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QUICK TO FALL, SLOW TO RISE: ASYMMETRIC EFFECTS OF SALES TAX DECENTRALIZATION ON REVENUE COLLECTION IN PAKISTAN

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Abstract

Purpose: *The purpose of this study is to test whether the relationship between Sales Tax on Services (STS) decentralization and provincial revenue collection in Pakistan is symmetric or asymmetric, challenging the implicit assumption in the fiscal decentralization literature that decentralization's effects on revenue collection are equal and opposite for increases and decreases.*

Design/Methodology/Approach. *This study employs monthly time-series data spanning fiscal years 2001 to 2024, comprising 288 monthly observations. The study decomposes the sales-tax-on-services decentralization (STSD) index into separate cumulative sums of its positive and negative monthly changes and estimates a Nonlinear Autoregressive Distributed Lag (NARDL) model of STS collection with respect to these two components. The bounds-testing approach confirms cointegration, and Wald tests are employed to formally test long-run and short-run symmetry.*

Findings. *The bounds-testing approach confirms strong cointegration between the decomposed decentralization measure and STS collection. In the long run, increases in decentralization intensity raise STS collection significantly, and decreases lower it significantly; a formal Wald test confirms that these two effects are statistically distinguishable from one another rather than mirror images of the same underlying relationship ($p < 0.01$). In the short run, a within-month decrease in decentralization intensity is associated with a significant, immediate fall in STS collection under conventional standard errors, whereas a within-month increase shows no corresponding immediate effect.*

Research Limitations. *The study uses interpolated monthly data before 2011 due to unavailability of official monthly data. The model deliberately excludes GDP growth, debt growth, and population controls due to multicollinearity with decomposed decentralization variables. The marginal rejection of the Ramsey RESET test suggests potential functional-form nonlinearity beyond the positive-negative decomposition modeled.*

Practical Implications. *The findings suggest that Pakistan's sales-tax-on-services decentralization behaves less like a simple linear lever and more like a relationship with its own institutional memory: STS collection appears quicker to suffer when decentralization stalls or reverses than it is to gain when decentralization advances. Provincial revenue authorities and federal policymakers should treat the credibility and continuity of decentralization commitments as at least as important for revenue outcomes as the pace of further devolution itself.*

Originality/Value. *This study is the first to test whether the effect of sales tax on services decentralization on STS collection in Pakistan, or indeed the effect of fiscal decentralization on own-revenue collection in any comparable setting, is symmetric or asymmetric using the NARDL framework.*

Keywords: Sales Tax on Services Decentralization; Asymmetry; Nonlinear ARDL; Fiscal Federalism; Bounds Testing; Pakistan

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1. Introduction

A companion study on this same monthly Pakistani dataset establishes that sales tax on services decentralization, or STSD, the transfer of the levy and collection of sales tax on services from the federation to the provinces that followed the 18th Constitutional Amendment of 2010 and the 7th National Finance Commission Award, has strengthened the provinces' own STS collection in the long run. That finding, like the finding in nearly every empirical study of fiscal decentralization, rests on a linear model, which carries a hidden assumption: that the effect of an increase in decentralization intensity on STS collection is the mirror image of the effect of an equivalent decrease. If decentralization advances by one unit and STS collection rises by some amount, the linear model assumes that a one-unit reversal of that same decentralization would lower STS collection by exactly the same amount. This assumption is rarely tested directly, and there are good reasons to doubt it holds for an institutional reform like STSD.

Provincial revenue authorities who are granted new powers have to develop their registration systems, train the staff, and put in place enforcement protocols, processes that will take time to stabilize and are not likely to smooth out as they are established (Bird & Vaillancourt, 2008). The advantages of decentralization could be gradually realized if decentralization is further intensified, provided that institutions can keep pace with the new authority. The compliance and enforcement system already established cannot, however, sit idly by if decentralization slows or even stalls; registered taxpayers who have adapted to the more decentralized system may be the first to react to a retreat in institutions in an asymmetric way. The study examines the same data as the accompanying study, but applies a very different econometric method to directly test whether STS collection is indeed faster to decrease in the face of decentralization, or faster to increase in the face of increased decentralization, as the linear model suggests.

To answer this, the study applies the Nonlinear Autoregressive Distributed Lag (NARDL) framework, which breaks the STSD index into absolute cumulative deviations from the trend into positive and negative values and estimates separate long-run and short-run relationships with STS collection. This is a completely new and more rigorous econometric model than the one employed in the companion study, which was the linear ARDL bounds-testing model that, by nesting the linear model as a special case, requires a formal test of the data to see whether the linear model is true.

1.1. Problem Statement

Despite the growing body of empirical evidence on fiscal decentralization and its impact on sub-national revenue collection, the existing literature, including the companion study on Pakistan's Sales Tax on Services (STS) decentralization, overwhelmingly relies on linear models that implicitly assume symmetry in the relationship between decentralization intensity and revenue outcomes. This assumption posits that an increase in decentralization intensity raises revenue collection by the same magnitude that an equivalent decrease would lower it, effectively treating decentralization's advances and reversals as mirror images of one another. However, institutional theory and behavioural economics literature on loss aversion and policy credibility suggest that this symmetry assumption may not hold in practice. When provincial revenue authorities are granted new taxing powers, they must develop registration systems, train staff, and establish enforcement protocols, a gradual institutional building process that yields revenue benefits slowly over time.

Conversely, when decentralization stalls or reverses, registered taxpayers who have already adapted to the more decentralized system may respond rapidly to institutional retreat, potentially yielding a faster and more pronounced decline in revenue collection than the increase that accompanied the original decentralization advance. This potential asymmetry has critical implications for policymakers, as it suggests that the credibility and continuity of decentralization commitments may be at least as important for revenue outcomes as the pace of further devolution itself. Yet, no study of which the authors are aware has tested whether the effect of sales tax on services decentralization on STS collection in Pakistan, or indeed the effect of fiscal decentralization on own-revenue collection in any comparable developing country setting, is symmetric or asymmetric. This gap leaves policymakers without crucial evidence on whether decentralization's revenue effects are reversible in a symmetric manner or whether institutional retreat carries

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a disproportionate revenue cost, thereby hindering informed decision-making on fiscal decentralization reforms and their potential rollbacks.

2. Literature Review

The linear ARDL bounds-testing approach of Pesaran, Shin and Smith (2001) cannot detect this kind of asymmetry because it constrains the effect of an increase and a decrease in the same regressor to be equal by construction. Shin, Yu and Greenwood-Nimmo's (2014) development of the Nonlinear Autoregressive Distributed Lag model addresses this by decomposing a regressor into the partial sums of its positive and negative changes and estimating each component's own long-run and short-run coefficients within a single cointegrating framework, nesting the linear ARDL model as the special case in which the two components' coefficients happen to be equal. This approach has been widely used to test asymmetric pass-through and asymmetric policy effects in energy prices (Zhang & Baek, 2022), exchange rates (Bahmani-Oskooee & Mohammadian, 2016), and monetary policy (Li, Si, & Ge, 2021), though its use in fiscal decentralization and sub-national tax collection remains limited. Within the broader fiscal federalism literature reviewed in the companion studies on this dataset, including Martínez-Vázquez, Lago-Peñas and Sacchi's (2017) survey and Rodden's (2003) cross-country study, the effect of decentralization on revenue collection is treated as a single linear relationship throughout, with no attention paid to whether decentralization's advances and reversals carry equal weight.

No study of which the authors are aware has tested whether the effect of sales tax on services decentralization on STS collection in Pakistan, or indeed the effect of fiscal decentralization on own-revenue collection in any comparable setting, is symmetric or asymmetric. The companion STS study on this dataset, like the wider literature it draws on, estimates a linear relationship without testing this assumption. This study fills that gap directly.

2.1 Theoretical Framework

The linear ARDL bounds-testing approach of Pesaran, Shin and Smith (2001) cannot detect this kind of asymmetry because it constrains the effect of an increase and a decrease in the same regressor to be equal by construction. Shin, Yu and Greenwood-Nimmo's (2014) development of the Nonlinear Autoregressive Distributed Lag model addresses this by decomposing a regressor into the partial sums of its positive and negative changes and estimating each component's own long-run and short-run coefficients within a single cointegrating framework, nesting the linear ARDL model as the special case in which the two components' coefficients happen to be equal. This approach has been widely used to test asymmetric pass-through and asymmetric policy effects in energy prices (Zhang & Baek, 2022), exchange rates (Bahmani-Oskooee & Mohammadian, 2016), and monetary policy (Li, Si, & Ge, 2021), though its use in fiscal decentralization and sub-national tax collection remains limited. Within the broader fiscal federalism literature reviewed in the companion studies on this dataset, including Martínez-Vázquez, Lago-Peñas and Sacchi's (2017) survey and Rodden's (2003) cross-country study, the effect of decentralization on revenue collection is treated as a single linear relationship throughout, with no attention paid to whether decentralization's advances and reversals carry equal weight.

2.2 Research Hypotheses

The study is guided by the following Research Hypotheses:

- **H_0:** The long-run and short-run effects of STSD on STS collection are symmetric; increases and decreases in decentralization intensity have equal and opposite effects.
- **H_1:** The long-run effect of STSD on STS collection is asymmetric; increases and decreases in decentralization intensity have significantly different effects.
- **H_2:** The short-run effect of STSD on STS collection is asymmetric; STS collection responds differently, and potentially more quickly, to decreases in decentralization intensity than to increases.

3. Research Methodology

3.1 Research Design and Philosophical Orientation

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The study employs a quantitative time-series design, using monthly data spanning fiscal years 2001 to 2024, comprising 288 observations, which were also used in the companion STS study on this dataset. Where that study estimates a single linear long-run and short-run relationship between STSD and STS collection, this study decomposes STSD into the partial sums of its positive and negative changes and estimates a Nonlinear Autoregressive Distributed Lag model, allowing each component to have its own long-run and short-run coefficient and formally testing whether the two are equal.

3.2 Population and Sampling

The study uses the full population of monthly STS collection data from the four provincial revenue authorities of Pakistan and, for the pre-devolution period, from Federal Board of Revenue records of collections made on the provinces' behalf. The sample comprises 288 monthly observations covering fiscal years 2001 to 2024 (July 2000 to June 2024). This represents the complete available data for STS collection and the constructed STSD index over this period

3.3 Data Source

STS collection and the STSD index are drawn from the same sources used in the companion STS study on this dataset: STS collection from the four provincial revenue authorities and, for the pre-devolution period, from Federal Board of Revenue records of collections made on the provinces' behalf, and the STSD index constructed from these same collection figures..

3.4 Partial Sum Decomposition

Following Shin, Yu, and Greenwood-Nimmo's (2014) Nonlinear ARDL framework, the STSD index is decomposed into two components, each expressed as a cumulative sum. The positive component, STSD_POS, is the running total of every month-on-month increase in STSD up to that point, and is held at its previous value in any month in which STSD does not rise. The negative component, STSD_NEG, is the running total of every month-on-month decrease in STSD up to that point, and is likewise held at its previous value in any month in which STSD does not fall. Formally, letting ΔSTSD denote the month-on-month change in STSD:

$STSD\_POS_t = \Sigma \max(\Delta STSD_j, 0)$, $STSD\_NEG_t = \Sigma \min(\Delta STSD_j, 0)$, for $j = 1$ to t

so that the original STSD series is exactly recovered, up to its initial level, as the sum STSD_POS + STSD_NEG. Both components are, by construction, cumulative sums of a stationary series and are therefore integrated of order one, which is confirmed empirically in Section 4.2. Both components are also, again by construction, positively correlated with each other and with any other trending regressor, since both accumulate over the same time span as the STS collection itself grows; the resulting elevated Variance Inflation Factors reported in Section 4.6 are an expected structural feature of the Nonlinear ARDL decomposition rather than evidence of a specification error, and are discussed accordingly.

3.5 Model Specification

The Nonlinear ARDL model estimated is:

$$\Delta LSTS_t = \alpha + \rho \cdot LSTS_{t-1} + \delta^{+} \cdot STSD\_POS_{t-1} + \delta^{-} \cdot STSD\_NEG_{t-1} + \theta^{+} \cdot \Delta STSD\_POS_t + \theta^{-} \cdot \Delta STSD\_NEG_t + \varepsilon_t$$

where ρ is the coefficient on the lagged dependent variable that, once negative and significant, confirms an error-correcting long-run relationship (Engle & Granger, 1987), and the long-run coefficients on the positive and negative components are recovered as $\beta^{+} = -\delta^{+}/\rho$ and $\beta^{-} = -\delta^{-}/\rho$, following the standard ARDL long-run solution. Long-run symmetry, the null hypothesis that decentralization's positive and negative components have equal long-run effects, corresponds to the restriction $\delta^{+} = \delta^{-}$, which is tested directly since $\beta^{+} = \beta^{-}$ if and only if $\delta^{+} = \delta^{-}$ for a given, common ρ. Short-run symmetry, the null hypothesis that a within-month increase and a within-month decrease in STSD have equal and opposite immediate effects, corresponds to the restriction $\theta^{+} = \theta^{-}$, which is likewise tested directly. This model is estimated on STS collection alone, without the GDP, debt, and population growth controls carried in the companion linear STS study, both to keep the asymmetry test as uncluttered as possible and because preliminary estimation showed that adding these controls alongside the two decentralization components produced severe multicollinearity, given that GDP in particular trends closely with the cumulative STSD components over this sample.

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3.6 Estimation Strategy

The Augmented Dickey-Fuller and Phillips-Perron tests are used to confirm the order of integration of STS collection and of the two decentralization components. The lag order of the ARDL model is chosen by minimizing the Akaike Information Criterion. The bounds F-test is applied to the unrestricted error-correction representation, Case III, to test for cointegration. Conditional on cointegration being confirmed, long-run coefficients are recovered from the error-correction parameterization, and a classical single-equation Error Correction Model is estimated to obtain the short-run coefficients and the error-correction term. Long-run and short-run symmetry are each tested through a Wald test on the relevant pair of coefficients, using the estimated covariance matrix of the underlying model parameters.

3.7 Diagnostic and Robustness Tests

The Breusch-Godfrey test is used to check for residual serial correlation, and the Breusch-Pagan test is used to check for heteroskedasticity; where either is detected, Newey-West heteroskedasticity- and autocorrelation-consistent standard errors are applied and compared against conventional standard errors, including for the short-run symmetry test itself. The Ramsey RESET test is used to check the model's functional form, the Variance Inflation Factor is used to characterize collinearity between the two decentralization components, the Jarque-Bera test is used to check the normality of the residuals, and the CUSUM test of recursive residuals is used to check the stability of the estimated coefficients across the sample period. As a further robustness check, both STS collection and the two decentralization components are converted to standardized form and the model is re-estimated

3.8 Ethical Considerations

This study adheres to strict ethical standards in financial econometrics research, as it exclusively employs secondary data from publicly available official sources including provincial revenue authorities and Federal Board of Revenue records, thereby eliminating any concerns related to human subjects, informed consent, or privacy violations. The research maintains the highest standards of data integrity by ensuring accurate and honest representation of all collected data without any manipulation or fabrication, while properly attributing and citing all data sources. Transparency is upheld through detailed documentation of all data processing steps, interpolation methods, and analytical protocols, enabling independent verification and replication of the study's findings by other researchers.

4. Results and Discussion

4.1 Descriptive Statistics

Table 1 reports descriptive statistics for STS collection and the two decomposed decentralization components. STSD_POS, the running total of decentralization's increases, rises from zero to a maximum of roughly 13.3 over the sample as decentralization intensified, while STSD_NEG, the running total of its decreases, falls to a minimum of roughly negative 10.6 as decentralization occasionally stalled or partially reversed. Both components depart significantly from normality according to the Jarque-Bera test, expected for cumulative sums built from a series with its own structural breaks, which the central limit theorem renders unproblematic for coefficient estimation at this sample size.

Table 1:

Descriptive Statistics

Variable	Mean	Std. Dev.	Median	Min	Max	Jarque-Bera (p)
LSTS (log STS collection)	7.831	2.035	8.643	4.782	11.052	33.5 (0.000)
STSD (decentralization index)	6.81	2.03	6.74	3.30	10.03	24.7 (0.000)
STSD_POS (cumulative positive changes)	7.11	4.99	7.57	0.00	13.28	31.5 (0.000)
STSD_NEG (cumulative negative changes)	-5.29	3.29	-5.92	-10.58	0.00	23.7 (0.000)

Note: n = 288 monthly observations, FY2001m1 to FY2024m12 (July 2000 to June 2024).

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4.2 Unit Root Tests

Table 2 reports Augmented Dickey-Fuller and Phillips-Perron unit root test results. STS collection, already confirmed to be integrated of order one in the companion study, and both decomposed decentralization components fail to reject the null of a unit root in levels under both tests, and are unambiguously stationary at first difference under both tests. This confirms that both STSD_POS and STSD_NEG are integrated of order one, as expected for cumulative sums of a stationary series, and that the bounds-testing approach applied in Section 4.3 is appropriate.

Table 2

ADF and Phillips-Perron Unit Root Test Results

Variable	ADF (level)	ADF (1st diff.)	PP (level)	PP (1st diff.)	Order of Integration
LSTS	-0.61 (0.869)	-3.81 (0.003)***	-0.35 (0.919)	-23.13 (0.000)***	I(1)
STSD_POS	-0.83 (0.811)	-15.44 (0.000)***	-0.73 (0.840)	-16.38 (0.000)***	I(1)
STSD_NEG	-0.36 (0.916)	-10.19 (0.000)***	-0.37 (0.916)	-15.85 (0.000)***	I(1)

*Note: p-values in parentheses. *** p<0.01. Test regressions include a constant.*

4.3 Cointegration (Bounds Test)

A lag order search based on the Akaike Information Criterion selected an ARDL(1,1,1) specification. Table 4.3 reports the corresponding bounds test for the nonlinear model. The calculated F-statistic exceeds the upper I(1) bound even at the 1 percent level, confirming strong cointegration between the decomposed decentralization measure and STS collection and providing the statistical foundation needed for the long-run and short-run asymmetry tests that follow to be meaningfully interpreted.

Table 3

Nonlinear ARDL Bounds Test for Cointegration

	F-statistic	10% bound	5% bound	1% bound
Calculated statistic	5.838			
I(0) lower bound		2.730	3.229	4.311
I(1) upper bound		3.747	4.322	5.543

Note: Case III (unrestricted intercept, no trend), k = 2 regressors. The calculated F-statistic exceeds the upper I(1) bound at the 1 percent level; the null hypothesis of no long-run relationship is rejected decisively.

4.4 Long-Run Asymmetry

Table 4 reports the long-run coefficients on the two decentralization components and a formal test of whether they are equal. Both components carry a statistically significant long-run coefficient and, as expected, opposite signs: an increase in decentralization intensity raises STS collection significantly, and a decrease in decentralization intensity lowers STS collection significantly. The two coefficients are not simply mirror images of one another. A formal Wald test of the restriction that the two underlying model parameters are equal is rejected decisively, confirming that the long-run relationship between decentralization and STS collection is genuinely asymmetric rather than symmetric. The negative component's long-run coefficient is somewhat larger in magnitude than the positive component's, indicating that a given reversal in decentralization intensity has depressed STS collection by slightly more, in the long run, than an equivalent advance in decentralization intensity has raised it. This is consistent with the theoretical expectation set out in Section 2.1, that institutional retreat carries a somewhat heavier revenue cost than institutional advance carries a revenue benefit.

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Table 4 (a)

Long-Run Coefficients and Test of Symmetry (Dependent Variable: LSTS)

Variable	Coefficient	Std. Error	t-statistic	p-value
STSD_POS	0.237	0.072	3.285	0.001***
STSD_NEG	-0.254	0.109	-2.322	0.020**
Constant	5.130	n/a	n/a	n/a

*Note: *** p<0.01, ** p<0.05. Standard errors from the ARDL error-correction parameterization.*

Table 4 (b)

Wald Test of Long-Run Symmetry (H0: coefficient on STSD_POS = coefficient on STSD_NEG)

Difference	Std. Error	t-statistic	p-value
0.056	0.014	4.056	0.000***

*Note: *** p<0.01. The null hypothesis of long-run symmetry is rejected decisively.*

4.5 Short-Run Asymmetry (Error Correction Model)

Table 5 reports the short-run Error Correction Model and the corresponding test of short-run symmetry, under both conventional and Newey-West heteroskedasticity- and autocorrelation-robust standard errors. The error-correction term is negative and highly significant under both, confirming a valid error-correcting mechanism. Under conventional standard errors, a within-month decrease in decentralization intensity is associated with a significant, immediate fall in STS collection, whereas a within-month increase shows no statistically significant immediate effect; the difference between the two is itself statistically significant, supporting the hypothesis of short-run asymmetry. This particular result, however, does not survive the application of Newey-West robust standard errors, which the diagnostic tests in Section 4.6 show are warranted given evidence of heteroskedasticity in the residuals. Once this correction is applied, neither component's short-run coefficient is individually significant, and the short-run symmetry test itself is no longer significant. This short-run asymmetry finding should therefore be treated as suggestive rather than robust, in contrast to the long-run asymmetry finding in Section 4.4, which does not depend on this particular standard-error choice.

Table 5

Short-Run Error Correction Model and Test of Symmetry (Dependent Variable: ΔLSTS)

Variable	Coef. (OLS)	p-value (OLS)	Std. Error (HAC)	p-value (HAC)
ΔSTSD_POS	-0.123	0.147	0.120	0.303
ΔSTSD_NEG	0.272	0.007***	0.219	0.215
Error Correction Term (ECT_{t-1})	-0.115	0.000***	0.039	0.004***
Symmetry test (POS = NEG)	p = 0.005***		p = 0.141	

*Note: *** p<0.01. HAC standard errors use the Newey-West correction with 4 lags. R squared of the short-run ECM = 0.087; n = 287.*

4.6 Diagnostic and Stability Tests

Table 6 summarizes the diagnostic battery applied to the estimated model. The Breusch-Godfrey test detects statistically significant serial correlation in the residuals, and the Breusch-Pagan test detects statistically significant heteroskedasticity, jointly motivating the Newey-West robust standard errors reported alongside conventional ones in Table 4.5. The Ramsey RESET test indicates a marginal lack of support for the correct functional form, reported explicitly here rather than hidden; residual nonlinearity beyond the positive-negative decomposition modeled is not excluded and is a worthy candidate for future improvement. The Jarque-Bera test indicates that the residuals are highly non-normal, which is consistent with the structural

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break in the STS collection, which shifted after 2010 to be non-normal, but not a problem for coefficient estimation at this sample size due to the central limit theorem. The VIFs of the two decentralization components are high but not due to a specification error, as both components are built over the same period of time; rather, it is due to the mechanical construction of the Nonlinear ARDL decomposition, and they do not appear to be causing problems in the coefficient estimates, as they are individually and jointly significant. The CUSUM test of recursive residuals is well within its critical bounds, indicating that the estimated asymmetric relationship is structurally stable over the sample period.

Table 6

Diagnostic Test Results

Test	Purpose	Statistic	p-value	Conclusion
Breusch-Godfrey LM (4 lags)	Serial correlation	15.36	0.004	Serial correlation present; HAC SEs applied
Breusch-Pagan	Heteroskedasticity	16.37	0.006	Heteroskedasticity present; HAC SEs applied
Ramsey RESET	Functional form	4.53	0.034	Marginal evidence against correct functional form
Jarque-Bera	Normality of residuals	4569.62	0.000	Non-normal; CLT invoked
Variance Inflation Factor	Collinearity	13.64 (both)	n/a	Elevated; expected feature of NARDL decomposition
CUSUM (recursive residuals)	Parameter stability	0.853	0.460	Model structurally stable

4.7 Robustness Check: Standardized Variables

As a robustness check, the STS collection and the two decentralization components were converted to standardized form and the model re-estimated. Because significance levels are unaffected by linear rescaling of the regressors, this re-estimation reproduces the same cointegration result and the same pattern of statistical significance for both components, confirming that the long-run asymmetry finding in Section 4.4 is not an artifact of the variables' original units of measurement.

Table 7

Robustness Check: Standardized (Z-Score) Long-Run Coefficients

Variable	Standardized coefficient	p-value
STSD_POS	0.581	0.001***
STSD_NEG	-0.411	0.020**

*Note: *** $p<0.01$, ** $p<0.05$.*

5. Conclusion and Policy Implications

5.1 Conclusion

This study sets out to test an assumption that the companion STS study, and nearly the entire fiscal decentralization literature, implicitly make that decentralization's effect on own-revenue collection is symmetric. Using a Nonlinear ARDL model that decomposes the sales-tax-on-services decentralization index into separate cumulative measures of its increases and decreases, the study finds that this assumption does not hold. In the long run, increases in decentralization intensity raise STS collection significantly, and decreases lower it significantly, but a formal test confirms that these two effects are statistically distinguishable, with the cost of a reversal running somewhat larger than the benefit of an equivalent advance. In the short run, a suggestive pattern points in the same direction: decentralization's decreases show a significant immediate association with falling collection while its increases do not, but this particular short-run result does not survive correction for heteroskedasticity in the residuals and should be treated with corresponding caution.

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Read alongside the companion STS study's linear finding of a significant positive long-run effect, this study does not overturn that conclusion so much as sharpen it. Decentralization's long-run benefit to STS collection is real, but it is not simply the inverse of what would happen if decentralization were reversed; STS collection appears more exposed to institutional retreat than it is rewarded by institutional advance. A policymaker or researcher relying solely on the linear model would miss this asymmetry entirely, since a linear model by construction cannot distinguish it from a symmetric relationship of the same average magnitude.

5.2 Policy Recommendations

First, because STS collection appears more sensitive to reversals in decentralization intensity than to advances, provincial and federal policymakers should treat the credibility and continuity of decentralization commitments as being at least as important for revenue outcomes as the pace of further devolution itself; a partial rollback, even a small one, appears to carry a disproportionate revenue cost. Second, provincial revenue authorities should build monitoring systems that distinguish between a genuine slowdown in STS collection growth and one driven specifically by a reversal in decentralization intensity, since the two may call for different administrative responses. Third, given that the short-run asymmetry finding is suggestive but not robust to heteroskedasticity-robust estimation, policymakers should place primary weight on the long-run asymmetry finding, which is robust, rather than reacting to short-run fluctuations in STS collection as though they were a reliable early warning signal. Fourth, this asymmetry test should be extended to the companion GST and income tax spillover findings on this dataset before drawing any general conclusion about whether STSD's spillover costs to federal tax collection are themselves symmetric or, as this study's STS findings suggest, asymmetric in their own right.

5.3 Limitations

The present study has few limitations. Official sources do not provide monthly data before 2011, necessitating the use of the Denton interpolation method, together with a proportional benchmark adjustment, to convert annual data into monthly data. The model deliberately excludes GDP growth, debt growth, and population because these variables were highly collinear with the decomposed decentralization variables in the preliminary estimation, and because isolating the asymmetry test as completely as possible from other factors is an important objective of the model. Accepting some loss of precision due to the resulting collinearity, a full asymmetric model that includes these controls is a direction for future research. The marginal rejection of the Ramsey RESET test suggests that there might be functional-form nonlinearity that is not captured by the positive-negative decomposition of STSD modeled here; an interesting extension of this test would be to test for asymmetry in the strength of the STSD changes, rather than the sign of the changes, in order to distinguish large from small decentralization shocks.

Author Contributions

All authors participated in ideation, development, and writing the manuscript. All authors read and approved the final manuscript.

Conflict of Interest Statement

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Informed Consent

Not applicable, as this study exclusively uses secondary data from publicly available official sources. No human subjects, personal data, or primary data collection from individuals were involved in this research.

Data Availability

The datasets generated during and analysed during the current study are available from the corresponding author upon reasonable request. The data are derived from publicly available official sources, and the authors commit to providing all necessary information for replication of the results.

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