

Assessing the Economic Returns of Broadband: Cross-Country Evidence from the Broadband Boom Era (1995-2015)

Introduction

As broadband has reshaped information flows, market integration, and productivity, it has become a key engine of modern economic growth. Understanding how broadband penetration affects cross-country macroeconomic performance is central to development economics. We aim to analyze:

"How well does broadband penetration explain cross-country variation in GDP per capita growth, controlling for key macroeconomic and demographic factors during the broadband boom era (1995–2015)?"

- Prior evidence shows that broadband expansion generates significant economic gains:
 - It increases GDP per capita growth (Czernich et al., 2011)
 - It exhibits threshold effects, with returns accelerating after widespread adoption (Koutroumpis, 2009)
 - It yields a “growth dividend”: a 10% rise in broadband penetration is linked to a 1.3% increase in economic growth (Qiang et al., 2009)

Data Collection

- Data Source:** World Bank's World Development Indicators database (World Bank, 2025).
- Provides standardized country-level statistics on economic, demographic, and ICT-related measures from 1995–2015 using a panel of 217 countries for 4557 observations.
- Collected through national statistical offices, censuses, household and firm surveys, administrative records, and international organizations.

Variables Considered:

- The response variable is GDP per-capita growth, modeled using broadband diffusion indicators (broadband, mobile, internet use) and economic, demographic, and institutional controls informed by literature.^{[1][3]}



Data Aptness:

- The dataset's panel structure enables linear regression modeling of broadband's marginal impact on growth over time.
- Cross-country GDP is assumed to be sufficiently independent for this analysis. Temporal correlation within countries is likely minor and negligible. Together, these properties make GDP per-capita growth an appropriate response variable for linear regression.

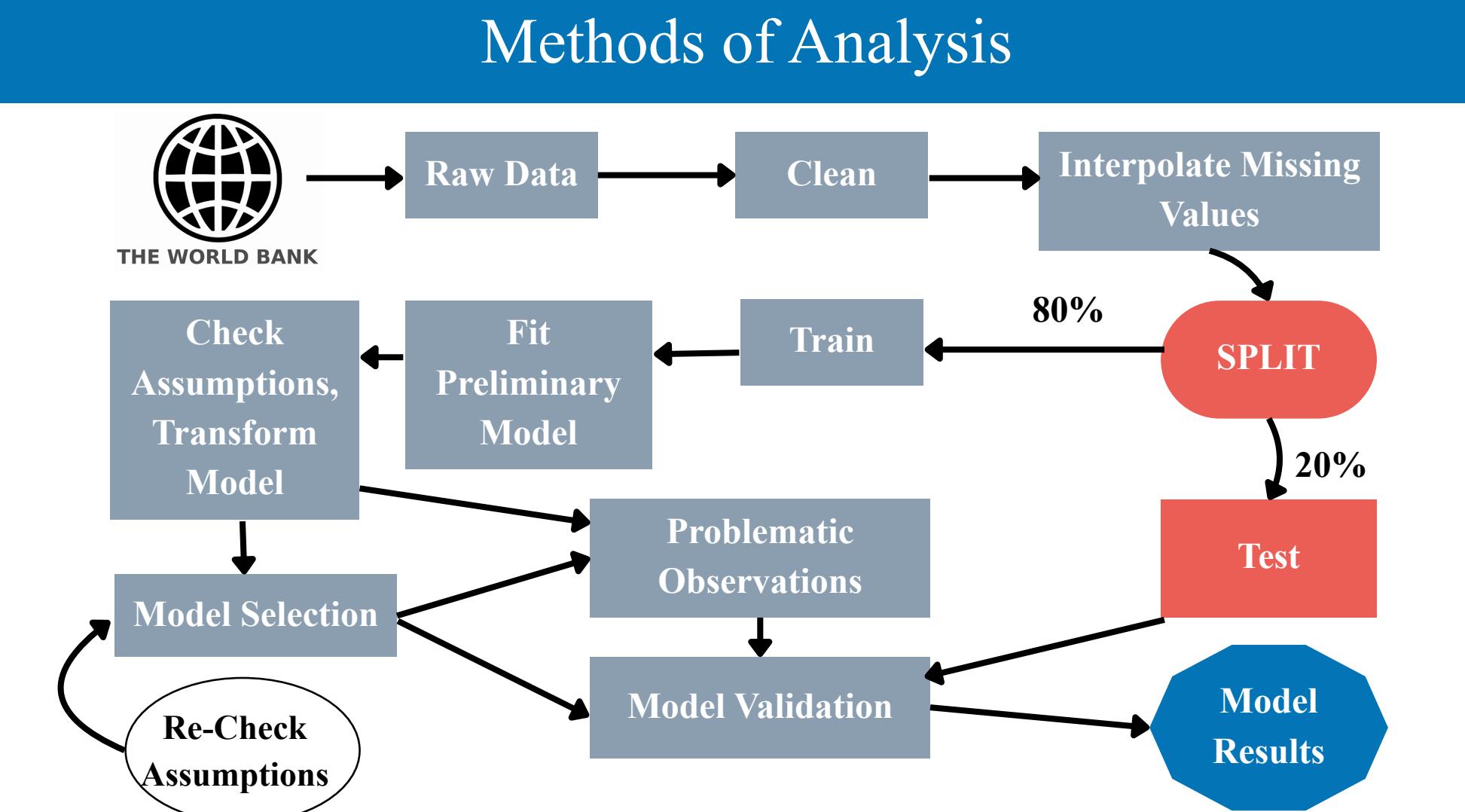


Figure 1: Flowchart illustrates data retrieval, cleaning, and interpolation, followed by model fitting. Observations missing all predictor values were omitted, while remaining incomplete predictor values were imputed using median substitution. Training ($n = 2672$) and testing ($n = 669$) sets were compared using a t -test to ensure they came from the same distribution ($p = 0.603$). Model selection employed backward selection and was verified using a partial F -test ($F = 1.49$, $df = 3$, $p = 0.216$), leading to the removal of FDI, Trade-to-GDP, and Rule of Law from the final specification.

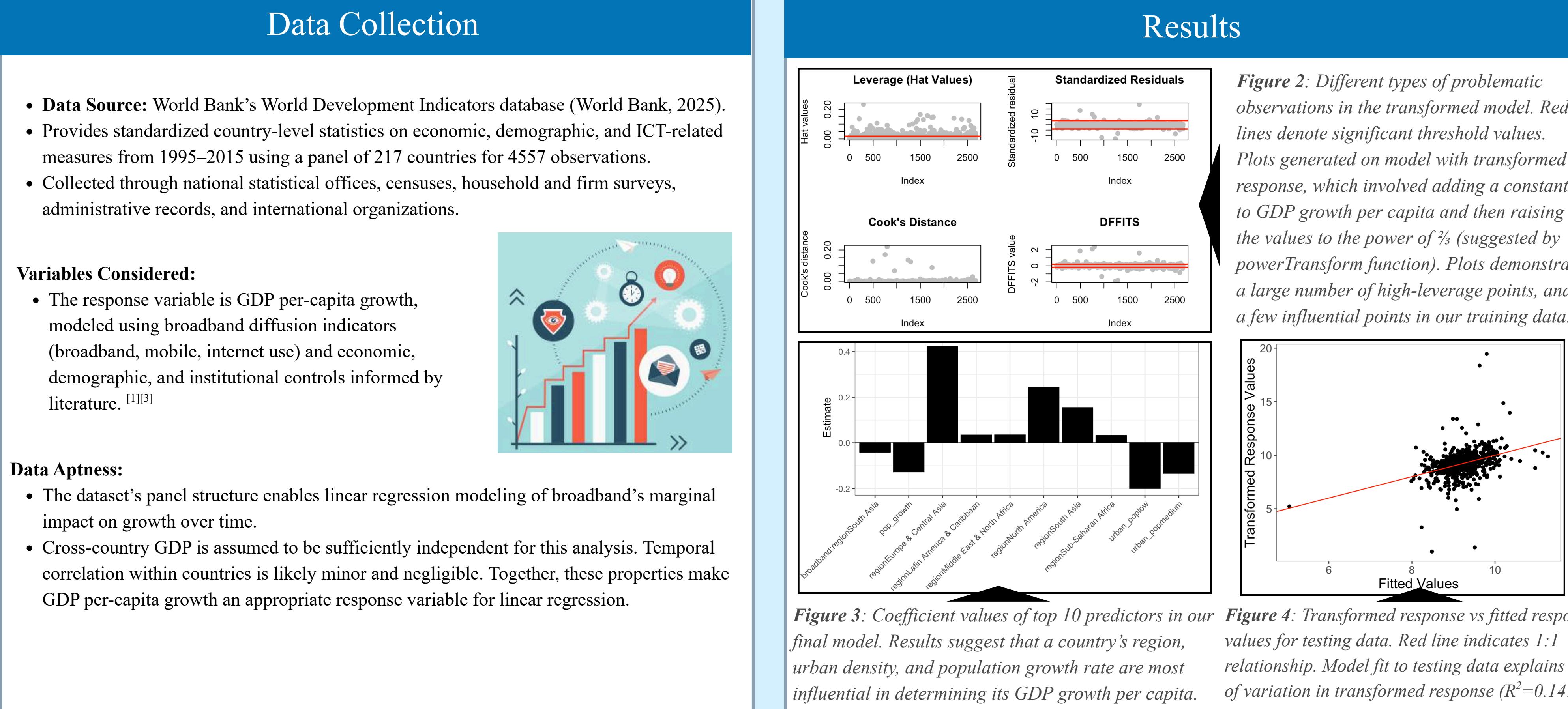


Figure 2: Different types of problematic observations in the transformed model. Red lines denote significant threshold values. Plots generated on model with transformed response, which involved adding a constant to GDP growth per capita and then raising the values to the power of $\frac{1}{3}$ (suggested by powerTransform function). Plots demonstrate a large number of high-leverage points, and a few influential points in our training data.

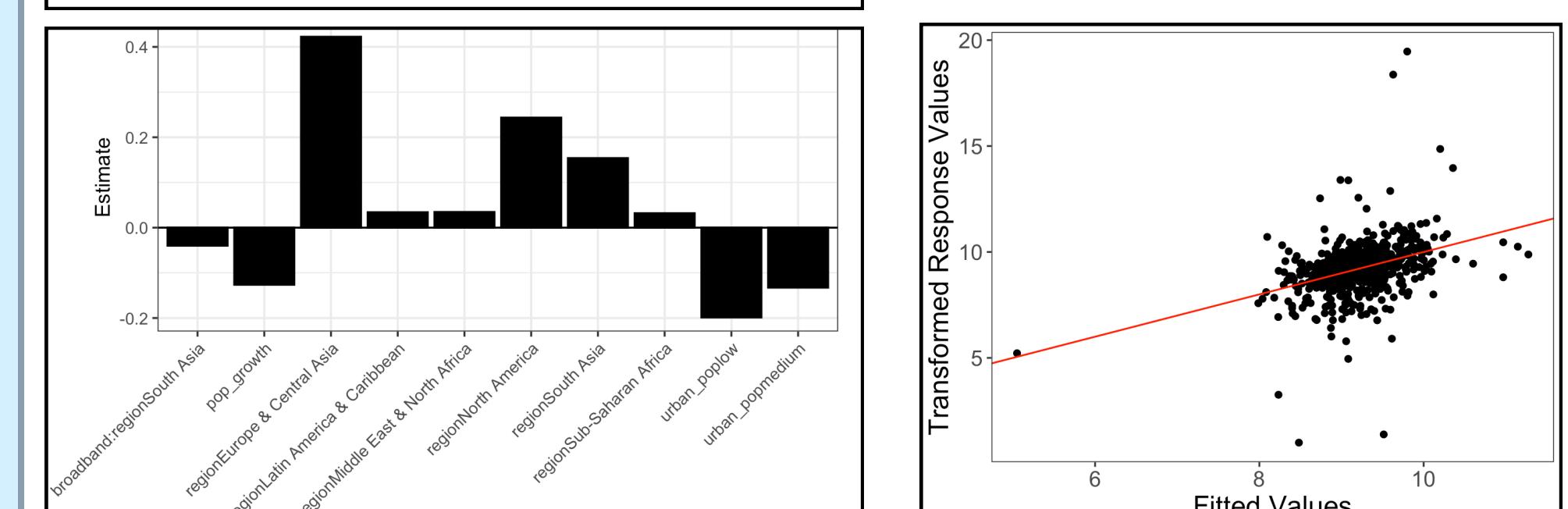


Figure 3: Coefficient values of top 10 predictors in our final model. Results suggest that a country's region, urban density, and population growth rate are most influential in determining its GDP growth per capita.

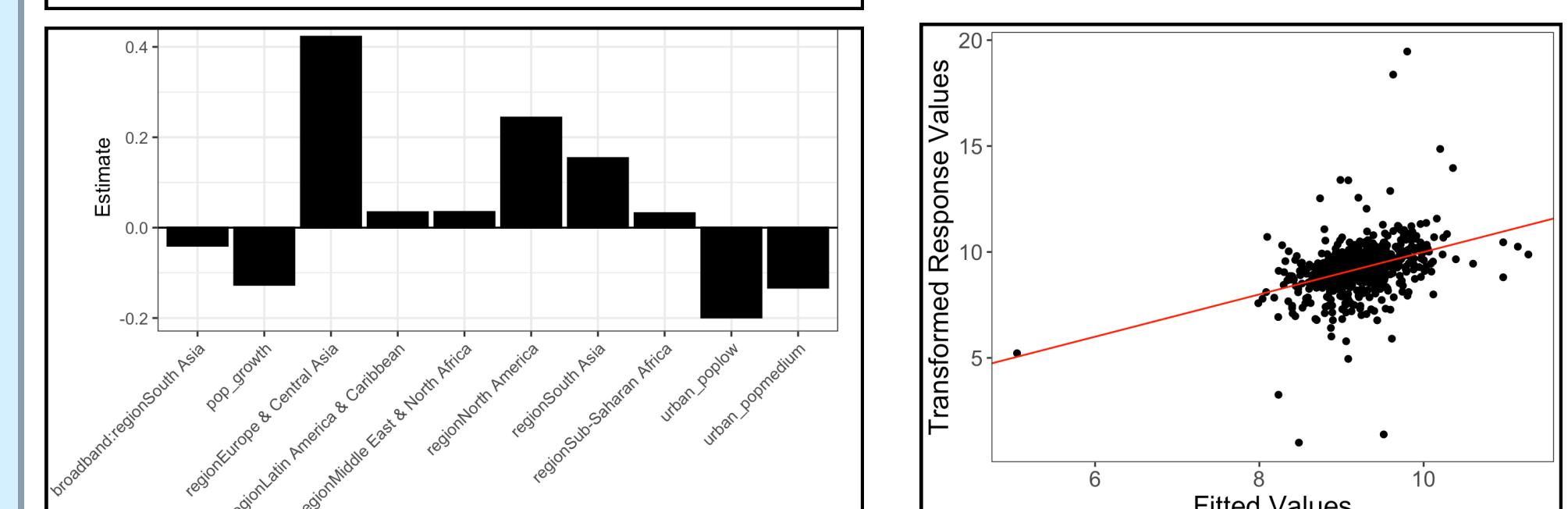


Figure 4: Transformed response vs fitted response values for testing data. Red line indicates 1:1 relationship. Model fit to testing data explains 14% of variation in transformed response ($R^2=0.1414$).

References

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- [4] Minges, M. (2016). Exploring the relationship between broadband and economic growth. *World Bank*. <https://documents.worldbank.org/curated/en/178701467988875888/pdf/102955-WP-Box394845B-PUBLIC-WDR16-BP-Exploring-the-Relationship-between-Broadband-and-Economic-Growth-Minges.pdf>
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- [6] Qiang, C. Z., Rossotto, C. M., & Kimura, K. (2009). Economic impacts of broadband. In *Information and Communications for Development 2009: Extending Reach and Increasing Impact* (pp. 35–50). World Bank / Oxford University Press. <https://thedoctors.worldbank.org/en/doc/834151434649067733-0190022009/original/IC4DBroadband3550.pdf>

Conclusion

Broadband's Economic Impact

Broadband's effect on GDP growth isn't uniform across regions.

(+) : Middle East & North Africa, Sub-Saharan Africa, East Asia & Pacific

(-) : Europe & Central Asia; North America; South Asia; Latin America & Caribbean

Economic returns to broadband depend on regional development conditions and complementary infrastructure.

Key Predictors of GDP Growth

Positive predictors

Gross capital formation

Inflation, population growth, urbanization, and school enrollment

Broadband, mobile, and internet use are not globally significant predictors of GDP growth.

ANSWER TO THE RESEARCH QUESTION

Broadband penetration helps explain cross-country GDP growth, but its effect varies markedly by region. Our model identifies positive broadband-growth relationships in MENA, East Asia & Pacific, and Sub-Saharan Africa, and weak or negative effects in Europe, North America, Latin America, and South Asia.

Limitations

ISSUES	IMPACT
Missing values & imputation	Median imputation may smooth real economy volatility and reduce the variation needed for accurate inference
Influential observations	Adds noise; contributes to heavy-tailed residuals
Normality violation	Weakened inference; indicates unmodeled cross-country heterogeneity
Model not fully validated	Coefficient instability between training and testing reduces confidence in model generalizability
Not using cross-validation	Estimated prediction error may be biased

SUGGESTIONS

- Use multiple imputation or model-based imputation instead of simple interpolation to preserve data structure and uncertainty better.
- Fit separate regional models to reduce cross-country heterogeneity.
- Use a larger holdout set or cross-validation to assess stability.
- Use resampling methods for cross-validation to obtain a more reliable measure of predictive accuracy.