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The opportunity cost of household transport expenditure in South Africa

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Background: Transport affordability is a significant concern for South African households, who spend nearly a fifth of their budgets on transport. Contributing factors include a lack of affordable public transport options and spatial mismatch. Since 2015, stagnating national budgets and a declining share allocated to the transport portfolio have exacerbated household transport expenses, limiting economic mobility.

Objectives: This article examines how changes in household transport expenses impact other essential expenses such as food, housing, clothing, recreation and education. Understanding these expenditure trade-offs provides insights for policy, especially as the National Public Transport Subsidy Policy is being prepared.

Method: Using data from the Living Conditions Survey of 2014/2015, the study applies fractional logit regression models to estimate the impact of varying household transport expenses on other expenditure categories across diverse household demographics.

Results: Findings indicate that increased household transport expenses significantly reduces allocations to essential items, notably food and housing, with the effects varying by income level, settlement type, and household composition.

Conclusion: A core recommendation is to reduce transport expenses for low-income households through government intervention as this will increase these, mostly previously disadvantaged households', economic mobility.

Contribution: Results show that if low-income households allocate no more than 10% of their expenditure budgets to transport, they could potentially increase their expenditure share on food (+1.30%) housing (+1.18%) clothing (+0.86%) recreation (+0.31%) and education (+0.08%).

Keywords: transport expenditure; household expenditure; transport subsidisation; transport justice; mobility inequality; transport poverty.

Introduction

Passenger transportation can be a key enabler of economic activity. The extent to which it enables is highly dependent on the quality, efficiency and affordability of the transport system (United Nations 2022). The affordability of transport for South Africans is questionable. South African households spend about 16% of their expenditure budget on transport. This relatively high percentage is attributable to the absence of an adequate (rail) public transport system, the concentration of employment in urban centres, mostly low-density housing and the remnants of pre-democracy spatial planning policies (Lucas 2011). Furthermore, since around 2015, the national budget has not been increasing in real terms and the transport budget has been in relative decline (NDoT 2023). These contributing factors are manifested in exorbitant household transport expenditure (TE), which impedes economic activity. The 2021 White Paper on National Transport Policy states 'the cost of transport should represent a reasonable and declining percentage of disposable income' (NDoT 2022).

Since 1995, household TE has increased both relatively and absolutely (Sutherland & Kerr 2021). The objective to limit household expenditure on transport to 10% is stated in multiple policy documents produced by the South African government. For example, the second draft of the forthcoming National Public Transport Subsidy Policy includes the following benchmark: 'Limit expenditure on transport to 10% of income per person with income' (NDoT 2023). Based on available academic research, it is unclear how South Africans will distribute a saving in their expenditure budget if their expenditure on transport is reduced to 10%. Understanding this and the trade-offs that households make in response to increased TE provides justification for the

South African government to intervene by increasing its transport budget to fund initiatives aimed at reducing the cost of transport for South Africans.

The purpose of this article is to explore the potential impact of increased and decreased household TE on other household expenditures in South Africa. The remainder of this article is divided into six sections. The next section provides a review of relevant existing literature. An outline of available and forthcoming (transport) expenditure datasets in South Africa is provided. Thereafter, the research methodology is discussed. The results section is divided into two sections. Firstly, the expenditure profile of South African households. Secondly, fractional regression results show the impact of increased or decreased TE on other household expenditure categories. Recommendations, especially with regard to policy, are suggested in the final section.

Review of existing literature

Household TE: International and national evidence

Globally, household TE generally fluctuates between 10% and 15% of total household expenditure (Rodrigue 2024). South African households spend about 16% of total household expenditure on transport (StatsSA 2017). Compared to other countries, this is relatively high. Gandelman, Serebrisky and Suárez-Alemán (2018) explored TE as a share of total household expenditure in Organisation for Economic Co-operation and Development (OECD) countries between 2008 and 2015. They found that, of the 38 OECD countries investigated, South Africa and Mexico are ranked in the first and second positions. Both countries experienced a steady year-on-year increase in TE as a share of total household expenditure. Conversely, many developed countries experienced stable levels. Sutherland and Kerr (2021) used five nationally representative surveys depicting South African household expenditure patterns between 1995 and 2015. They found that transport is the only expenditure category of 13 main expenditure categories that experienced a continual increase in its share of total household expenditure over time.

In South Africa, household TE is rising both absolutely and relatively to total expenditure. In 1995, 11% of households spent more than 10% of their budget on transport (Sutherland & Kerr 2021). Two decades later, in 2015, 45% of households spent more than 10% of their budget on transport. Poor South African households spend a smaller share of their budget on transport compared to wealthy households[1] (StatsSA 2012, 2017), with modal choice as a contributing factor (Venter 2011). However, TE as a share of total expenditure has been growing at a faster rate for poor households compared to wealthy households in South Africa. A decade into democracy, poor households' transport budget share grew +3.4% in the 10-year period from 2005 to 2015, compared to nearly no change (+0.1%) for wealthy households (Sutherland & Kerr 2021). High TE is of particular concern for poor households in developing regions (Gwilliam 2002). It compromises poor households' ability to access livelihood-enhancing opportunities and needed services that can improve living conditions.

1.The 2018–2023 Comprehensive Integrated Transport Plan (CITP) of the City of Cape Town states that its lowest income quintile households spend 43% of their income to commute to work by public transport. However, the 2023–2028 CITP insinuates that this statistic is questionable.

The impact of TE on other expenditure categories

What trade-offs do poor and wealthy households make in response to a budget share increase in TE? Two studies provide insight into the aforementioned question although in North American context and they do not differentiate by income group. Ferdous et al. (2010) predicted the trade-offs that US households make in response to increased household TE in the form of doubling fuel prices. Anowar, Eluru and Miranda-Moreno (2018) conducted a similar study but considered Canadian households. Both deployed a multiple discrete continuous extreme value (MDCEV) model informed by cross-sectional data from household expenditure surveys with a sample size of about 20 000 households.

Significant differences in trade-offs between US and Canadian households were observed. In the case of US households, Ferdous et al. (2010) predicted that a 2.96% budget share increase in fuel expenditure will primarily be funded by a budget share reduction in savings of –0.79% (short term – ST) and –0.52% (long term – LT). Other largely affected expenditure categories are food, housing and vehicle purchases totalling to a budget share reduction of –1.11% (ST) and –1.27% (LT). In contrast, the least affected expenditure categories in the US were predicted to be public transport, education and personal care totalling to a budget share reduction of only –0.08% (ST) and –0.05% (LT). In the case of Canadian households, Anowar et al. predicted that a 4.92% (ST) and 3.78% (LT) budget share increase in fuel expenditure will primarily be funded through a modal shift from private and public transport to non-motorised transport together with a relatively substantial reduction in alcohol and tobacco consumption. Consequently, if Canadian policy attempted to double the Canadian fuel price in an effort to encourage a healthier population, the model's results suggest that this policy attempt would be successful.

Noticeable from both studies is the assumed failed policy attempt to promote modal shift from private to public transport by increasing the price of fuel. This is because Ferdous et al. and Anowar et al. predicted that the percentage expenditure spent on public transport either remains somewhat constant (Ferdous et al. 2010) or decreases (Anowar et al. 2018). Ferdous' prediction is supported because public transport ridership grew a mere 4% year-on-year following the highest nationwide average fuel price recorded in 2008 (Dawson 2009). Ferdous attributes the limited impact on

public transport ridership to the inelasticity of vehicle travel to fuel prices. In fact, between 2007 and 2008 fuel prices in the US increased by about 20% while vehicle miles travelled reduced by only 2% (FHWA 2008). Aside from price inelasticity as a contributor, the failed modal shift attempt could also be attributed to increased ticket fares of public transport as public transport operators typically transfer increased operating (fuel) cost onto passengers.

In summary, empirical evidence suggests that US households would make a range of long-term adjustments across various expenditure categories to accommodate increased fuel prices to maintain a mostly steady level of private transport travel. In contrast, Canadian households would primarily make long-term adjustments on motorised transport, specifically vehicle purchases. Consequently, existing literature suggests that country-specific factors impact the trade-offs that households make in response to a budget share increase in TE.

The impact of TE on mutually exclusive expenditure categories

While a discrete choice model such as the MDCEV model determines the impact of changed TE on other expenditures simultaneously, regression and elasticity analysis measure the impact of changed TE on mutually exclusive expenditure categories (one category at a time). Gicheva, Hasting and Villas-Boas (2007) used ordinary least square (OLS) regression to study the impact of increased TE, measured by fuel prices, on food expenditure. Specific to households in California (US), they found that households adjust food consumption patterns to compensate for a 100% increase in fuel prices instead of lowering fuel expenditure. This suggests an inelastic nature of fuel consumption (travel behaviour), similar to Ferdous' finding of the inelastic nature of vehicle travel to fuel prices also in the US. In contrast, Gandelman, Serebrisky and Suárez-Alemán (2019) estimated the expenditure elasticity of fuel in Latin America at 2.6. This high value suggests that Latin American households will likely lower their fuel expenditure following a 100% increase in fuel prices. As the expenditure elasticity of private transport in South Africa is 2.1 (Sutherland & Kerr 2021), it can be argued that South African households too will likely lower their fuel expenditure following a 100% increase in fuel prices. However, country-specific factors such as concerns over safety and infrastructure availability and quality of private transport alternatives (non-motorised and public transport) suggest a reluctance to make a modal shift.

In conclusion, the direction of the relationship between TE and other household expenditures seems to be inverse. The literature indicates that households trade off increased TE by reducing expenditure on other expenditure categories when income is held constant. The type of categories and the extent to which each is reduced depend on country-specific factors and expenditure elasticities. The remainder of this article identifies the trade-offs that South African households would potentially make in response to changed TE. The next section explains the datasets and methodology to do so.

Data and methodology

Data

Publicly available data on household expenditure at national scale is scarce in South Africa. In the US, consumer expenditure surveys (CES) are conducted annually. Whereas in South Africa, data on household expenditure are collected infrequently through various surveys, each with different objectives. Table 1 provides a summary of some publicly available and forthcoming datasets that contain South African household TE data at national scale, representative of 2015 onwards.

The most comprehensive and recent dataset concerning household expenditure at national scale in South Africa, at the time of writing, is the Living Conditions Survey 2014/2015 (LCS 2015). This second of two LCSs was conducted between 13 October 2014 and 25 October 2015. The main aim of this survey was to provide data that will contribute to a better understanding of living conditions and poverty in South Africa. Data were collected from 27 527 households across the country although the dataset contains entries from 23 380 unique household identification numbers. The survey primarily used the diary method but supplemented it using the recall method. Households were asked to record their daily expenses in diaries provided by Stats SA for a single week. The dataset contains annualised adjusted (for inflation) and weighted values to reflect household expenditure of the typical South African household in 2015.

This article employs the LCS 2015 dataset. Table 2 shows descriptions of each main expenditure group selected for the purpose of this article. The dependent variable in this article is the share of total expenditure devoted to the expenditure categories of food, housing, clothing, recreation and education. This share (percentage) was derived from the LCS 2015 dataset. This was calculated by dividing household expenditure on an expenditure category by total household expenditure (in South African Rands). The explanatory variables in this article were guided by empirical literature and multicollinearity testing. These include settlement type (metro, urban, rural) and household characteristics. Household characteristics included income group (lowest, middle, highest based on LCS 2015 income quintiles), motorised vehicle access (ownership, access only, no ownership or access), household size (less than and more than the mean), head of household age (less than and more than the mean), head of household gender (male and female) and head of household race (black people, Colored, Asian people and white people).

In addition to the LCS 2015 dataset, the datasets of the 2020 National Household Travel Survey (NHTS) and the 2022 General Household Survey (GHS) were used to showcase the evolution of household TE between 2015 and 2022. Methodological differences are evident among

TABLE 1: Available and forthcoming household expenditure datasets since 2015 in South Africa.[2]

Dataset name	Producer	Sample size	Lowest geographic aggregation	Major limitations
Living Conditions Survey (LCS) 2014/2015	Stats SA	23 380 households	Provincial	Weekly expenditure diary data were annualised
National Income Dynamics Study (NIDS) 2008–2017 (wave 5)	Southern Africa Labour and Development Research Unit (SALDRU)	Up to 7300 households	Provincial	Relatively small sample size
National Household Travel Survey (NHTS) 2020	Stats SA	42 138 households	Transport Analysis Zone	Expenditure data categorical and limited to public transport and vehicle cost to work
Geneal Household Survey (GHS) 2022	Stats SA	19 351 households	Provincial	Expenditure data categorical and limited to public transport
Income Expenditure Survey (IES) 2022/2023	Stats SA	32 000 households (envisaged)	Provincial	This dataset has not yet been released at the time of writing

Stats SA, Statistics South Africa.

TABLE 2: Description of main expenditure groups for this study.

Expenditure category	Description
Transport	Purchase, operating costs and fares paid inclusive of all modes of public and private transport.[3]
Food	Grocery and other food items and non-alcoholic beverages.
Housing	Rental and bond payments, water, electricity, gas and other fuels used as energy sources for the house as well as irregular maintenance related to the house.
Clothing	Clothing and footwear including the purchase, hire, cleaning and repair thereof.
Recreation	Equipment and stationery used for recreational purposes including books, toys and instruments as well as costs related to pets, cultural services and holidays.
Education	Pre-primary, primary, secondary, tertiary education expenses and other education expenses not definable by level.

these three surveys. The NHTS and GHS used the recall method and captured expenditure data as categorical data. On the contrary, the LCS used the diary method only supplementing with the recall method and captured expenditure data as continuous data. Furthermore, the Income Expenditure Survey 2022/2023 (IES) would have been preferred over the LCS 2015 because of more recent data from a larger sample. However, the envisaged release date of the IES 2023 dataset is after the time of writing. In the absence of time series data from annually repeated expenditure surveys (such as the CES in the US), these limitations are accepted.

Research methods and design

The purpose of this article is to explore the potential impact of increased and decreased household TE on other household expenditures in South Africa. Different types of statistical analysis can be employed in this regard. Techniques, as outlined in section 'The impact of TE on other expenditure categories' and 'The impact of TE on other expenditure categories', include the MDCEV model, regression analysis and expenditure elasticity analysis. Consideration of the advantages, disadvantages and data requirement of each technique led to the decision to use regression analysis, specifically fractional regression. This decision is mainly based on the fractional nature of the data used to inform the model. Data derived from the LCS 2015 dataset include values between zero and one, representative of the proportion of households' budget allocated to expenses.

Fractional regression has attractive qualities in comparison to other methods for modelling proportions. This is because of its ability to constrain predictions within the bounds of zero and one and because it does not require special procedures for handling cases that take endpoint values (Crowell & Fossett 2018). Linear regressions such as OLS do not guarantee that the predictions will remain within the bounds and are inappropriate for handling the error distribution and zero values (Kieschnick & Mccullough 2003). The fractional regression model is fit by the method of quasi-maximum likelihood from the family of generalised linear models. Papke and Woolridge (1996) introduced fractional regression and quasi-maximum likelihood estimation for applications in economics. Fractional regression predicts the mean of the dependent variable y conditional on covariates x (i.e. μx). Because y is in the range of zero to one, it is necessary to ensure that predictions of the mean (μx) fall in this range. Instead of interpreting the coefficients of the model, marginal effects (dydx) are interpreted in this article to show the effect of a change in one of the explanatory variables (transport) on the expected conditional mean of five expenditure categories' budget share, that is food, housing, clothing, recreation and education. Fractional regression results were estimated in this article using the fracreg command in Stata.

The next section presents the results of the analysis. Firstly, the expenditure profile of South African households per income group and settlement type. Secondly, fractional regression results show the impact of increased and decreased TE on other expenditure categories per settlement type and household characteristics.

Ethical considerations

This article followed all ethical standards for research without direct contact with human or animal subjects.

2.The questionnaire of Census 2022 does not contain questions pertaining to TE.

3.TE consists of the following specific expenses, as stated in the LCS 2015 report: Purchases of vehicles including motor cars, motorcycles and bicycles; operation of personal transport equipment including spare parts and accessories, fuels and lubricants, maintenance and repairs; transport services including passenger transport by railway, road, air, sea and inland waterway and other purchased transport services.

Results

Household expenditure profile of South Africans

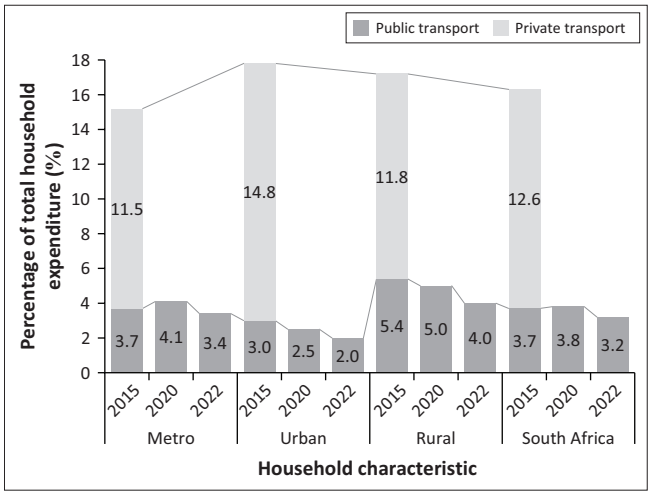
Descriptive analysis (Figure 1) shows that on average, South African households allocate a relatively large share of total household expenditure (16%) to transport. Households from the highest income quintile (earning more than R15 518 per month) allocate a larger proportion of their budget to transport than the middle and the lowest income households. This finding is verified by Sutherland and Kerr (2021) and is likely justified by a preference of high-income households for private vehicles as confirmed by Venter (2011). Households from the lowest income quintile (earning less than R 1690 per month) allocate a larger portion of their budget to survival, that is food, while spending relatively less on housing because of the assumed use of informal dwellings. Households in metros allocate a smaller portion of their budget to transport. This is likely explained by the greater availability of public transport in metros (bus rapid transport, rail and minibus taxis). Instead, metro households allocate a larger portion of their budget to housing because the cost of property is more expensive per equivalent unit in metros compared to urban and rural areas.

Evolution of the household expenditure profile of South Africans

From 2015 to 2020, total household expenditure increased by 12% (R 8608 to R 9642 per month) and by 11% from 2020 to 2022 (R 9642 to R 10 682 per month). However, analysis at the settlement type level reveals that total household expenditure in metros decreased by 19% between 2020 and 2022. This is likely attributed to the greater impact of the coronavirus (COVID-19) pandemic in metros compared to urban and rural areas.

Figure 2 shows that South African households allocated a relatively large share of total household expenditure (12.6%) to private transport in 2015 despite public transport being the main mode of transport for most households. Private transport budget allocation in 2015 was the highest in urban areas (14.8% or R 1606 per month) but similar in metros (11.5%) and rural areas (11.8%). However, in absolute terms, households in metros spent more on private transport than rural areas (R 1311 vs. R 497 per month). While households allocated 3.7% (R 320) of their budget to public transport in 2015, and similarly 3.8% (R 364) in the first quarter of 2020 (before the pandemic-induced lockdown), by 2022 public transport budget share allocation decreased to 3.2% (R 343).

This overall trend of an increase followed by a decrease in household budget allocation to public transport is observed in metros (3.7% to 4.1% to 3.4%). In absolute terms, households in metros spent R416 per month on public transport in 2015. This value increased to R 704 in 2020 and decreased to R466 by 2022. The substantial deterioration of passenger rail in metros since 2019 might have contributed to this as passengers opt for minibus taxis, which are more expensive although



TE, Transport Expenditure.

FIGURE 2: Evolution of the household TE profile in South Africa per settlement type between 2015 and 2022.

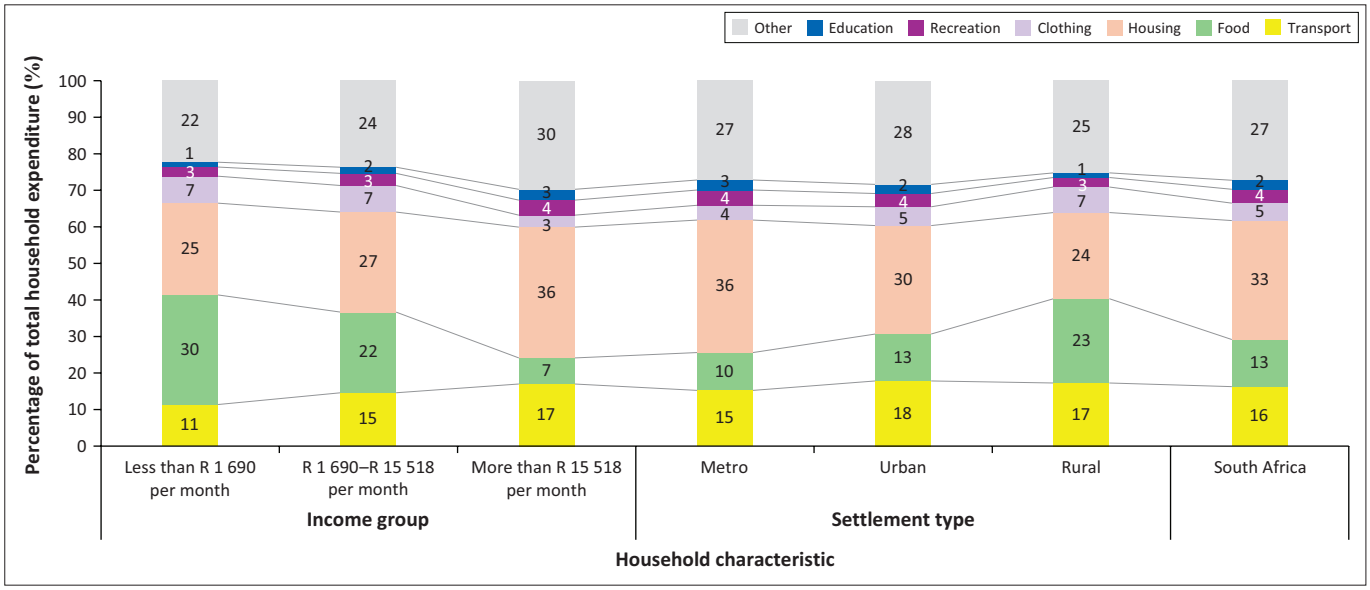


FIGURE 1: Household expenditure allocation in 2015 per income group and settlement type.

more reliable than rail. In 2022, rail transport completed nearly 500 million less passengers journeys compared to 2015 (StatsSA 2016, 2023). A continuous decrease in household budget allocation to public transport is observed between 2015 and 2022 in urban areas (3.0% to 2.5% to 2.0%) and in rural areas (5.4% to 5.0% to 4.0%). Likely contributable to the decrease in public TE between 2020 and 2022 is the work-from-home tendency encouraged since the pandemic.

Expenditure data in the NHTS and GHS datasets are limited to overall monthly household expenditure, public TE and vehicle cost to work in the case of the NHTS. Consequently, it is not possible to indicate whether households experienced an increase in their budget share allocation to overall transport (i.e. public and private transport) from 2015 to 2022. What can be derived from the data is that on average, households increased their budget share allocation to public transport from 2015 to 2020. This finding would then be relatively in line with the finding of Sutherland and Kerr (2021) in that South African households continuously increased their budget share allocation to transport over time.

The impact of TE on mutually exclusive expenditure categories in South Africa

Table 3 presents the average marginal effects of the fractional model estimations showcasing the impact of a +1% increase in household budget share allocation to transport. Settlement type, income group and other household characteristics are treated as exogenous. The results show that a +1% increase in household budget share allocation to transport has a negative and statistically significant effect on the share of household expenditure on food, housing, clothing, recreation and education (in this order). This order is similar to the findings of Ferdous et al. (2010) who found that an increase in transport (fuel) expenditure in the US affects housing, food, recreation, clothing followed by education (in this order). Anowar et al. (2018) also found in the Canadian context that of these five expenditure categories, housing followed by food, are affected the most although clothing, recreation and education are similarly affected.

In terms of *food*, a +1% increase in the TE budget share is associated with a 0.88% decrease in the budget share allocated to food for the average South African household, holding other expenditures constant ($r^2 = 0.14$, $p < 0.000$). When considering settlement types, income groups and household characteristics, a 1% increase in the TE budget share will have the greatest impact (0.95% to 0.91% decrease) on households from the lowest income group, consisting of more than four people, who reside in rural areas that do not own or have access to a motorised vehicle. The least impacted (0.65% to 0.72% decrease) are households from the highest income group who owns a motorised vehicle and are white people or Asian people.

In terms of *housing*, a 1% increase in the TE budget share is associated with a 0.86% decrease in housing budget share

TABLE 3: Average marginal effects of fractional model estimations of a +1% increase in household budget share allocation to transport.

Household characteristic	Observations	Food	Housing	Clothing	Recreation	Education
South Africa	23 880	-0.8783	-0.8604	-0.6307	-0.3652	-0.1433
Settlement type						
Metro	6114	-0.8100	-0.9100	-0.5729	-0.3961	-0.2037
Urban	8111	-0.8807	-0.8750	-0.6456	-0.4111	-0.1607
Rural	9155	-0.9470	-0.8201	-0.6595	-0.3039	-0.0869
Income group						
Lowest	4802	-0.9432	-0.8532	-0.6208	-0.2244	-0.0559
Middle	14 767	-0.9057	-0.8479	-0.6672	-0.3799	-0.1230
Highest	3811	-0.6767	-0.9245	-0.5054	-0.4865	-0.3415
Motorised vehicle						
Owns	5538	-0.7199	-0.9145	-0.5563	-0.5250	-0.2970
Do not own, but have access	1568	-0.8879	-0.8646	-0.5996	-0.3723	-0.1493
No	16 119	-0.9103	-0.8354	-0.6693	-0.3235	-0.0978
Household size						
1–4 people	15 789	-0.8588	-0.8772	-0.5877	-0.3528	-0.1245
More than 4 people	7591	-0.9143	-0.8304	-0.7105	-0.3986	-0.1774
Age: Head of household						
18–50 years of age	12 740	-0.8791	-0.8569	-0.6600	-0.3694	-0.1597
More than 50 years of age	10 640	-0.8785	-0.8651	-0.5954	-0.3643	-0.1230
Gender: Head of household						
Male	12 919	-0.8536	-0.8650	-0.6074	-0.3789	-0.1523
Female	10 461	-0.8960	-0.8520	-0.6553	-0.3537	-0.1329
Race: Head of household						
Black people	18 995	-0.9029	-0.8432	-0.6613	-0.3357	-0.1266
Colored people	2490	-0.8820	-0.9109	-0.5897	-0.4600	-0.1910
Asian people	442	-0.7088	-0.9864	-0.5383	-0.4600	-0.2587
White people	1453	-0.6519	-0.9847	-0.4085	-0.5198	-0.2915

Note: All marginal effects are statistically significant at $p < 0.0000$.

for the average South African household, holding other expenditures constant ($r^2 = 0.14$, $p < 0.000$). A 1% increase in the TE budget share will have the greatest impact (0.99% to 0.91% decrease) on white, Asian and Colored households from the highest income group who reside in metros. The least impacted (0.82% to 0.84% decrease) are households consisting of more than four people who reside in rural areas that do not own or have access to a motorised vehicle.

In terms of *clothing*, a 1% increase in the TE budget share is associated with a 0.63% decrease in the clothing budget share for the average South African household, holding other expenditures constant ($r^2 = 0.11$, $p < 0.000$). A 1% increase in the TE budget share will have the greatest impact (0.71% to 0.66% decrease) on black and female-headed households from the middle-income group, consisting of more than four people, who reside in rural areas who do not own or have access to a motorised vehicle. The least impacted are white households (0.41% decrease) and Asian households (0.50% decrease).

In terms of *recreation*, a 1% increase in the TE budget share is associated with a 0.37% decrease in the recreation budget share for the average South African household, holding other expenditures constant ($r^2 = 0.15$, $p < 0.000$). A 1% increase in the TE budget share will have the greatest impact (0.53% to 0.49% decrease) on white households in the highest income group who owns a motorised vehicle. The least impacted (0.22% to 0.34% decrease) are black households in the lowest income group who reside in rural areas and do not own or have access to a motorised vehicle.

In terms of *education*, a 1% increase in the TE budget share is associated with only a 0.14% decrease in the education budget share for the average South African household, holding other expenditures constant ($r^2 = 0.27$, $p < 0.000$). A 1% increase in the TE budget share will have the greatest impact (0.34% to 0.29% decrease) on white households in the highest income group who owns a motorised vehicle. The least impacted (0.06% to 0.10% decrease) are households in the lowest income group who reside in rural areas and do not own or have access to a motorised vehicle.

Overall, the severity of those affected the most and the least by a +1% increase in TE is similar for the expenditure categories of recreation and education. The inverse is observed when comparing the results of food and housing. The impact on clothing seems to be based on cultural views on clothing because different racial groups are impacted differently.

Transport is the only household expenditure category in South Africa that experiences a continual increase in its share of total household expenditure over time (Sutherland & Kerr 2021). Table 4 shows that if this trend continues, in which transport as a share of total expenditure increases from its current 16.3% to 20%, the impact on other expenditures is negative. Table 4 presents the extrapolated results of the fractional regression model estimations showcasing the impact on five expenditure categories if TE increased to 20% and decreased to 10%. Settlement types and income groups are treated as exogenous.

The results show that an increase in the share of households' expenditure budget on transport (TE) to 20% would result in a reduction in the share that households spend on food by 3.26% (from 12.87% to 9.61%). Housing expenditure budget share would reduce by 3.19% (from 32.55% to 29.36%). The third largest impact would be on clothing, which would reduce by 2.34% (from 4.78% to 2.44%). Then, recreation would reduce by 1.36% (from 3.81% to 2.45%). Lastly, education would reduce by 0.53% (from 2.45% to 1.92%). In terms of settlement type, metro households' expenditure on food, housing, clothing, recreation and education would be more negatively affected if their TE increased to 20%, compared to urban and rural households. In terms of income groups, expenditure on the essentials (food, housing, clothing) of low-income households would be more affected than middle and high-income households if low-income households' TE increased to 20%. Expenditure on recreation of middle-income households would be more affected than low and high-income households. The highest income groups' expenditure on education would be most affected compared to the other income groups if transport represented 20% of their budget.

Discussion

Empirical results indicate that decreased TE has a positive impact on the share of total household expenditure allocated to food, housing, clothing and to a lesser extent, recreation and education. Strategies to reduce household TE may include a modal shift from private to public and non-motorised transport or subsidies either paid directly to specific households or to the public transport operator with the intention that these operators reduce their public transport fares.

What is the optimal share of household TE relative to all household expenditures? Some have argued 0%. In other words, free transport or at least free public transport. The latter has been piloted in a few countries and cities. In February 2020, Luxembourg became the first country to offer free public transport on all public transport modes to all people, followed by Malta in October 2022 (Luxembourg 2023; Malta, 2022). In October 2021, the Los Angeles County Metropolitan Transportation Authority (LA Metro) launched a free public transport pilot specifically for school learners. The impact on student ridership was a 200% increase over the 18-month pilot period (Wiggins 2023). Other cities such as Bogotá (Columbia), Chengdu (China) and Vienna (Austria) have piloted either highly subsidised or free public transport for low-income earners. However, income verification processes have been reported as an administrative burden and a barrier to entry (Guzman & Hessel 2022). Although free formalised public transport for all is associated with a low administrative burden, it can attract the homeless. Other

TABLE 4: Extrapolated results of the fractional regression model showcasing the impact on five expenditure categories if TE increased to 20% and decreased to 10%.

Household expenditure	South Africa (%)	Settlement type			Income group		
		Metro (%)	Urban (%)	Rural (%)	Lowest (%)	Middle (%)	Highest (%)
Food							
Base	12.87	10.35	12.83	23.04	29.98	22.08	7.11
if TE = 20%	9.61	6.50	10.92	20.46	21.86	17.18	5.09
if TE = 10%	18.39	14.59	19.73	29.93	31.29	26.24	11.86
Housing							
Base	32.55	36.27	29.70	23.60	25.12	27.39	35.80
if TE = 20%	29.36	31.94	27.80	21.37	17.77	22.81	33.04
if TE = 10%	37.96	41.04	36.55	29.57	26.30	31.29	42.28
Clothing							
Base	4.78	4.04	5.14	6.99	7.38	7.25	3.27
if TE = 20%	2.44	1.32	3.74	5.20	2.03	3.64	1.76
if TE = 10%	8.75	7.05	10.19	11.79	8.23	10.32	6.82
Recreation							
Base	3.81	4.20	3.64	2.60	2.51	3.33	4.11
if TE = 20%	2.45	2.31	2.75	1.77	0.57	1.27	2.66
if TE = 10%	6.10	6.27	6.86	4.81	2.82	5.07	7.52
Education							
Base	2.45	2.73	2.48	1.27	1.32	1.66	2.96
if TE = 20%	1.92	1.76	2.13	1.04	0.84	1.00	1.94
if TE = 10%	3.35	3.80	3.74	1.91	1.40	2.23	5.35

Note: Authors derived from the LCS 2015 dataset. Base refers to the household budget share allocated to the relevant expenditure category before intervention. TE represents transport expenditure household budget share.

disadvantages of a free-for-all public transport model include the difficulty of subsidising informal public transport. In this regard, a large number of minibus taxi associations and owners exists in South Africa. Considering the aforementioned and other unmentioned disadvantages of free public transport, the optimal share of household TE relative to all household expenditures is likely not 0% in South Africa. Instead, free or subsidised public transport for targeted recipients are arguably more beneficial.

If low-income households' TE reduced to 10% (in line with policy objectives), then the impact from most to least affected expenditure categories would be food, housing, clothing, recreation followed by education. Whereas if this subsidy was aimed at the highest-income households, then housing, instead of food, would be impacted the most of the five expenditure categories. The same trend is observed for rural versus metro households. Consequently, if more subsidised public transport (such as bus rapid transit or otherwise) is offered in metros, then households in metros would likely increase their budget share on housing the most of the five categories. The immediate expenditure multiplier effect of housing is less than that of food (agricultural sector), clothing (manufacturing sector) and recreation (service sector). Ferdous et al. (2010) states that less food consumption, clothing purchases and recreational activities suggest that rising TE can have substantial effects on the economy as people decrease their discretionary activity engagement and goods consumption. Therefore, if economic performance is the target, then it is advised that if transport is subsidised, that it is aimed at those whose food, clothing and recreation expenditure will be impacted the most.

Table 5 identifies those whose food, clothing and recreation expenditure will be impacted the most by a reduction in TE, as derived from Table 3 and Table 4. It shows that if the goal is to stimulate expenditure on food relative to other expenditures by reducing TE, then government should make rural households or lowest-income households the target of transport subsidies. If the goal is to stimulate expenditure on clothing, then government should target households consisting of more than four people. If the goal is recreation related, then the results show that government should target motor vehicle owners or white-headed households. However, the latter would be controversial given the South African background.

Some governments implement strategies to increase the cost of transport for private transport users for environmental reasons. Strategies include toll fees to enter a city's central business district, congestion pricing or increased fuel levies or parking fees. Table 3 indicates the potential impact of increased TE on households who own a motorised vehicle. Based on these results, increasing the cost of transport for these households in the form of fuel levies or a different method will impact their expenditure on housing and food the most, followed by clothing, recreation and education.

Recommendations

Determining the relationship between TE and the economy is especially important for policy design (Tüzemen & Lögün 2018). Many South African government policies[4] emphasise the need to address expensive TE. For example, the 2021 White Paper on National Transport Policy states that: 'Transport authorities must define public transport needs at affordable fare levels in order to identify and target recipients

4.National Land Transport Strategic Framework 2023, National Development Plan 2030 and the National Land Transport Act 2009 among other.

TABLE 5: Those whose food, clothing and recreation expenditure will be impacted the most by a reduction in transport expenditure.

Household characteristic	Food	Clothing	Recreation
Settlement type	Rural households	Rural households	Urban households
Income group	Lowest-income households	Middle-income households	Highest-income households
Motor vehicle ownership	No ownership or access to a motorised vehicle	No ownership or access to a motorised vehicle	Owns a motorised vehicle
Household size	More than four	More than four	More than four
Age: Head of household	Indifferent to younger or older than 50 years of age	Household headed by a younger than 50-year-old	Indifferent to younger or older than 50 years of age
Gender: Head of household	Female headed households	Female headed households	Male headed households
Race: Head of household	Black headed households	Black headed households	White headed households

Note: Authors derived from the LCS 2015 dataset.

of mobility support'. The results of this article can assist in determining such target recipients of mobility support. The recommended target recipients depend on which expenditure category government aims to stimulate. For example, if the goal is to stimulate expenditure on food relative to other expenditures by reducing TE, then government should make rural households or lowest-income households the target of transport subsidies. Whereas if the goal is to stimulate expenditure on clothing, then government should target households consisting of more than four people. Since low-income households have been increasing their TE budget share at a higher rate than high-income households (Sutherland & Kerr 2021), it is recommended to implement strategies aimed at lowering the TE budget share of low-income households. If the TE budget share of low-income households is capped at 10% of total expenditure, then this will impact, from most to least affected, food (+1.30%), housing (+1.18%), clothing (+0.86%), recreation (+0.31%) followed by education (+0.08%).

Future research is proposed to address the limitations of this article. Firstly, it is recommended that data derived from the IES 2023 instead of LCS 2015 be used to inform a MDCEV model since the IES 2023 contains more recent household expenditure data. It is recommended that the MDCEV model differentiates between private and public TE. Secondly, precaution should be taken before applying the findings stated in this article to different administrative levels. While data from a nationally representative survey were used to inform the fractional regression model, this article does not provide provincial or city specific analysis other than differentiating between metro, urban and rural areas. Precautionary measures include a comparison of the socio-economic characteristics of households in the LCS 2015 to that of the area under investigation. Before implementing the findings on the ground, guidance from government at the relevant administrative level would be needed regarding which household expenditure category government aims to stimulate.

Conclusion

As a starting point, this article established the (transport) expenditure profile of South Africans using three countrywide surveys. The results highlighted that TE was the second largest expenditure for South African households in 2015. It confirmed the finding made by Sutherland and Kerr (2021) that TE has been increasing consistently both in relative and absolute terms. The core of this article explored the potential impact of increased and decreased TE on other household expenditures in South Africa using cross-sectional data derived from the LCS of 2015.

Fractional regression modelling estimated the impact on food, housing, clothing, recreation and education expenditures if TE continued to increase. The results showed that the impact would be negative. The severity of this negative impact varies across settlement type, income groups and other household characteristics. Consequently, this article agrees with Ferdous et al. (2010) that expensive transport limits household expenditure on more 'productive' expenditures, which could have contributed more to the economy because of their higher multiplier effects. In fact, transport has more negative utility (pollution elements, opportunity cost of time) than other expenditures such as food, clothing and recreation. As a result, this article agrees with the Department of Cooperative Governance and Traditional Affairs (2016) statement that the ability to achieve the full economic and social benefits of transport is more attainable when transport systems are efficient and travel cost affordable.

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Competing interests

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Authors' contributions

M.K. contributed as the main author and wrote the article, S.K. supervised the research conducted by M.K.

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Data availability

The original dataset, from which data were derived, can be found on Statistics South Africa's website: http://nesstar.statssa.gov.za:8282/webview/.

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