 1997 to 2024 are presented in Table 3.

Table 3. Descriptive statistics from 1997 to 2024

Variable	N	Mean	Std. dev.	Min	Max
RGSP (million chained 2017 \$)	28	89,448.86	12,599.64	67,718.10	119,044.50
Employment (thousand)	28	806.014	44.813	708.500	889.100
Population (thousand)	28	1,996.341	133.074	1,722.939	2,126.774
Electricity price (cents/kWh)	28	8.315	1.169	6.570	10.020
Renewable generation (MWh)	28	4,595,016	5,671,256	229,616	19,600,000
Inflation (%)	28	2.511	1.550	-0.400	8.000
RPS stringency (%)	28	8.929	7.572	0.000	20.000
U.S. real GDP (billion chained 2017 \$)	28	17,502.73	3,016.116	12,370.30	23,358.44

Figure 1 shows how stringent New Mexico's statutory RPS has become from 1997 to 2024.

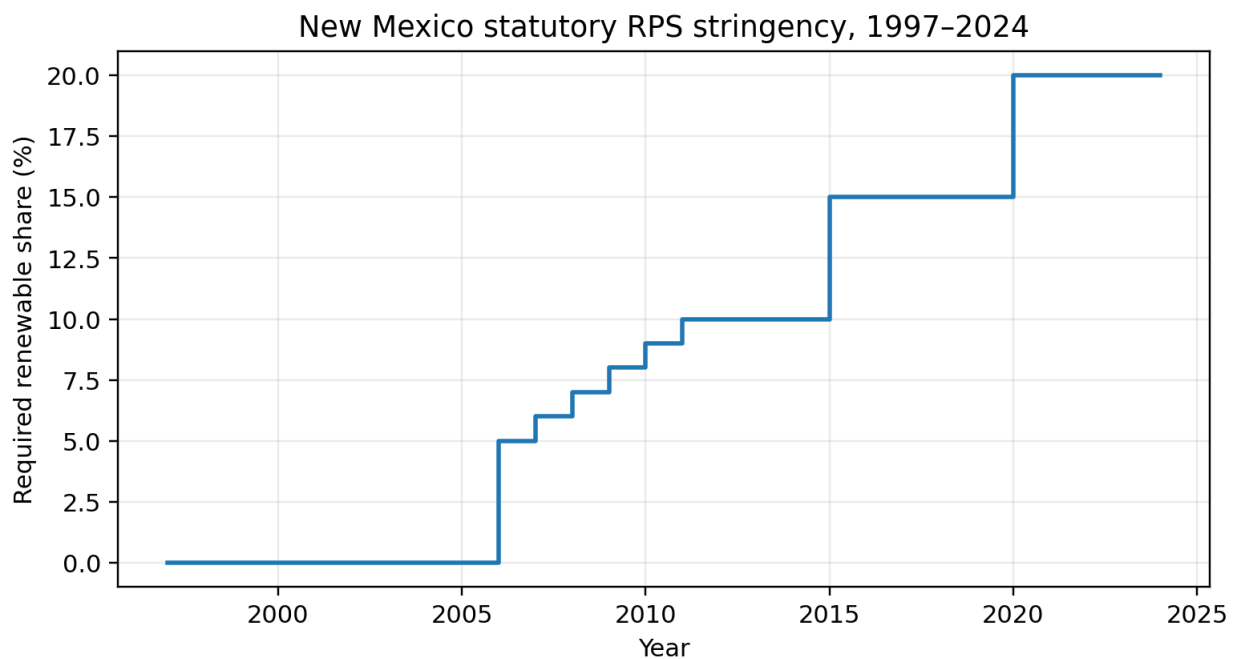


Figure 1. The stringency of New Mexico's statutory RPS from 1997 to 2024.
The source is the statutory schedule from New Mexico as included in the audited dataset.

Figure 2 shows the trajectory of New Mexico's real Gross State Product during the study period.

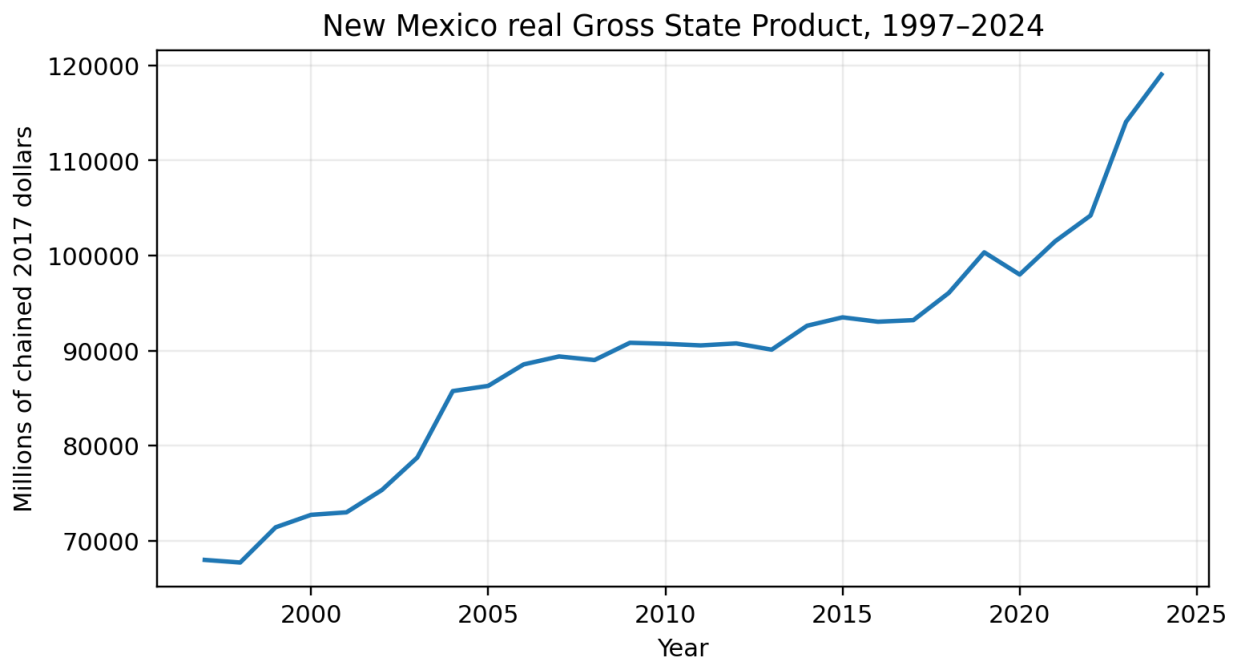


Figure 2. The gross state product of New Mexico from 1997 to 2024.
The data come from the BEA/FRED series in the audited dataset.

As shown in Figure 3, renewable electricity generation in New Mexico has expanded significantly from 1997 to 2024.

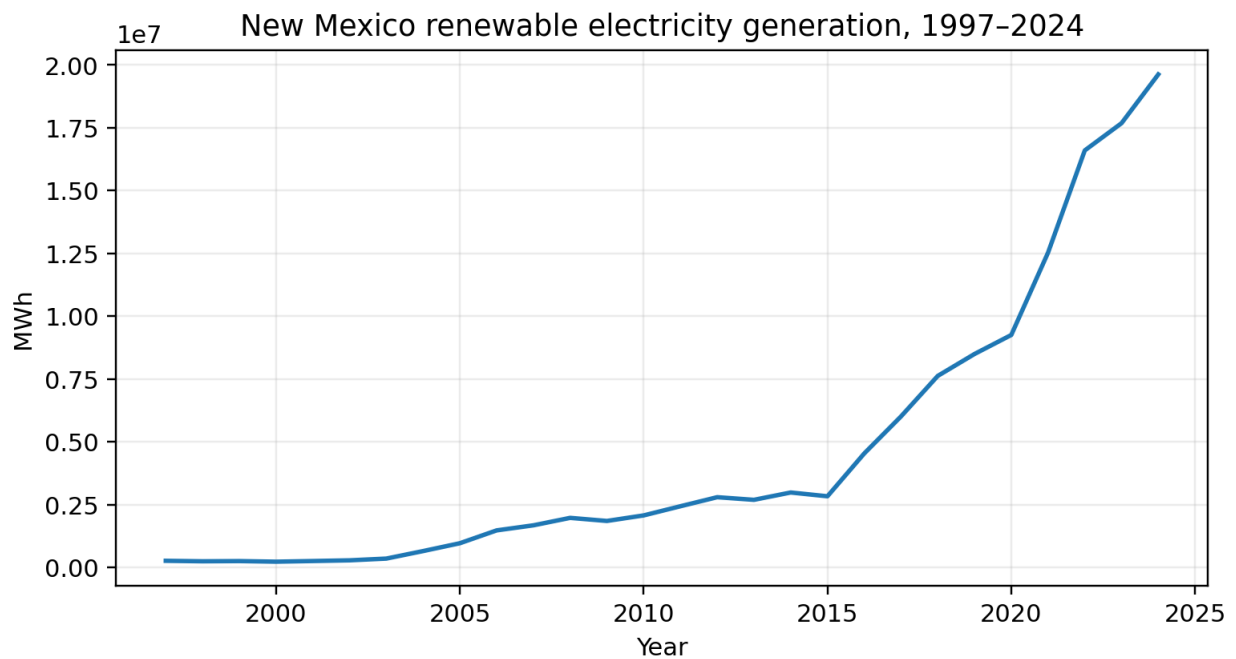


Figure 3. The amount of renewable electricity generation in New Mexico from 1997 to 2024. Source: state generation data from the audited dataset of the U.S. EIA.

Figure 4 shows what proportion of the U.S. real GDP is made up by New Mexico's real GDP, thus giving a further indication of the state's relative economic performance.



See Figure 4, which shows New Mexico's real GDP as a proportion of the United States' from 1997 to 2024.

Source: Based on calculations carried out by the author using data from the BEA/FRED for New Mexico and for U.S. real GDP.

4. Econometric Methodology:

4.1 Preferred ARDL specification

The preferred specification models New Mexico's real output as a function of the statutory RPS stringency, employment levels, electricity prices, inflation, and real U.S. GDP, and includes a national output control to reduce the likelihood that a common U.S. business-cycle trend is attributed to state renewable policy.

$$\ln(RGSP_t) = \beta_0 + \beta_1 RPS_t + \beta_2 \ln(EMP_t) + \beta_3 \ln(EP_t) + \beta_4 INF_t + \beta_5 \ln(USGDP_t) + \varepsilon_t \dots \dots \dots (1)$$

The general ARDL representation is:

$$y_t = \alpha_0 + \sum_{i=1}^p \phi_i y_{t-i} + \sum_{j=0}^{q_1} \beta_{1j} RPS_{t-j} + \sum_{j=0}^{q_2} \beta_{2j} \ln EMP_{t-j} + \sum_{j=0}^{q_3} \beta_{3j} \ln EP_{t-j} + \sum_{j=0}^{q_4} \beta_{4j} INF_{t-j} + \sum_{j=0}^{q_5} \beta_{5j} \ln USGDP_{t-j} + u_t \dots \dots \dots (2)$$

AIC is used to determine the lag length, with a deliberately modest maximum lag because the annual dataset is small. The model chosen is ARDL (1,0,1,1,1,1).

4.2 The conditional ECM and the bounds test

The null hypothesis in the bounds test is that the lagged level terms do not establish a level relationship. As suggested by Pesaran et al. (2001), the F and t statistics are compared with the lower I(0) and upper I(1) bounds. Given the small sample size of only 27 observations, finite-sample response-surface critical values and approximate p-values are used, consistent with Kripfganz and Schneider's small-sample refinements. A coefficient in the long-run block should not be interpreted as indicating an established equilibrium effect unless the bounds evidence confirms a level relationship.

4.3 Unit-root diagnostics

The augmented Dickey–Fuller and Phillips–Perron tests are mainly employed with respect to the stochastic macroeconomic and energy series in order to eliminate the possibility of I(2) behavior, since such behavior would render the standard ARDL bounds inference invalid. RPS is regarded as a deterministic statutory policy schedule, not as a substantive stochastic integration order.

The results of the ADF and Phillips–Perron unit-root tests are given in Table 4.

Table 4. Integration diagnostics

Series	ADF level p	ADF Δ p	PP level p	PP Δ p	Assessment
ln(RGSP)	0.6901	0.1596	0.8302	0.0003	Mixed: PP supports I(1); ADF first difference not stationary
ln(Employment)	0.2780	0.0059	0.4552	0.0012	I(1)
ln(Electricity price)	0.9078	0.0001	0.7551	0.0000	I(1)
ln(Renewable generation)	0.2562	0.1048	0.3797	0.0070	Mixed: PP supports I(1); ADF first difference not stationary
Inflation	0.0117	—	0.0188	—	I(0)
ln(U.S. real GDP)	0.2884	0.0062	0.1933	0.0000	I(1)

Note that the values are drawn from the final Stata log. The ADF tests for the logged-level variables include a trend, whereas the first-difference ADF tests are conducted without one. The Phillips–Perron tests use the same level or difference specifications. For RGSP and renewable generation, the ADF and PP tests yield mixed evidence in first differences; hence, their integration order should be described with caution rather than mechanically classified.

4.4 Toda–Yamamoto predictive-causality robustness

The Toda-Yamamoto method uses a VAR of order $k + d_{\max}$, with respect to the number of lags, and applies the modified Wald constraints only to the first k lags, thus reducing the need for prior cointegration tests (Hacker & Hatemi-J, 2006). In the simple system consisting of $\ln(\text{RGSP})$, RPS stringency, and $\ln(\text{U.S. real GDP})$, the AIC criterion selects $k = 1$ and sets the maximum integration order at $d_{\max} = 1$, yielding an augmented VAR of order 2. Table 9 gives the conventional asymptotic chi-square p-values. Since asymptotic adjustment may be unreliable in very small samples, the findings are regarded as a supplementary check of predictive precedence and not as definitive evidence of causality. A residual-based bootstrap would be a valuable future extension to assess robustness, but the bootstrap p-values are not included in this study.

5. Empirical Results

5.1 The representation of ARDL levels preferred

The estimates of the coefficients obtained from the preferred ARDL(1,0,1,1,1,1) levels specification are given in Table 5.

Representation of the preferred ARDL(1,0,1,1,1,1) levels in Table 5

Term	Coefficient	Std. err.	t	p
L1 $\ln(\text{RGSP})$	0.5813	0.1582	3.68	0.002
RPS	−0.00651	0.00270	−2.41	0.028
$\ln(\text{Employment})$, current	−1.0060	0.4619	−2.18	0.045
$\ln(\text{Employment})$, L1	1.4862	0.6157	2.41	0.028
$\ln(\text{Electricity price})$, current	−0.1372	0.1001	−1.37	0.189
$\ln(\text{Electricity price})$, L1	0.2302	0.1295	1.78	0.094
Inflation, current	0.00534	0.00471	1.14	0.273
Inflation, L1	0.00941	0.00329	2.86	0.011
$\ln(\text{U.S. real GDP})$, current	1.7914	0.4864	3.68	0.002
$\ln(\text{U.S. real GDP})$, L1	−1.3987	0.4979	−2.81	0.013

Note that N equals 27; R squared is 0.9904; the adjusted R squared is 0.9844; the root mean square error is 0.0169. The individual dynamic coefficients should not be regarded as long-run causal effects.

Although the representation in terms of levels has a high explanatory fit, the RPS coefficient of −0.00651 ($p=0.028$) should not be interpreted alone as indicating a long-run policy effect. In a dynamic ARDL model, both the contemporaneous and the lagged terms together determine the short-run and long-run responses, and before concluding that a level relationship exists the bounds test must be carried out.

5.2 The ECM and the long-run coefficients as reported

Table 6 presents the error-correction representation, along with the reported long-run and short-run coefficients.

Table 6. The preferred ARDL error-correction form

Component	Coefficient	Std. err.	t	p
Adjustment: L1 $\ln(\text{RGSP})$	−0.4187	0.1582	−2.65	0.018
LR: RPS	−0.01554	0.00866	−1.79	0.092
LR: $\ln(\text{Employment})$	1.1468	0.4949	2.32	0.034
LR: $\ln(\text{Electricity price})$	0.2222	0.2314	0.96	0.351
LR: Inflation	0.03524	0.01481	2.38	0.030
LR: $\ln(\text{U.S. real GDP})$	0.9379	0.4335	2.16	0.046
SR: $\Delta \ln(\text{Employment})$	−1.4862	0.6157	−2.41	0.028
SR: $\Delta \ln(\text{Electricity price})$	−0.2302	0.1295	−1.78	0.094
SR: $\Delta \text{Inflation}$	−0.00941	0.00329	−2.86	0.011
SR: $\Delta \ln(\text{U.S. real GDP})$	1.3987	0.4979	2.81	0.013

Note that Stata's ARDL ECM transformation displays the long-run estimates. Since the bounds test does not show a level relationship at the 5% significance level, these coefficients should be interpreted with caution and must not be regarded as proven equilibrium effects.

The adjustment coefficient is -0.4187 and is statistically significant at the 5 per cent level ($p=0.018$); given the model, the sign of the coefficient is consistent with correcting deviations from the implied dynamic path. In terms of numbers, around 42 per cent of deviations are adjusted within one year. Yet the fact that the adjustment coefficient is significantly negative does not overturn the bounds-test decision.

The reported long-run RPS coefficient is -0.01554 and the p-value is 0.092. In the case of a stable-level relationship, the log-level/semi-log form would indicate that a one-percentage-point increase in the statutory RPS requirement is associated with a roughly 1.55% lower long-run RGSP, all else equal. However, the bounds test does not offer the conventional evidence needed to support that interpretation. The coefficient is therefore referred to only as a marginal negative long-run association resulting from the conditional model, and not as a causal or established equilibrium effect.

5.3 Bounds-test decision:

The finite-sample bounds-test results used to evaluate the existence of a level relationship are presented in Table 7.

Table 7. Finite-sample ARDL bounds test

Statistic	Value	10% I(0)	10% I(1)	5% I(0)	5% I(1)	Decision
F statistic	3.601	2.664	4.110	3.318	5.018	Inconclusive at 10%; no rejection at 5%
t statistic	-2.647	-2.501	-3.809	-2.907	-4.312	Does not satisfy the upper-bound rejection rule

Note that this is Case 3, with five forcing variables, 27 observations, and Kripfganz–Schneider finite-sample critical values; Stata considers the overall decision to be inconclusive at the 10 per cent level and fails to reject the hypothesis at the 5 per cent and 1 per cent levels.

The key inferential conclusion is based on the bounds. At the 5% level, $F=3.601$ is higher than the lower bound of 3.318 but lower than the upper bound of 5.018, and the t statistic is not negative enough to lead to rejection according to the upper-bound criterion. Stata thus decides not to reject the null hypothesis at the 5% level. At the 10% level, the evidence is inconclusive rather than supportive. As a result, the study does not assert a robust long-run level relationship between RPS stringency and New Mexico real output.

5.4 Preferred ARDL diagnostics

The diagnostic tests associated with the preferred business-cycle-adjusted ARDL specification are given in Table 8.

The diagnostic tests for the preferred business-cycle-adjusted ARDL are given in Table 8.

Diagnostic	Statistic	p / critical value	Inference
Breusch–Godfrey LM, lag 1	$\chi^2(1)=0.216$	0.6423	No serial correlation
Breusch–Godfrey LM, through lag 2	$\chi^2(2)=0.262$	0.8772	No serial correlation
Breusch–Pagan/Cook–Weisberg	$\chi^2(1)=1.47$	0.2249	Constant variance not rejected
Skewness–kurtosis joint normality	Adj. $\chi^2(2)=0.04$	0.9824	Normality not rejected
Ramsey RESET	$F(3,13)=0.66$	0.5909	No RESET evidence of misspecification
Recursive CUSUM	0.6700	5% CV=0.9479	No structural-break rejection

The preferred model performs well on standard diagnostic tests. The Breusch–Godfrey tests show no indication of first- or second-order residual autocorrelation. The Breusch–Pagan test does not lead to rejection of the hypothesis of constant variance, and the joint skewness–kurtosis test strongly fails to reject the null hypothesis that the residuals are normally distributed. Ramsey RESET finds no evidence of the functional-form misspecification that was tested. Since the value of the recursive CUSUM statistic, 0.6700, is below the critical values at the 10%, 5%, and 1% levels, the preferred specification does not reject the hypothesis of parameter stability over the estimation sample.

5.5 Toda–Yamamoto robustness

Table 9 gives the Toda–Yamamoto modified Wald tests concerning predictive causality between the stringency of the RPS and the real GDP of New Mexico.

Table 9. The modified Wald tests of Toda and Yamamoto

Direction	χ^2	df	p	Decision
RPS → New Mexico real GDP	0.49	1	0.4836	Do not reject noncausality
New Mexico real GDP → RPS	1.06	1	0.3035	Do not reject noncausality

Note that in the case of the three-variable parsimonious system—consisting of $\ln(\text{RGSP})$, RPS, and $\ln(\text{U.S. real GDP})$ —the AIC determines k to be 1, $d_{\max}$ to be 1, and the order of the augmented VAR to be 2; restrictions are applied only to the first lag.

There is no evidence from the lag-augmented VAR that changes in the stringency of RPS Granger-predict real output in New Mexico when U.S. real GDP is taken into account. The opposite null hypothesis is also not rejected. This outcome is in line with the cautious ARDL interpretation, namely that the data do not show robust predictive precedence in either direction.

The results of the tests for stability, serial correlation, and residual normality regarding the parsimonious lag-augmented VAR are given in Table 10.

Table 10. Simple lag-augmented VAR checks

Diagnostic	Result	Assessment
Eigenvalue stability	All roots inside unit circle; largest modulus ≈ 0.9934	Pass
VAR LM lag 1	$\chi^2(9)=4.0245$; $p=0.9098$	No residual autocorrelation
VAR LM lag 2	$\chi^2(9)=4.7008$; $p=0.8596$	No residual autocorrelation
Joint Jarque–Bera normality	$\chi^2(6)=19.185$; $p=0.00386$	Normality rejected

It should be noted that the non-normality of the VAR is explicitly acknowledged; since the available annual sample is very small, the Toda–Yamamoto evidence is regarded as a complementary robustness check rather than a definitive conclusion regarding causality.

The VAR constructed in a parsimonious way is dynamically stable and shows no residual autocorrelation at the first two lags; however, the hypothesis of joint residual normality is rejected, particularly for the equation relating to U.S. real GDP. While this does not contradict the modified-Wald result, it suggests that the VAR should be regarded as providing only suggestive evidence rather than as the primary inference mechanism in the paper.

6. Discussion

The cautious interpretation is supported by both the ARDL and the complementary Toda-Yamamoto tests. While the ARDL adjustment coefficient is negative and statistically significant, the long-run RPS coefficient reported is also negative and only marginally significant. Nevertheless, the finite-sample bounds test fails to reject the null hypothesis of no level relationship at the 5% level, and the lag-augmented VAR does not indicate predictive precedence in either direction. The ARDL residual and CUSUM diagnostics alleviate concerns about serial correlation, heteroskedasticity, non-normality of residuals, misspecification of the functional form, and parameter instability; however, they do not establish cointegration or causality. Although the VAR is dynamically stable and exhibits no residual autocorrelation up to the first two lags, the joint normality of the residuals is rejected. Thus, the overall evidence does not support a robust long-run or predictive relationship between statutory RPS stringency and aggregate real state output.

The negative coefficients identified in the selected ARDL model should not be interpreted in isolation; without referring to the bounds test, the conditional dynamics are compatible with a negative association, but the available annual data fail to show the presence of a stable long-run equilibrium relationship. This point is at the heart of the study's title, its conclusions, and the policy implications.

The Toda-Yamamoto findings support this warning: when U.S. real GDP is included, the previous level of RPS stringency is no longer a significant predictor of real GDP in New Mexico, and the previous level of state output is no longer a significant predictor of RPS stringency. The fact that predictive noncausality is not rejected does not imply that the policy has no economic effects; the effects could be specific to certain sectors, occur with a delay, cancel each other out through different channels, be transmitted across state borders, or simply be too small to pick up in a 28-year annual sample.

This view is consistent with the general body of literature, which demonstrates that the effects of RPS policies vary with the outcome, policy design, technology involved, and time horizon. Mamkhezri et al. (2021) likewise find that the impact of New Mexico's renewable policy varies from one location and one stakeholder group to another. Aggregate RGSP must therefore be regarded as a single policy indicator, not as a full measure of the performance of renewable policy.

6.1 The reason why the annual sample might not show a significant overall effect

Statistical detection is limited for several reasons. First, RGSP combines sectors with very different levels of exposure to investment in renewable energy and to changes in electricity costs. Second, statewide output may remain nearly unchanged even if renewable development affects local employment, land rents, the tax base, electricity prices, or emissions. Third, the statutory RPS series changes only on specific policy dates, offering limited independent variation over time. In New Mexico, output is also affected by oil and gas activities, commodity cycles, federal policy, technological change, and national recessions and recoveries. Finally, policy endogeneity persists, as states may introduce or reinforce their RPS requirements in response to political and economic conditions, which in turn influence economic performance.

7. Policy Implications

The findings do not justify using total RGSP as the sole basis for judging whether New Mexico's renewable energy policy is a success. Instead, policymakers ought to use a broader dashboard that monitors renewable capacity and generation, electricity prices, the energy burden on households, reliability, emissions, investment, job quality, and the geographic distribution of benefits and costs. In terms of the SDGs, this involves monitoring renewable deployment and affordability for SDG 7, employment and productive activity for SDG 8,

transmission, storage, and interconnection for SDG 9, and emissions reductions for SDG 13. Future tightening of the RPS therefore needs to be accompanied by transparent monitoring of electricity cost channels, complementary infrastructure and workforce investment, and a clear distinction among statutory targets, utility compliance, and actual procurement. New Mexico should make machine-readable quarterly or annual data on policy, compliance, investment, generation, prices, emissions, and employment available to enable a more effective causal assessment. The absence of a strong aggregate-output relationship does not mean that the RPS should be weakened or that it has no environmental or social value; it only means that the economic argument should not be based on the assumption that a higher statutory percentage of renewables will automatically lead to a rise in statewide RGSP. This study does not directly measure attainment of the SDGs; rather, it specifies the indicators that should accompany RGSP when assessing whether the RPS supports an affordable, resilient, and economically durable energy transition.

8. Limitations and Future Studies

The main limitation lies in the small number of observations each year ($n = 28$). Since the dynamic model is preferred with 27 observations, this imposes restrictions on the lag length, the model's dimensions, the structural-break analysis, and the power of the bounds and Wald tests. A statistically insignificant or inconclusive result does not mean that a small, yet economically important effect can be ruled out.

The RPS variable measures statutory stringency, not a randomly assigned treatment or actual compliance. The aggregate RGSP may mask effects at the sectoral and distributional levels. While U.S. real GDP captures the national business cycle, it cannot capture all common shocks, federal policies, commodity cycles, or energy-sector shocks specific to New Mexico. Because the Toda-Yamamoto VAR rejects the joint normality of the residuals, the evidence it provides is considered complementary rather than definitive.

Future assessments of the intensity of policy measures should incorporate statutory targets, actual compliance, the prices of renewable energy credits, and rules governing eligible resources, exemptions, and procurement. A state panel could use modern staggered-adoption or continuous-treatment methods to compare New Mexico with credible counterfactual states and examine sectoral, distributional, affordability, infrastructure, and emissions outcomes.

9. Conclusion

The study examines whether New Mexico's statutory Renewable Portfolio Standard was associated with the state's economic performance from 1997 to 2024. The preferred business-cycle-adjusted ARDL(1,0,1,1,1,1) model yields a negative and statistically significant adjustment coefficient and a long-run RPS coefficient that is negative but only marginally significant.

The finite-sample bounds test is inconclusive at the 10 percent level and fails to reject the null hypothesis of no level relationship at either the 5 percent or 1 percent level. Therefore, the reported long-run coefficient does not provide conclusive evidence of an equilibrium or a causal relationship. The complementary Toda-Yamamoto tests also fail to reject predictive noncausality in either direction after the U.S. real GDP has been included. Although the preferred ARDL model passes the residual, functional-form, and CUSUM diagnostics, these tests do not turn an inconclusive bounds result into evidence of a long-run policy effect.

The results must not be taken as proof that Renewable Portfolio Standards (RPS) have no economic effects. On the contrary, the short annual time series does not provide strong evidence of a lasting long-run or predictive impact of RPS stringency on total state output. This point is crucial when interpreting the findings. Evaluation of the economic performance of renewable energy requirements should therefore consider a wider range of outcomes, including electricity market conditions, environmental benefits, distributional effects, investment

responses, employment figures, and regional development. It should not therefore be expected that statutory RPS stringency alone will produce a readily identifiable change in the state's real gross state product (RGSP), especially over a relatively brief observation period. A goal-oriented assessment in the context of the Sustainable Development Goals (SDGs) should also report on clean energy access and affordability, productive employment, enabling infrastructure, and emissions outcomes, in addition to overall output.

Data Availability and Reproducibility

The dataset used in the annual study was compiled from public sources, and uploaded in submission system.

The real GDP figure for New Mexico comes from the U.S. Bureau of Economic Analysis through FRED (NMRGSP: <https://fred.stlouisfed.org/series/NMRGSP>); total nonfarm employment in New Mexico is obtained from the U.S. Bureau of Labor Statistics via FRED (NMNA: <https://fred.stlouisfed.org/series/NMNA>); the resident population figure is from the U.S. Census Bureau via FRED (NMPOP: <https://fred.stlouisfed.org/series/NMPOP>); the real U.S. GDP is sourced from the U.S. Bureau of Economic Analysis via FRED (GDPCA: <https://fred.stlouisfed.org/series/GDPCA>); and the CPI-U is from the U.S. Bureau of Labor Statistics via FRED (CPIAUCSL: <https://fred.stlouisfed.org/series/CPIAUCSL>), annual inflation being calculated from the index. Data on state electricity prices and renewable generation come from the U.S. Energy Information Administration's historical state electricity data sets (landing page: <https://www.eia.gov/electricity/data/state/>; annual generation file: https://www.eia.gov/electricity/data/state/annual_generation_state.xls; EIA-861 files for the period 1990–2009 and from 2010 onwards: <https://www.eia.gov/electricity/data/state/xls/861/HS861%201990-2009.xlsx> and <https://www.eia.gov/electricity/data/state/xls/861/HS861%202010-.xlsx>). The statutory RPS schedule was derived from New Mexico's Renewable Energy Act and its amendments (2004 SB 43: <https://www.nmlegis.gov/Sessions/04%20Regular/bills/senate/SB0043.pdf>; 2007 SB 418: <https://www.nmlegis.gov/Sessions/07%20Regular/final/SB0418.pdf>; 2019 SB 489: <https://www.nmlegis.gov/Sessions/19%20Regular/final/SB0489.pdf>).

The cleaned annual dataset and the Stata code were uploaded in the system.

Declarations

We did not receive any external funding.

There is no conflict of interest to declare on the part of the authors.

Ethics approval is not needed. The study uses public aggregate secondary data.

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CRedit authorship contribution statement

Iqbal Uddin Pervez: writing – original draft, review, visualization, validation, supervision, software, resources, methodology, investigation, formal analysis, data curation, and conceptualization.

Ivy Nasreen: formal analysis, methodology, resources, supervision, writing – review and editing.

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