

Foreign Aid, Real Exchange Rate Dynamics and Dutch Disease in Rwanda: Evidence from a Cointegrated Time-Series Model, 1990–2023

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Abstract

This study examines the relationship between foreign aid and the real exchange rate in Rwanda using annual data for 1990–2023 and a five-variable Vector Error Correction Model (VECM). The principal system contains the real effective exchange rate (REER), aid relative to gross national income (AID/GNI), terms of trade (TOT), trade openness (OPEN), and government expenditure relative to GDP (GOV/GDP). The empirical strategy uses Johansen maximum-likelihood cointegration with one lag in first differences and a restricted constant in the cointegrating relation. The trace test identifies one cointegrating relationship. In the normalized long-run vector, AID/GNI is 0.895 (SE 0.069; $p < 0.001$), while TOT and GOV/GDP are positive and statistically significant and OPEN is negative and statistically significant. The REER adjustment coefficient is -0.230 ($p < 0.001$). Short-run aid changes are negative but not statistically significant at the 5 percent level. Sensitivity specifications using intervention pulses for 1994 and 2002 show that the estimated aid relationship is sensitive to treatment of the exceptional 1994 disturbance, whereas the 2002 intervention has little effect on the principal coefficients. The findings document a statistically significant long-run association between aid and the REER but do not by themselves establish a causal Dutch-disease effect.

Keywords: foreign aid; official development assistance; real effective exchange rate; Dutch disease; Rwanda; cointegration; VECM; trade openness; terms of trade.

JEL Classification: F31; F35; F41; O11; O55.

1. Introduction

Foreign aid can relax foreign-exchange and fiscal constraints, finance infrastructure and human-capital investment, and support public services. Large external inflows can also affect domestic absorption, relative prices, resource allocation and the real exchange rate. These effects matter because the real exchange rate is closely related to international competitiveness.

The Dutch-disease framework explains how an external inflow can raise domestic demand and the relative price of non-tradables, producing real appreciation and potentially shifting resources away from tradable production (Corden and Neary, 1982). Aid-specific models emphasize that the outcome depends on absorption, expenditure, monetary conditions, imports and productivity (Van Wijnbergen, 1986; Adenauer and Vagassky, 1998; Nkusu, 2004). Empirical evidence is heterogeneous, with studies reporting appreciation, depreciation or weak effects (Nyoni, 1998; Li and Rowe, 2007; Rajan and Subramanian, 2011; Ahmad et al., 2023).

Rwanda provides a useful case because external assistance has been important to development financing while the economy remains small, landlocked and dependent on international trade. The early 1990s also contain exceptional observations associated with civil war and the 1994 genocide and its economic destruction. Such observations can affect estimates from a short annual sample.

This article re-estimates the relationship using a corrected 1990–2023 dataset and a parsimonious five-variable VECM. It asks whether a stable long-run relationship exists, what the conditional long-run association between aid and the REER is, and whether the result is sensitive to intervention treatment of 1994 and 2002. The Dutch-disease conclusion is not imposed in advance.

2. Literature Review and Theoretical Framework

Corden and Neary (1982) distinguish expenditure and resource-movement effects through which an external boom can alter sectoral allocation. Van Wijnbergen (1986) applied the logic to aid and export promotion, emphasizing that the macroeconomic outcome depends on how aid is absorbed and spent. Adenauer and Vagassky (1998) reported aid-related appreciation in several African economies, while Nkusu (2004) cautioned against treating appreciation as an automatic outcome of aid.

Country evidence remains mixed. Nyoni (1998) examined Tanzania and did not find evidence supporting a simple aid-induced Dutch-disease mechanism. Li and Rowe (2007) reported an appreciation relationship for Tanzania using cointegration methods. Rajan and Subramanian (2011) linked aid and manufacturing performance to exchange-rate mechanisms, and Ahmad et al. (2023) emphasized interactions among aid, debt-interest repayments and real exchange rates.

The expected sign is therefore empirical. A positive coefficient is consistent with appreciation only under a convention in which a higher REER represents appreciation. More importantly, a cointegrating coefficient is a conditional long-run association rather than a structural causal elasticity. The present analysis follows that distinction.

3. Rwanda's Macroeconomic and Historical Context

Rwanda's small and landlocked economy makes foreign exchange, imports, exports and external financing closely connected. Development assistance has supported public investment and development programmes, while exchange-rate conditions influence the domestic-currency cost of imports and export competitiveness.

The early 1990s require particular care. Civil war beginning in 1990 disrupted production, while the 1994 genocide caused exceptional human, physical and institutional losses. The corrected REER observations for 1990–1994 are 100.0, 76.0, 73.4, 80.5 and 64.6. The observations are retained rather than deleted or winsorized, but intervention specifications are used to test their influence.

The 1994 intervention is a statistical sensitivity device, not a causal estimate of the historical events. The same applies to the 2002 intervention.

4. Data and Econometric Methodology

4.1 Data

The corrected dataset contains 34 annual observations, 1990–2023. The principal VECM uses REER, AID/GNI, TOT, OPEN and GOV/GDP. All five positive variables are transformed using natural logarithms. Inflation observations missing for 1994 and 1995 are not imputed because inflation is not part of the principal system. No observations are deleted or winsorized.

Table 1. Principal variables

Variable	Definition	Transformation
REER	Real effective exchange rate index	$\ln(\text{REER})$
AID/GNI	Aid relative to gross national income	$\ln(\text{AID/GNI})$
TOT	Terms-of-trade index	$\ln(\text{TOT})$
OPEN	Trade openness measure	$\ln(\text{OPEN})$
GOV/GDP	Government expenditure relative to GDP	$\ln(\text{GOV/GDP})$

4.2 VECM specification

Let $y_t = [\ln(\text{REER}), \ln(\text{AID/GNI}), \ln(\text{TOT}), \ln(\text{OPEN}), \ln(\text{GOV/GDP})]'$. The VECM is $\Delta y_t = \Pi y_{t-1} + \Gamma_1 \Delta y_{t-1} + u_t$, where $\Pi = \alpha\beta'$. The principal specification uses one lag in first differences, equivalent to two lags in the levels VAR, and a constant restricted to the cointegrating relation (Johansen, 1988; Johansen and Juselius, 1990). The effective estimation sample is 32 observations.

Table 2. Johansen trace test

Null rank	Trace	5% critical	Decision
$r=0$	113.012	69.819	Reject
$r \leq 1$	44.760	47.854	Do not reject
$r \leq 2$	20.585	29.796	Do not reject
$r \leq 3$	5.020	15.494	Do not reject
$r \leq 4$	0.916	3.842	Do not reject

Note. The selected cointegration rank is one.

4.3 Structural-break sensitivity

Pulse interventions are added for 1994 and 2002 separately and jointly. They are sensitivity specifications rather than causal identification.

5. Empirical Results

5.1 Normalized long-run relationship

The normalized baseline long-run coefficients are statistically significant for all four explanatory variables. Aid has a coefficient of 0.895 (SE 0.069; $p < 0.001$). Terms of trade and government expenditure are positive, while openness is negative.

Table 3. Normalized long-run coefficients

Variable	Coefficient	SE	z	p
ln(AID/GNI)	0.8948	0.0685	13.06	<0.001
ln(TOT)	0.5477	0.0657	8.34	<0.001
ln(OPEN)	-0.3761	0.0914	-4.12	<0.001
ln(GOV/GDP)	0.5897	0.1187	4.97	<0.001

Note. The vector is normalized on ln(REER); coefficients are conditional long-run cointegrating coefficients.

The positive aid coefficient is consistent with a long-run association between aid and a higher REER under the study's convention. This is compatible with an expenditure channel but is not evidence of a causal aid shock. The positive terms-of-trade coefficient is consistent with external-price effects, while the negative openness coefficient indicates a conditional association with a lower normalized REER. Government expenditure is positively associated with the REER, although the model does not identify expenditure composition.

5.2 Error correction and short-run dynamics

Table 4. REER-equation short-run results

Term	Coefficient	SE	p
ECT(t-1)	-0.2301	0.0519	<0.001
$\Delta \ln(\text{REER})(t-1)$	-0.0063	—	0.969
$\Delta \ln(\text{AID/GNI})(t-1)$	-0.1028	0.0636	0.106
$\Delta \ln(\text{TOT})(t-1)$	-0.1065	—	0.105
$\Delta \ln(\text{OPEN})(t-1)$	0.1754	—	0.025
$\Delta \ln(\text{GOV/GDP})(t-1)$	0.4096	—	<0.001

The error-correction coefficient is negative and significant at -0.230, indicating adjustment toward the estimated long-run equilibrium. The short-run aid coefficient is negative but not significant at 5 percent. The difference between long-run and short-run aid effects shows that the relationship is horizon-dependent.

6. Structural-Break and Robustness Analysis

Table 5. Long-run sensitivity estimates

Specification	Aid/GNI	TOT	OPEN	GOV/GDP	ECT
Baseline	0.8948* **	0.5477* **	-0.3761 ***	0.5897* **	-0.2301 ***
1994 pulse	2.5668* **	0.2889 ns	0.5618* ***	0.5903* **	-0.0741 ***
2002 pulse	0.8912* **	0.5464* **	-0.3748 ***	0.5870* **	-0.2268 ***
1994 + 2002	1.5844* **	0.2291* **	0.3376* ***	0.1506 ns	-0.1163 ***

*Note. *, **, *** denote approximately 10%, 5% and 1%; ns=not significant.*

The 1994 intervention substantially increases the estimated aid coefficient and changes other coefficients, showing that the exceptional early-period disturbance matters for magnitude and specification. The 2002 intervention leaves the baseline coefficients almost unchanged. The joint intervention retains a positive and significant aid coefficient but reduces the government-expenditure coefficient to statistical insignificance.

Table 6. Short-run aid and intervention sensitivity

Specification	Aid coefficient	p	1994 pulse	p	2002 pulse	p
Baseline	-0.10	0.106	—	—	—	—
1994	-0.08	0.090	-0.18	0.002	—	—

	46		61			
2002	−0.10	0.102	—	—	−0.04	0.518
	33				71	
Both	−0.08	0.072	−0.18	0.001	−0.04	0.472
	63		53		09	

An alternative aid measure, AID_USD, produces cointegration rank two rather than one. Its baseline REER adjustment coefficient is not significant, while the intervention specification produces a significant negative adjustment coefficient. Because its rank differs from the principal system, this alternative is treated as secondary sensitivity evidence rather than being forced into the rank-one model.

7. Discussion

Table 7. Residual diagnostics

Specification	Ljung–Box p	Jarque–Bera p
Baseline	0.276	0.311
1994 pulse	0.495	0.143
2002 pulse	0.367	0.216
1994 + 2002	0.778	0.174

Note. Diagnostics should be interpreted cautiously because the annual sample is small.

The residual checks do not indicate statistically significant serial correlation at the reported lag or strong evidence against residual normality. The principal robustness evidence, however, is the explicit treatment of the 1994 disturbance. The baseline aid coefficient is statistically significant in the corrected five-variable model, whereas the older manuscript used a materially different variable set and unverified historical estimation output. Those older coefficients are not carried into this article.

The results are compatible with a long-run appreciation mechanism but do not identify a causal Dutch-disease effect. Aid may respond to macroeconomic conditions, and the cointegrating vector captures joint equilibrium comovement. Causal identification would require an external instrument, donor-driven shock or structural model.

The 1994 sensitivity result reinforces the importance of historical context. It does not invalidate the baseline relation; it shows that exceptional macroeconomic disruption can materially affect estimated long-run parameters in a small annual sample.

8. Policy Implications

Aid absorption should be coordinated with fiscal and monetary policy so that foreign-currency inflows do not create avoidable instability. Aid-financed investment that expands productive capacity and tradable-sector productivity may have different exchange-rate implications from expenditure concentrated in non-tradable consumption. Exchange-rate monitoring should therefore be combined with export performance, imports, inflation, productivity and the composition of external finance.

Policy interpretation should also recognize that a movement in the REER alone does not establish Dutch disease. Better data on aid composition, disbursement timing, expenditure channels and sectoral outcomes would permit more precise assessment of the mechanisms.

9. Limitations and Future Research

The main limitation is the small annual sample of 34 observations. Estimates can be sensitive to deterministic terms, lag length and exceptional observations. A second limitation is causal identification: cointegration does not solve endogeneity between aid and macroeconomic conditions. A third limitation is measurement because AID/GNI and AID_USD represent different dimensions of aid exposure. Future work should consider donor-driven instruments, sectoral aid, higher-frequency data where available, and explicit transmission channels through expenditure, imports and productivity.

10. Conclusion

Using corrected 1990–2023 data, the principal VECM identifies one cointegrating relationship among the REER, aid, terms of trade, openness and government expenditure. The normalized aid coefficient is positive and statistically significant at 0.895, while the REER error-correction coefficient is −0.230 and statistically significant. Short-run aid changes are not significant at the 5 percent level.

The 1994 intervention materially changes the magnitude of the long-run aid coefficient, whereas the 2002 intervention has little effect. The evidence therefore supports a statistically significant long-run association between aid and the REER under the maintained specification, but it should not be presented as proof of a causal Dutch-disease effect. The article's contribution is a transparent updated estimate that separates long-run equilibrium association from short-run adjustment and explicitly accounts for Rwanda's exceptional historical disturbance.

Declarations

Ethics information

The study uses secondary macroeconomic data and does not involve human participants, personal-data collection or animal subjects. Formal ethics approval was not applicable.

Author contributions

Alan Tuyisenge: conceptualization, literature review, data preparation, empirical analysis, interpretation and manuscript preparation.

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Conflict of interest

The author declares no conflict of interest.

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Data Availability

The corrected annual dataset used for the principal analysis is archived with the research materials. Replication materials should include the final dataset, variable definitions, transformations, intervention-dummy construction and estimation output.

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Appendix. Replication Specification

Principal variables: $\ln(\text{REER})$, $\ln(\text{AID/GNI})$, $\ln(\text{TOT})$, $\ln(\text{OPEN})$, $\ln(\text{GOV/GDP})$. Estimator: Johansen VECM. Cointegration rank: 1. One lag in first differences. Constant restricted to the cointegrating relation. Effective observations: 32. Normalization: coefficient on $\ln(\text{REER})$ equals 1. Sensitivity: 1994 pulse, 2002 pulse, and both jointly.

Normalized baseline relation: $\ln(\text{REER})=0.8948$ $\ln(\text{AID/GNI})+0.5477$ $\ln(\text{TOT})-0.3761$ $\ln(\text{OPEN})+0.5897$ $\ln(\text{GOV/GDP})+\text{constant}$, interpreted as a cointegrating relation rather than a structural causal equation.