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► To cite this version:

Marlène Guillon, Martine Audibert, Jacky Mathonnat. Efficiency of district hospitals in Zimbabwe: Assessment, drivers and policy implications. *International Journal of Health Planning and Management*, 2021, 10.1002/hpm.3337 . hal-03354076

HAL Id: hal-03354076

<https://hal.science/hal-03354076>

Submitted on 18 Oct 2021

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Efficiency of district hospitals in Zimbabwe: Assessment, Drivers and Policy Implications

Running title: Efficiency of district hospitals in Zimbabwe

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Funding: This study was financed by the FERDI and the Agence Nationale de la Recherche (France) as part of the programme " Investments for the Future " ANR-10-LABX-14-01 ".

Conflict of interest statement for all authors: Each author declares that there are no conflicts of interest.

Acknowledgements: The authors wish to thank the Ministry of Health and Child Care of Zimbabwe for the access to the data and for the extensive discussions regarding the study preparation and the results' analysis. We are grateful to three anonymous reviewers for their helpful comments.

Abstract

The Government of Zimbabwe is committed to making progress towards universal health coverage. Unmet health needs are huge and the health system suffers from serious dysfunctions and weaknesses. The situation is further complicated by a weak governance. To address these challenging issues, many of which would require an increase in public health expenditures, the government faces severe macroeconomic constraints. In this context, improving the efficiency of public health expenditures is of paramount importance. This study focuses on the efficiency of district hospitals, whose role is crucial for the strengthening of the health care system and achieving significant results in implementing the universal health coverage. Based on a sample of 31 district hospitals observed from 2015 to 2017 we use the double bootstrap procedure developed by Simar and Wilson to 1) estimate bias-adjusted DEA efficiency scores and to 2) investigate the factors associated with the previously calculated scores using truncated regression. The average efficiency of district hospitals is low and stagnant over 2015-2017. The findings suggest the existence of a significant room for maneuver to get more results with the resources spent. The analysis of the efficiency drivers shows the importance of both supply and demand-side factors, leading to several policy-oriented considerations. The study also highlights important shortcomings in the routine collection of basic data that need to be addressed by the Ministry of Health and Child Care.

Key words: Healthcare - Efficiency – DEA – Hospitals - Zimbabwe

1. Introduction

This study aims to analyze the efficiency of Zimbabwean district hospitals (DHs) over the 2015-2017 period. DHs play a key role in the provision of health care and constitute a cornerstone to achieve progress towards universal health coverage in Zimbabwe. The study was carried out following a proposal from the Ministry of Health and Child Care (MoHCC). The results were thoroughly discussed with the MoHCC and included in the medium-term evaluation process of the 2016 - 2020 health strategy. This study was conducted to provide the MoHCC with operational information to support its efforts to

better understand the scope of the challenges to be addressed. It is also echoing Article III of the October 2018 Declaration of the Astana Conference on Primary Health Care emphasizing that “(...) We cannot afford waste in health care spending due to inefficiency”.

Zimbabwe suffers from a shaky economic situation bolstering the rationale for improving the efficiency of the health care facilities. The economic policy of the years 2000-2010 led to a collapse of agricultural production, an overvaluation of the real exchange rate, an excessive wage bill in the public sector (in 2016, the wage bill absorbs about 100% of the government's tax revenues and 20% of GDP), emigration of part of the elite and very high levels of current account and budget deficits. These deficits were financed by a debt strategy that proved unsustainable^{1,2}. The failure of the Government to engage credibly in a policy addressing the growing macroeconomic imbalances, as well as concerns about high corruption and serious repeated violations of human rights, caused the isolation of Zimbabwe from the international community. This led to a drastic reduction in external aid, with a suspension of grants channeled through the budget for the 2015-2017 period. Exogenous factors (fall in export prices, exceptional climatic events as El Nino and induced catastrophic drought) aggravated the deterioration of the economic situation. In 2017, macroeconomic imbalances have worsened, the overall deficit was approaching 10%, net external financing was negative, the accumulation of payment arrears continued and reserves covered only two weeks of imports of goods and services² while it is generally considered that at least 5 months of coverage is required. Consequently, during the 2015-2017 period under review, real GDP per capita growth was almost null in total for the three years. Inequalities have increased and extreme poverty worsened being particularly worrying in rural areas³.

During the period under review, Zimbabwe then experienced a severe political and economic situation, exacerbated by protean governance problems. This situation has accentuated the drift and disorganization of the health system, despite the introduction of relevant reforms, such as the results-based financing program, while it has deeply affected the supply and demand for care. The new government which came to power at the end of 2017 inherited a challenging environment, including huge financial and human resource needs in the health sector. The persistent precariousness of the economic situation makes a sustainable increase in public expenditure on health care highly unlikely in Zimbabwe. In other words, 'conventional' approaches to broadening fiscal space for health - fiscal space being succinctly defined as the ability of a state to increase resources for a particular sector through additional domestic revenue, greater budget prioritization of the sector or increased concessional external financing - while sustaining (but in Zimbabwe's case not further degrading) the public sector's financial position, turned out to be dead ends. In this very constraining context, getting the “best value for money”; i.e., improving the efficiency of the limited health care financial and human resources available; is a paramount issue for Zimbabwe's health policy.

2. Data and methods

The Zimbabwean health system is a four-tiered pyramidal system with lower-level primary health care facilities (clinics), secondary level facilities (district hospitals) and tertiary level (provincial hospitals) and quaternary level (central hospitals) facilities. The 44 District Hospitals (DHs) operating in Zimbabwe are homogeneous in terms of their missions, their places in the health system and the diversity of care they provide.

Technical efficiency refers to the capacity of a Decision-Making Unit (DMU) to transform a certain amount of resources (inputs) into a certain quantity of outputs through the production process. Then,

improving technical efficiency means obtaining a given output using fewer inputs (input orientation) or getting the maximum output for a given set of inputs (output orientation). We analyze the technical efficiency of Zimbabwean DHs for which data were available in at least one year of the 2015-2017 study period. As data could not be retrieved for the three years for all DHs, the sample is composed of 89 hospital-year observations, emanating from 38 DHs, with complete inputs and outputs data in 2015, 2016 or 2017.

We use a two-stage model to 1) estimate the output-oriented technical efficiency scores of Zimbabwean DHs over the 2015-2017 period under the hypothesis of variable returns to scale and to 2) assess the factors associated with DHs' efficiency level. Various publications have discussed several possible approaches to analysing efficiency in the health sector^{4,7}. We follow Simar and Wilson⁷ who propose a double bootstrap procedure that produces bias-adjusted Data Envelopment Analysis (DEA) scores and provides valid inference for the regression of non-parametric DEA efficiency estimates on a set of explanatory variables in the second stage. This double bootstrap procedure requires data on second stage explanatory variables for the calculation of the bias-adjusted DEA scores and for the estimation of efficiency drivers. Because of missing data for some explanatory variables, our final sample is reduced to 75 hospital-year observations stemming from 31 DHs.

Based on yearly average of monthly activity and resources data, bias-corrected DEA scores are first calculated for every DH for each year available over the 2015-2017 period. DEA scores are relative efficiency scores since DHs are compared to each other on the basis of the inputs they use and the outputs they produce. The best performing DHs in the sample obtain a score of 1 while sub-efficient DHs have an efficiency score between 0 and 1. More precisely, a DH with an efficiency score of x_i could theoretically increase its production by $(1 - x_i)$ in absolute terms and $\left(\frac{1}{x_i} - 1\right) * 100\%$ in relative terms without an increase in its inputs. Bias-corrected DEA scores are then regressed on a set of explanatory variables using a bootstrapped truncated regression that produces unbiased parameter estimates and confidence intervals.

Given data constraints and our discussions with the MOHCC, we consider three output variables that best reflect the main activities of DHs: the number of inpatients, the number of outpatients and the number of operations. Three input variables that constitute the main resources available to DHs to produce health care are introduced: the number of beds, the number of doctors and the number of nurses.

Regarding the assessment of potential efficiency drivers, no endogenous variables related to the organization and the management of DHs could be studied due to data unavailability. The efficiency drivers' analysis then focuses on four exogenous variables measured at the district level: the population density, the dependency ratio (ratio of the population aged 0 to 14 and 65+ to population aged 15 to 64), the poverty gap index showing the average shortfall of the total population from the national poverty line and the share of the population with access to electricity (this last variable being used in replacement of the poverty gap index in robustness analysis). These variables, even if not under the control of the DHs or health authorities, might indeed affect the volume and composition of health care demand faced DHs and then impact their efficiency level.

Table A1 in Appendix A provides the descriptive statistics of the inputs, outputs and explanatory variables used in the analysis of DHs' efficiency. The studied DHs substantially vary in size, as is often the case in the literature which also shows that there is no clear relationship between the size and efficiency of hospitals when they are health facilities with the same missions⁸.

3. Results

Efficiency scores. The average technical efficiency score for the 2015-2017 period is 0.695, which means that, in average, DHs could potentially increase their health care production by about 31% in absolute terms and 44% in relative terms without an increase in their inputs. The heterogeneity of efficiency across DHs is pretty high. Indeed, efficiency scores of DHs range from 0.370 to 0.990 and the standard deviation to the mean ratio is equal to 0.16.

All district hospitals in our sample are scale efficient using the returns to scale test developed by Badunenko and Mozharovskyi⁹. The average technical efficiency is stable over years, but the evolution of efficiency is heterogeneous among DHs. Nevertheless, variations in efficiency over time remain limited for most DHs: among the 27 DHs hospitals for which we have data over at least two years, only 6 experienced an increase in efficiency of more than 10 % over time (only 2 for an increase of more than 20%) and 8 experienced a decrease in efficiency of more than 10 % over time (only 4 for a decrease of more than 20%).

We tested the robustness of our results using three alternative models with fewer inputs and/or outputs. The results are very close, which is confirmed by the Spearman rank correlation coefficients (see Tables B1 to B3 in Appendix B).

Role of a selection of potential drivers. In our four models, we find a positive and significant correlation between the population density and the efficiency scores of hospitals ($b = 0.00256$, $p < .01$ in the main model). DHs located in districts with proportionally more children and elderly (higher dependency ratio) tend to be less efficient ($b = -0.00422$, $p < .01$ in the main model). DHs located in poorer districts also tend to be less efficient ($b = -0.00375$, $p < .05$ in the main model). Figure C1 in Appendix C displays the relationships between each of our explanatory variables and the efficiency scores at the DH level once controlled for the effect of the other explanatory variables. From this graph it appears that the population density is the factor that most influences the efficiency of DHs. The positive association between the population density and DHs' efficiency is confirmed when the analysis is run at the hospital level rather than the hospital-year level.

Complementary analyses have been carried out with descriptive statistics and bivariate associations showing that there is no close relationship between per capita health staffing (doctors, nurses and both, working at the district hospital, per inhabitants) and efficiency scores. Nor is there any close relationship between the variation in the rankings of efficiency scores and the variation in health staff allocations related to the district population. This is an important point since the wage bill absorbs most of the public health expenditure in Zimbabwe.

4. Discussion

Our results for the efficiency scores (average and dispersion) are within the range of efficiency scores and standard deviations found in the literature for hospitals in Botswana¹⁰, Ghana¹¹, Ethiopia¹², China¹³⁻¹⁵ or OECD countries^{8,16}. These results show the existence of a potentially significant margin of maneuver for « getting more value for money » in the Zimbabwean health system.

The positive and significant correlation we find between the population density and the efficiency scores of DHs is in line with results found in other low- and middle-income countries^{17,18}. It means that DHs located in more densely populated districts tend to be more efficient which is probably linked to a demand effect that spurs the activity of these DHs.

The negative impact of poverty on the efficiency of DHs is coherent with previous studies of health care facilities' efficiency conducted for instance in China^{13,17} or in Burkina Faso¹⁹. When using the share of

the population with access to electricity, instead of the poverty gap index, in the regression analysis we find no significant association between this variable and the efficiency scores. The negative impact of both the poverty gap index and the dependency ratio on the efficiency of DHs point to a household income constraint. The national high level of poverty (71%) and of extreme poverty (29% nationwide and 41% in rural areas)³ is a driver of low demand for health care. Financial barriers are the main reason cited for not seeking medical treatment by 42% of the extremely poor and 37% of the poor²⁰, suggesting a high incidence of foregone care due to high hospital treatment costs with large direct payments²¹, impeding health care demand and DHs' efficiency. The negative association found between the dependency ratio and the efficiency of DHs is higher for dependency as measured by the share of the over 64s than for the 0-14s. This reflects the fact that the foregoing of care is more widespread for the over-50s, who are often suffering from costly chronic diseases with high out of pocket payments, than for the other age groups as highlighted in Zeng et al. (2018)²¹.

Five main policy-oriented recommendations can be derived from the study results.

- i. *Improving DHs' efficiency must be a top priority for the MoHCC given the scarce human and financial resources for health available in Zimbabwe.* The average technical efficiency score of DHs is 0,695 suggesting that DHs could potentially increase their health care production by about 44% in relative terms without an increase in their inputs. These results show that improving efficiency would provide significant financial leeway. It confirms that widening the fiscal space for health by focusing on efficiency is a high potential approach when a country is faced with strong macroeconomic constraints²² as is the case in Zimbabwe.
- ii. *Addressing demand side issues and the negative impact of poverty and dependency ratio on DHs' efficiency.* Our analyses show that poverty and the dependency ratio (regardless of the model used) have a negative impact on efficiency. Both highlight a household income constraint and a foregone health care requiring higher direct payments, particularly for the elderly²¹ as they more often suffer from serious and costly pathologies than younger populations. This is a driver of low demand for health care impeding DHs' efficiency as financial barriers are the main reason for not seeking medical treatment^{3,20,21}. This suggests that a policy to improve the efficiency of DHs must pay close attention to the demand for care of the poor and especially for the elderly. One could consider that continuing to operate inefficient district hospitals in areas where the population density and the demand faced by district hospitals are low is a kind of subsidy to facilitate healthcare access for the poor. However, no significant correlation is found in our data between population density and poverty at the district level which indicates that reallocating resources devoted to district hospitals from low to high density areas would not disproportionately harm the poor. Moreover, in the specific Zimbabwean context, characterized by severe resource constraints, low quality of care and acute governance problems at the national and healthcare system levels^{1,20}, continuing with the running of highly inefficient DHs in a "business as usual" mode could hardly be seen as a form of appropriate subsidy for the poor aimed at reducing inequalities in healthcare access, which might be the case in another context. For these reasons, addressing the issue of inefficient DHs suggests reconsidering the policy approach to the removal of user-fees in two directions. First, by revising its unconditional feature to take into account 1) that some households are able to contribute to the financing of healthcare and 2) that user fees removal in a context of poor governance²³ can worsen the quality of care which can in turn lead to a decrease, rather than an increase, in healthcare demand. Second, by effectively and systematically enforcing - it is not always the case currently²⁴ - the new rules that will be taken in this respect. The additional financing that would result from these new orientations would on the one hand directly stimulate the demand of the poorest due to their

systematic application and on the other hand free up resources to improve the quality of care - including by a better drug supply and by expanding the scope of payment-for-performance schemes - particularly in hospitals located in low-density districts, as perceived quality is an important driver of healthcare demand.

- iii. *Acting on supply side drivers of efficiency.* A possible policy implication of our results could be considering closing inefficient district hospitals in low-density areas, thereby creating fiscal space to finance a reduction in user fees as well as measures to improve the quality of care in the remaining district hospitals without increasing the pressure on public finances. This would increase the average efficiency of district hospitals and consequently the average efficiency of the health care system while being budget neutral. Given Zimbabwe's resource constraints, this approach could make sense, but only if (a) there is an alternative supply of health care in the private sector in terms of average proximity and quality, (b) a scheme is put in place that allows the poor to access it under terms that are at least similar (including for opportunity costs) to those that prevailed before for attending the closed district hospitals, and (c) the net cost of this new approach is less than the cost of continuing running the former. If this is not the case for points (a) and (b), the closure of district hospitals in low-density areas would create a redistribution effect benefiting households living near hospitals whose resources would increase following the reallocation but penalizing those living in areas where hospitals have been closed. If it is not the case for point (c), the efficiency gain for the health system will be less than expected. Assessing the relevance of this approach would require in-depth investigations, especially since our results do not show a significant correlation between population density and poverty at the district level. We cannot address these issues within the scope of this paper with the available data but we encourage future studies to investigate them, possibly by assessing the efficiency of the health sector as a whole (i.e., including all levels of care and public as well as private providers) at the district level.

Our findings suggest that there is no close relationship between medical staff endowments in relation to population and technical efficiency of DHs. In a context as Zimbabwe, very constrained by insufficient financial and human resources, this suggests two broad policy-oriented recommendations. *First of all*, the criteria for assigning staff to district hospitals should be reconsidered, with of course, realism and a sound knowledge of the complexity of local situations. Four additional arguments reinforce this recommendation: (a) the allocation of resources is not linked to districts' epidemiological profile and disease burden; (b) the distribution of health staff is skewed and concentrated in less poor areas²⁰; (c) the MoHCC considers that the sector faces a critical shortage of staff, not only of health workers but also of technicians for equipment maintenance; (d) most of the government health expenditure is spent on the wage bill. *Second*, the lack of a tight relationship between the health workforce and the efficiency of DHs calls for making the most of the staff in place. Three hot issues need to be considered by DH managers: addressing unauthorized absenteeism without complacency; making maximum use of task-shifting; and systematically exploring the possibilities of expanding the scope of implementing incentives linking staff remuneration to output and quality of care outcomes, with a specific focus on remote areas. The existing payment-for-performance program for maternal and child health in rural health centers is a solid foundation to build on the third issue. These orientations are also likely to foster the necessary increase in demand for care as we have seen above.

- iv. *Improving the quality of routinely collected data.* Our analysis has shown the pressing need to improve the quality of the data routinely collected by the MoHCC. The preparation of the data

files for this study highlighted that the data collection process by the District Health Information Software 2 (DHIS2) was not adequately controlled and monitored in Zimbabwe. The data collection involved a lot of cross checks with the MoHCC's statistics department, and 6 hospitals out of 44 could not be included in the analysis due to fragmented or aberrant data for inputs and outputs. This issue was thoroughly discussed with the MoHCC which is tackling it. Reliable data are critical for informing decision-makers, managing and evaluating health policy. Zimbabwe's situation in this field is not atypical²⁵.

- v. *Conducting in-depth analysis of a limited selection of "good" and "poor" performing DHs and complementing the quantitative analyses by taking into consideration quality indicators will be useful to fine-tune the analysis.*

The findings of the study are robust and provide useful insights for policymakers. However, as noted, statistical availability constraints limited the thoroughness of the analyses, more for potential efficiency drivers than for efficiency scores. Regarding exogenous (or environmental) drivers, other health or socioeconomic characteristics of the population living in the catchment area of the district hospitals might impact their efficiency; as for example, the share of urban/rural population and health profiles indicators such as the prevalence of HIV or infant/under five/maternal mortality rates, the remoteness of the DH, etc. Regarding endogenous variables, DHs' efficiency might also be affected by the characteristics of their financing (share of resources from government, donors and user fees) or by their inclusion into a results-based financing program. The inclusion of such endogenous and exogenous variables would help refine the findings of the analysis.

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Appendices

Appendix A: descriptive statistics of inputs, outputs and explanatory variables

Variable	Observations	Mean	Standard deviation	Coefficient of variation	Minimum	Maximum
Doctors	75	8.05	2.25	0.28	2.33	18
Nurses	75	166.65	51.78	0.31	72.83	336.2
Beds	75	113.18	48.61	0.43	30	257
Inpatients*	75	366.49	172.12	0.47	53	853.27
Outpatients*	75	2893.49	1558.11	0.54	717.22	7053.67
Operations*	75	58.57	57.07	0.97	2.89	291.22
Population density	75	57.67	95.97	1.66	9.45	510.45
Dependency ratio†	75	96.87	12.08	0.12	72.44	123.87
Poverty gap index	75	34.88	9.49	0.27	13.8	60.4
Access to electricity (%)	75	21.35	12.58	0.59	3.9	48.72

*Monthly means over a given year

† The dependency ratio is an age-population ratio of those typically not in the labor force (the dependent part - ages 0 to 14 and 65+) and those typically in the labor force (the productive part - ages 15 to 64)

Table A1: descriptive statistics of inputs, outputs and explanatory variables

Appendix B: robustness analyses of efficiency scores using different inputs and/or outputs

	Model 1	Model 2	Model 3	Model 4
Inputs				
Nurses	X		X	
Doctors	X	X	X	X
Beds	X	X	X	X
Outputs				
Inpatients	X	X	X	X
Outpatients	X	X	X	X
Operations	X	X		

Table B1: inputs and outputs used in alternative models

	Mean	Std. Dev.	Min	Max
Model 1	0.6945	0.1558	0.3695	0.9856
Model 2	0.6717	0.1682	0.3102	0.9802
Model 3	0.6541	0.1481	0.3621	0.9846
Model 4	0.6332	0.1623	0.2993	0.9803

Table B2: efficiency scores of the four alternative models

	Model 1	Model 2	Model 3	Model 4
Model 1	1.0000			
Model 2	0.9538***	1.0000		
Model 3	0.9336***	0.8851***	1.0000	
Model 4	0.8846***	0.9315***	0.9356***	1.0000

* p<0.10, ** p<0.05, *** p<0.01

Table B3: Spearman rank correlations between the efficiency scores of the four alternative models

Appendix C: relationships between population density, dependency ratio, poverty gap index and the efficiency scores at the DH level

To produce this graph, we averaged the values of the efficiency scores and explanatory variables of the 31 district hospitals over the three years. Only 30 out of the 31 DHs with available data are pictured since one observation with very high population density (> 500) which distorted the first figure was excluded from the analysis.

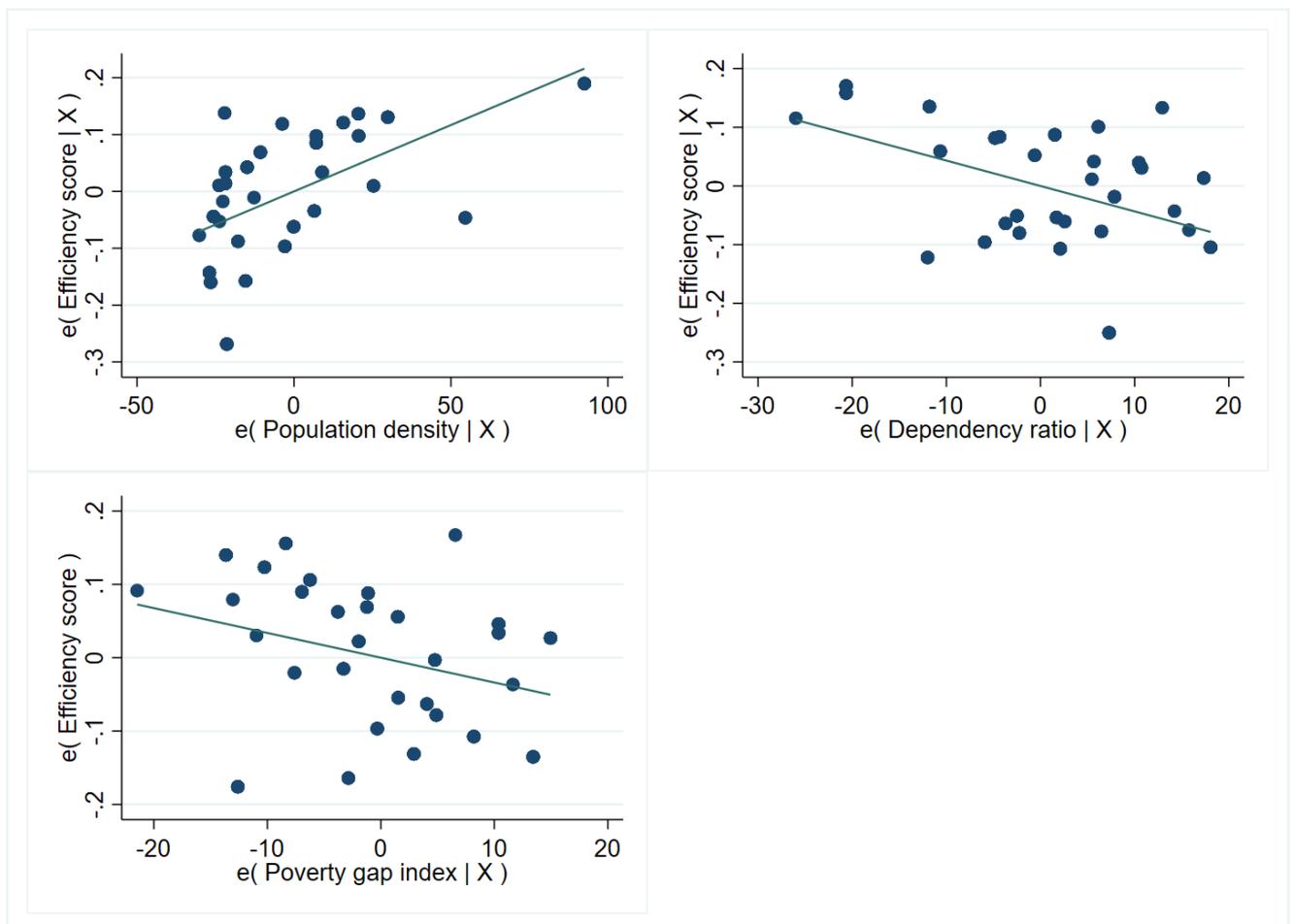


Figure C1: added-variable scatter plots