Insights into the links between electricity access and household dynamics in South Africa between 2008 and 2012

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COMPULSORY DECLARATION

This work has not been previously submitted in whole, or in part, for the award of any degree. It is my own work. Each significant contribution to, and quotation in, this dissertation from the work, or works, of other people has been attributed, and has been cited and referenced.

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HOUSEHOLD ELECTRICITY ACCESS AND HOUSEHOLD DYNAMICS

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Abstract:

This paper investigates the details behind aggregate shifts in household electricity access in South Africa. More specifically, when viewed from a cross-sectional perspective, we note a significant (and surprising) decline in electricity access between 2008 and 2010, followed by a substantial improvement in access between 2010 and 2012. In order to further investigate these interesting dynamics and move beyond a limited cross-sectional analysis, we then set up the National Income Dynamics Study (NIDS) in a novel form that allows one to track household units in a longitudinal fashion. Using this data, we identify the initial drop in electricity access to have come as a result of a large number of household disconnections, as well as a significant degree of "misdirected" household formation (with people leaving household with access and setting up households in locations without access). We also identify the subsequent improvement in aggregate access to have come primarily as a result of a significant fall in the number of households that lose access over the period, an increase in the number of households that gain access, and favourable household formation processes (with people leaving households without access and moving into households with access). It is therefore vital that those involved in coordinating service delivery take into account that, if one's aim is to improve aggregate electricity access, preventing loss of access is just as important as expanding access. Policy makers should also take note of household formation and dissolution processes when considering service delivery expansion – to prevent government from needlessly chasing a moving target.

1. INTRODUCTION:

Despite significant progress in the last 20 years, public service delivery remains one of the largest development issues faced by post-apartheid South Africa. While the National Development Plan highlights housing, water, electricity and sanitation as vital components of a decent standard of living; there is a distinct inequality in access to these services, and where they are available, their quality is often sub-standard – especially for those living below (or just above) the poverty line (Department of the Presidency, 2012; Bhorat and van der Westhuizen, 2013). Given that many of these services (such as electricity) are delivered to household units, there is need for research that explores how household service access is changing - rather than simply considering changes in service access for individuals. Such research is necessary to ensure that efforts to improve service delivery are properly evaluated and appropriately directed.

One way to explore the dynamics of household electricity access (as one example of household-based service delivery) is to use multiple waves of cross-sectional data, and report average household access in each period. A comparison of these averages will offer a broad impression of how household electricity access has changed over the period of interest. Using this cross-sectional approach on the National Income Dynamic Study (a nationally representative sample of South African households), household electricity access is estimated to have dropped slightly between 2008 and 2010, and then improved substantially between 2010 and 2012. An analysis of the Statistics South Africa's General Household Surveys (GHS) between 2002 and 2013 reveals similar results: with household electricity access rising to an initial peak in 2008, before declining significantly between 2008 and 2010, and then recovering impressively again after this period of decline.[12] While these results are interesting, and potentially concerning for policy makers, it must be noted that this methodology is limited in its application, and is only useful in describing trends in service delivery at an aggregate level for household units.

There are in fact many different processes that can lead to such aggregate changes in service access; and the appropriate response to any such change will depend on the reasons behind it. A thorough analysis of service delivery should therefore be able to answer some more nuanced questions regarding the processes behind these aggregate shifts. For example, the cross-sectional approach

[1] Estimates of electricity access from the GHS were provided by Martin Wittenberg (personal communication, 2016).
[2] A graphical representation of the trends described can be found in Section 1 of the Appendix.

is unable to provide an indication of whether the decline in access is due to people leaving households with electricity and moving into houses without, or whether people are losing access where they are. As such, an approach that moves beyond the constraints of this cross-sectional technique is required if research of this nature is to be truly useful to those involved in coordinating service delivery. However, to disentangle aggregate service delivery trends in this way, one requires a longitudinal data set that tracks the same household units over time (i.e. a panel of households). This type of panel will allow one to investigate how electricity access has changed for the same household units over time (where these households remain intact), and to what extent government may in fact be chasing a moving target – i.e. whether household formation processes are working against efforts to expand service delivery.

When a household panel approach is used to assess service delivery in South Africa, it reveals an interesting and somewhat paradoxical image of the dynamics of electricity access – exposing details which could not be unveiled through a standard cross-sectional analysis. This image can be decomposed into three stylised facts. Firstly, even when many households gain access to electricity over a period, these positive transitions can be outweighed by a large number of household disconnections (i.e. households that lose access to electricity) – leading to a decline in aggregate electricity access (as occurred between 2008 and 2010). Secondly, household formation and dissolution can work against service delivery efforts (as occurred between 2008 and 2010) – when newly formed households demonstrate lower access rates than the dissolving units they 'replace'. Finally: improvements in household electricity access can come as a result of improvements in any one, or all, of the following three areas: an increase in connections, a decline in disconnections, or a favourable change in household formation and dissolution (with all of these factors contributing to the improvement in electricity access between 2010 and 2012).

Hence, a panel of households is clearly crucial to developing a proper understanding of service delivery dynamics in South Africa. However, as noted by Collinson and Wittenberg (2014), the problem with most social surveys is that they offer only a "snap shot" of where individuals are living within a given period, and fail to capture how people migrate, or "move between households and locations". Many researchers within the development sphere have noted the value of longitudinal studies that focus on individuals – as these studies are argued to provide powerful insights into how people transition in and out of poverty and deprivation (Woolard, Leibbrandt and Lee, 2006). In South Africa, this rationale led to the formation of the National Income Dynamic Study (NIDS), a nationally representative panel study which began in 2008, and is

currently set up so as to track a sample of individuals over time. Thus far, NIDS has only been used as a panel of individuals, and has not yet been set up as a panel of households (i.e. to track the household as the observational unit over time). In fact, no such nationally representative panel of households yet exists in South Africa.

The contribution of this paper is therefore threefold. Firstly, we transform the National Income Dynamics Study (originally an individual level panel study) to create the first nationally representative panel of South African households, for the period 2008 to 2012. Secondly, we provide an analysis of household formation and dissolution in South Africa, with the results indicating that net household formation was significantly higher between 2008 and 2010 than in the 2010-2012 period, and that this difference may have been due to repressed housing prices. Thirdly, we offer a panel analysis of one particular component of service delivery – namely, access to electricity – using the newly-constructed NIDS household panel. As part of this analysis, we present a new technique which allows us to decompose the change in aggregate electricity access and identify to what extent household formation and dissolution have been working against (or in favour of) service delivery efforts.

The paper therefore proceeds as follows. In Section 2 we present a discussion of the literature across three topics: the concept of the household, the longitudinal tracking of household units, and the dynamics of electricity access in South Africa. In Section 3, we discuss the details of NIDS, the data set that will be used in the investigation that follows. Section 4 presents the methods used to transform NIDS into a panel of households, and then explores how this newly constructed data set can be used to analyse household formation in South Africa. Section 5 begins by outlining the decomposition technique discussed above, and then presents a novel investigation into the dynamics of household electricity access, and the processes behind these dynamics. Finally, Section 6 offers some conclusions on the usefulness of the newly constructed household panel, along with a summary of our key findings.

2. LITERATURE REVIEW:

A brief analysis of the literature within the domain of economic development highlights the emphasis that has been (and continues to be) placed on the household as a unit of measurement – particularly in research that centres on topics such as labour supply and unemployment, poverty and well-being measurement, and service delivery (Deaton, 1997; Keller, 2004; Klasen and

Woolard, 2009; Abdul-Hanan, 2014). It has been demonstrated that the household unit and its characteristics are an important determinant of both individual well-being (Rosenzweig, 1986; Keller, 2004; Woolard and Leibbrandt, 2001) and labour market outcomes (Posel et al, 2006; Klasen and Woolard, 2009). In addition, Keller (2004) points out that most per-capita poverty measures are calculated at the household level, and are thus centred around (and sensitive to) a household definition. Even the methodology used for NIDS (and other similar surveys) rests on the assumption that a household is a useful concept, which can be neatly defined (Leibbrandt et al., 2009)[3]. While the concept of a household is widely accepted as a sensible entity, there is still much debate surrounding how to correctly define a household over more than one period, or identify when a household unit forms or dissolves.[4]

Due to these complexities, household panel surveys are generally designed so as to track individuals as the observational unit over time. An example of this type of household panel is the British Household Panel Survey (BHPS). While the first wave (in 1999) of this study was designed to be a nationally representative sample of British households, it is the (adult) residents of these households that were tracked in each subsequent year, rather than the selected household units (Taylor et al., 2010). Therefore, as it stands, this longitudinal sample cannot be used to accurately examine the longitudinal dynamics of household characteristics, because respondents migrate in and out of different households units. NIDS, and most other large-scale household panel studies – such as the European Community Household Panel, and the United States' Panel Study of Income Dynamics – take on a similar form (McGonagle et al., 2012; Peracchi, 2002). There is a short list of panel surveys which have been designed to track the household as the observational unit[5], such as the Ethiopian Rural Household Panel (Dercon and Hoddinott, 2011), and the ICRISAT Village Studies in India (Singh et al., 1985). However, aside from these few (generally rural, or farm-based) exceptions, there are seemingly no examples of large scale household panels which track households as the observational unit – particularly not at the national level.

[3] NIDS defines a household as: "a "roof" or compound/homestead/stand" that is occupied by individuals that share food from a common source. The individuals in the household are classified as either members, residents or both. Household members are defined as individuals that have been living in the household for at least 15 days during the last 12 months OR have arrived at the household in the last 15 days and the household is now their usual residence. Resident members are defined as individuals that live in the household for more than four nights a week (Southern Africa Labour and Development Research Unit, 2013).

[4] However, there is general agreement on the pitfalls of tethering a household definition to the concept of a household "head" (i.e. key economic decision-maker) (Budlender, 1997).

[5] The "household" in this case is the farm, and those individuals living on the farm.

There is also a dearth of literature which attempts to explore the longitudinal dynamics of household units, or considers how to construct a panel of households (Keller, 2004; Collinson and Wittenberg, 2014). One of the exceptions to this statement is found in "Household formation and household size in post-apartheid South Africa: Evidence from the Agincourt sub-district 1992-2003" by Wittenberg and Collinson (2014). In this paper, Wittenberg and Collinson use data from the Agincourt Health and Demographic Surveillance System to examine patterns of household change (particularly changes in household size) in a specific rural area in the north-east of South Africa. As part of their analysis, the authors demonstrate how categorising households as new, surviving and dissolving units (in each period of data collection) can assist in tracking household units over time – and accordingly provide a useful methodology for developing a panel of households.

For the purposes of this study, it is also worthwhile here to consider the literature on electrification, and service delivery more generally, in South Africa. During apartheid, many African households (particularly those in homeland areas) were denied access to basic public services, such as piped water, electricity and sanitation (Gaunt, 2003); however, as apartheid rule began to crumble, so government began to address these issues. Household electricity access expanded from 35 percent to 69 percent between 1990 and 2001 (Eberhard and Van Horen, 1995; Gaunt, 2003), before rising to 85 percent in 2011 (Statistics SA, 2013). Over the period, this process was coordinated under the National Electrification Plan (NEP) (1994-1999) and the Integrated National Electrification Plan (INEP) (2001-Current). Similar successes have been witnessed in other aspects of service delivery too, with access to piped water and sanitation also improving significantly over the period 1990-2012 (Bhorat and van der Westhuizen, 2013). While there is a literature which has explored (and continues to explore) these aggregate trends in electrification, most existing studies on the topic tend to utilise only a (limited) cross-sectional approach – and generally extrapolates long-term electrification trends using cross-sectional surveys which are many years apart. In addition, published data on electrification has been shown to vary considerably depending on the source, and is therefore suggested to be somewhat unreliable (Bekker et al., 2008).

There is also a smaller pool of literature which has investigated electricity access in a more applied sense. Dinkelman (2011) explores the strong relationships that exist between electrification, migration and the labour market in rural areas, and finds that electrification increases female employment and raises male earnings. In a different vein of research, Bhorat and van der Westhuizen (2013) compile various components of service delivery (including electricity access)

and asset holdings into an asset index to investigate the dynamics of non-monetary wellbeing. These studies highlight the links between the dynamics of service delivery, migration, household composition and well-being– adding further weight to the argument for a longitudinal analysis of service delivery which can provide insight into the details of, and processes behind, electricity access transitions.

3. DATA

In this analysis we draw on data from the National Income Dynamics Study (NIDS) - the first nationally representative panel study in South Africa, which aims to track "changes in… incomes, expenditures, assets, access to services, education, health and other dimensions of well-being" for individuals from 7,305 originally interviewed households (Leibbrandt et al., 2009). In the first wave of this panel study (conducted in 2008), the fieldwork team attempted to interview 10,642 households randomly selected from 409 Primary Sampling Units (PSUs) (the PSUs were in turn selected from the Statistics SA's 2003 Master Sample of PSUs) (Leibbrandt et al., 2009). 7,305 households agreed to be interviewed (a response rate of 69 percent), and individual interviews were then conducted for all residents within these households. Household level probability weights, which are available in the NIDS data, adjust for sample design and non-response and are required for the reduced sample to be nationally representative.

Every respondent that was resident in each of the 7,305 households interviewed in Wave 1 is classified by the NIDS team as a continuing sample member (CSM), or a permanent member of the panel study. Every two years the NIDS team aims to locate and re-interview all these CSMs (even where they may have moved), along with any additional individuals that are residing in the same household as these CSMs. Any additional individuals - who are resident with CSMs, but are not CSMs themselves - are termed temporary sample members (TSMs). TSMs are not added to the list of permanent sample members (i.e. the list of individuals to be tracked), hence they may or may not be interviewed in a subsequent wave (depending on whether they are again resident with a CSM or not), and thus they can pass in and out of the study. The only additional individuals who are added to the list of permanent sample members (or CSMs) are children born to existing CSM mothers after 2008.

The second and third waves of NIDS were conducted in 2010 and 2012. The household response rate was reasonably good across both waves, at approximately 74 percent and 79 percent

respectively. Where households had split, or where individual CSMs had migrated to new household units, these CSMs were then tracked and interviewed in the new households in which they happened to be resident at the time of the interview (along with their co-resident TSMs). This migration, household dissolution and household formation resulted in a working sample of 9 134 households in Wave 2 (2010), and 10 236 households in Wave 3 (2012) – up from the 7 305 households originally sampled in Wave 1 (2008).[6]

Variables termed "w2_stayer" and "w3_stayer" (for Wave 2 and Wave 3 respectively) are available within the NIDS data to identify migration activity in every period. This "stayer" variable is a categorical variable which identifies every individual as either: a stayer, a mover, or a new respondent. A *stayer* is a respondent who can be identified to be living in the same dwelling unit at the time of their last interview (i.e. in the previous wave), while a *mover* is a respondent who can be identified to have moved into a new dwelling unit since their last interview. A *new* respondent is an individual who is new to the panel study and has not been interviewed before (and thus their prior residence location is unknown). As discussed below, this variable is used to identify household formation and dissolution across the waves. A question asking whether a household "has electricity", which was asked in each wave, is used as an indicator of electricity access. The level of non-response on these variables is relatively low. Any missing information is therefore assumed to be missing at random, and should thus have no bearing on the results that follow.

4. CONSTRUCTING A PANEL OF HOUSEHOLDS – FORMATION AND DISSOLUTION

4.1 *Methodology*

4.1.1 Constructing a Panel of Households – An Introduction

To construct a panel of households using longitudinal data such as NIDS, it is necessary to strictly define when a given household may be identified as the same observational unit across any two consecutive periods, when a given household can be identified to have dissolved after a given period, or when a given household can be identified to be newly formed (i.e. formed between the previous period and current period).

[6] We noted a significant degree of non-response at the household level for incidences where entire families migrated (primarily due to the fact the field team could not locate these families in subsequent waves). This non-response therefore seems to be related to household formation. While this dimension is side-stepped for the purposes of the analysis presented in this paper, it can and should be explored in a follow-up investigation. Such an investigation could attempt to adjust the household weights to account for this attrition issue.

As suggested above, "Household formation and household size in post-apartheid South Africa: Evidence from the Agincourt sub-district 1992-2003", by Wittenberg and Collinson (2014), provides a useful basis for such definitions. Wittenberg and Collinson (2014) classify a household to be the same observational unit across two waves if there is at least one individual who can be identified to have been resident in the given dwelling unit in both periods. To identify a household as the same observational unit, two criteria are therefore necessary: (1) the dwelling unit must be the same (2) there must be an overlap of residents. Therefore, if an entire family moves from one dwelling unit in period t, into a new dwelling unit in period t+1, this would amount to the dissolution of the original household in period t, and the formation of a new household in period t+1. Or, if a family of five were living in a given dwelling unit in period t, and four of these five individuals moved into a new dwelling unit period t+1 while one remained in the same dwelling unit as before, the dwelling unit containing the single, non-migrating family member would be classified as the original household, and the dwelling unit containing the four migrating family members would be classified as a new household.

"Overlapping" individuals who are resident in the same dwelling unit over two or more time periods can be termed *surviving* residents. In the context of retrospective household formation classifications, *surviving* residents (in period t) are individuals that can be identified to have been living in that same dwelling unit in the current period (period t) and the previous period (period t-1). In terms of dissolution classifications, *surviving* residents are individuals that can be identified to have been living in the same dwelling unit in both period t and the following period (period t+1).

The analysis that follows therefore adapts this methodology and uses it to transform NIDS from a panel of individuals into a panel of households. While such a rule-based categorisation of household formation and dissolution may seem arbitrary, it must be noted that 1) most analyses of household formation tend to use arbitrarily defined rule-based systems (such as household headship changes) to identify and estimate household formation rates, 2) given one is careful in the type of analysis that is applied to this household panel, and how it is explained and interpreted, we expect that a panel of households constructed using the given methodology will provide results which are robust to reasonable changes in these definitions.

4.1.2 Tracking Households over Time – Constructing a Panel of Households

Household Formation:

Therefore, for the purposes of the analysis presented in this paper, a household is defined as a newly formed unit in a given wave (period t) if there are no *surviving* residents living in the dwelling unit at the time of the interview.

However, a number of TSMs are added to the sample in each new successive wave (from Wave 2 onwards) - when they are resident in a household with a CSM - and the location of these new TSMs in period t-1 is unknown. There are three ways in which such new TSMs enter the NIDS sample: (1) a TSM joins an existing CSM household, (2) a CSM and a TSM jointly form a new household, or (3) a CSM moves into an existing household and the other residents of the household (who are new to the panel) become TSMs. Identifying incidences of case (1) are simple, and present no problem for household formation classifications. However, a problem does arise in attempting to distinguish between cases (2) and (3) – given the lack of information on new TSMs' prior location. Conveniently, the NIDS survey includes a series of questions which ask if the respondent has ever lived in another province, town/city or suburb. If the respondent has lived elsewhere, they are then asked when they had moved to the province, town/city and suburb they are living in at the time of the interview.

Using these responses, we are able to define upper and lower bound household formation classifications for all panel households that contain new TSMs, and thus identify a possible range of household formation ratios for each wave.[7] All households not identified as newly formed households are categorised as surviving households.

Household Dissolution:

A household is defined as a dissolving unit in a period t if there are no *surviving* residents living in the same dwelling unit in the period t+1. In line with categorisation, deceased members are classified as non-*surviving* residents, and thus household units where all residents from period t are deceased in period t+1 are classified as dissolving households.

[7] The definitions for the upper and lower bounds of household formation can be found in Section 2 of the Appendix.

However, there is potential for a slight problem to arise in the categorisation of certain households that contain TSMs. As noted above, TSMs are included in the NIDS sample for a given wave (from Wave 2 onwards) when they are resident in the same dwelling unit as a CSM. However, these TSMs are not actively 'tracked' in period t+1. Therefore, while some of the TSMs that appear in Wave 2 are 'accidentally' tracked in Wave 3 (i.e. when these TSMs are co-resident with a CSM in Wave 3), many such TSMs are not. Therefore, when defining household dissolution, one cannot always conclusively identify whether such TSMs are surviving residents or not. This creates an issue in the identification of household dissolution for particular cases.

For example, consider a Wave 2 (2010) household that is comprised of one male CSM and one female TSM. In Wave 3 (2012), NIDS tracks the CSM and records that he had moved out of the dwelling unit he was living in in Wave 2 (2010), but that the female TSM no longer lives with him. NIDS thus has no information for this TSM in 2012, because she has not been actively or 'accidently' tracked: not only is she no longer co-resident with this male CSM, but she is also not co-resident with any of the other CSMs in the NIDS sample. Hence, one cannot know whether she is living in the same dwelling unit that she was in 2010, or if she has since moved out. One therefore cannot conclusively identify whether the given Wave 2 (2010) household unit has dissolved, as its dissolution categorisation rests on the movements of this untracked female TSM.

We therefore incorporate upper and lower bound rules to classify households that contain untracked TSMs into a household dissolution category, and thus identify a possible range of household dissolution ratios for each wave.[8] This methodology also accounts for the potential problem of CSMs that were unable to be located in a given wave.

Panel Households, Non-Panel Households, and Household Weights:

Given that NIDS was designed to be nationally representative, we assume the original [weighted] sample of households in 2008 is nationally representative. As the individual members of the NIDS panel may move in and out of these panel households in subsequent waves, and are tracked to their locations, it is therefore necessary to classify households as either panel or non-panel households, and adjust the weights accordingly – to ensure the continuing sample remains representative of South Africa.

[8] The definitions for the upper and lower bounds of household dissolution can be found in Section 2 of the Appendix.

Naturally, every household that is interviewed in Wave 1 is classified as a panel household. In the subsequent waves, a household is classified as a panel household if it is: (a) identified as a panel household that has survived from a previous period, or (b) identified as a newly established household (i.e. a household established by CSMs). Certain household are identified as surviving non-panel households – where one or more CSMs are identified to have moved into a household that existed before, but was not part of the panel (i.e. a household that was established in the past by an individual who is not a permanent member of the study).

The NIDS household probability weights that are attached to any given house unit (in Wave 1) indicate the number of households in South Africa that the sampled unit represents. All panel households that exist in Wave 1 are therefore assigned the household probability weight that is attached to their household unit in Wave 1. Any panel household that is formed after Wave 1 is allocated the household probability weight of the household in which the establishing CSM lived previously. All non-panel households are given a weight of zero.

4.2. Results

Table 1 provides the aggregate values for household formation and dissolution between Waves 1, 2 and 3 of NIDS. Both the upper bound and lower bound estimates of household dissolution are reported, while only the lower bound estimates of household formation are reported.[9] The results are weighted using the NIDS post-stratified household weights – which (as outlined above) have been adjusted appropriately to take into account the transformation of the individual level data into a panel of household units – in order to render the results representative of South Africa.

The [weighted] household dissolution rate between Wave 1 and Wave 2 (i.e. roughly between 2008 and 2010) was estimated to be approximately 17.3 percent.[10] In other words, of all the households units that existed in South Africa in 2008, roughly 17 percent of them had disbanded by 2010. However, this is not to say that the number of South African households in existence decreased – as household formation over the period must also be taken into account. More specifically, the household formation rate between 2008 and 2010 was approximately 26.1 percent. In other words,

[9] In order to test the robustness of our approach, the upper and lower bounds of both household formation and household dissolution were estimated. However, because the upper or lower bound estimates of household formation coincide in both periods, we chose to report only the lower bound estimates.

[10] The upper and lower bound rules produce the same household dissolution estimate for this first period. This is because all respondents in Wave 1 are defined as CSMs, and thus there are no untracked TSMs between Wave 1 and Wave 2.

of all the households that existed in South Africa in 2008, 26 percent of these were new households.

Table 1

Household Formation, South Africa, 2008-2012

	Wave 1 - Wave 2	Wave 2 - Wave 3
	Proportion	Proportion
Newly Formed Households (lower bound)	0.261	0.225

Household Dissolution, South Africa, 2008-2012

	Wave 1 - Wave 2	Wave 2 - Wave 3
	Proportion	Proportion
Dissolving Households (upper bound)	0.173	0.209
Dissolving Households (lower bound)	0.173	0.196

These results indicate rapid household formation, and growth in the population of households, over the period 2008 to 2010. To explore these changes further, Table 2 presents estimates of the number of households in existence in 2008, 2010 and 2012.[11] Our estimates suggest that of the 14,399,219 households estimated to be in existence in South Africa in 2008, about 2,494,401 had dissolved by 2010, while 4,210,701 new households had formed by this time. This equates to a 1,716,300 net increase in the number of households over the period – or an 11.9 percent increase in the population of households (as demonstrated in Table 2). Given that the period between each wave of NIDS is approximately two years, if we assume an equal increase in the number households over the two years, this equates to a net annual increase of 6.0 percent and 5.6 percent in the number of households respectively in 2009 and 2010.

Table 2

Number of Households in South Africa, 2008-2012

	Total	Change	Change (%)
2008	14 399 219		
2010	16 115 519	1 716 300	11.92
2012	16 433 599	318 080	1.97

The results for household formation and dissolution between Wave 2 and Wave 3 (i.e. roughly between 2010 and 2012) suggest a sharp decline in formation rates, and an increase in the dissolution rates. The household dissolution rate estimated for this period is between 19.6 and 20.9

[11] These estimates are based on the definition of the household (and the subsequent household formation and dissolution rules) outlined in the Methodology presented above.

percent – at least two percentage points higher than the dissolution rate estimated for the previous period. A change in the other direction is evident for formation rates: household formation rates between 2010 and 2012 are estimated to be slightly less than four percentage points lower than they those estimated for the 2008-2010 period. More specifically, approximately 22.5 percent of the households that existed in 2012 were estimated to have formed between 2010 and 2012.[12]

Again, if we instead discuss household formation and dissolution in terms of numbers of household units (using the upper bound of household dissolution and the lower bound of household formation), our estimates suggest that of the 16,115,519 households estimated to be in existence in South Africa in 2010, about 3,372,424 had dissolved by 2012, while 3,690,505 new households had formed. This equates to a 318,080 net increase in the number of households over the period – or a 2.0 percent increase in the population of households. Assuming an equal increase in the number households over the two years, this equates to a net annual increase of about 1.0% in both 2011 and 2012.

4.3 *Discussion*

Household Formation and Dissolution in South Africa

South Africa's average annual population growth rate over the 2008-2010 period is estimated at 1.4 percent, while the same annual rate for the 2010-2012 period is estimated at 1.5 percent (The World Bank, 2015). Given these figures, the estimated net household growth rates for the periods 2008-2009 and 2009-2010 - of 6.0 percent and 5.6 percent respectively - seem exceptionally high, especially when compared to the net household growth rate estimated for the 2010-2012 period (of approximately 1.0 percent per annum). While Wittenberg and Collinson (2014) estimate the net household growth rate within the Agincourt site to exceed the population growth rate for almost every period under analysis (e.g. 1993-2002), these estimates are at no point more than 2.0 percentage points higher than population growth. It is therefore worth considering why the estimated increase in the number of households in South Africa over the 2008-2010 period was so high, and why this rate declined so significantly in the period that followed.

One potential explanation provided by the literature is falling housing prices. In particular, Borsch-Supan (1986) shows how increases (or decreases) in housing prices tend to significantly influence household formation and dissolution decisions. Accordingly, when the property bubble burst and

[12] The upper and lower bound rules, again, produce the same household formation estimate.

South Africa's housing prices began to fall after 2008, this can be expected to have positively influenced household formation decisions[13], and may also have deterred (or delayed) household dissolution decisions - resulting in a high net house holding growth. This explanation is supported by the fact that nominal housing prices demonstrated a net increase between the 2010 and 2012 period – the same period when a decline in the net household growth rate is witnessed.

Whether it was primarily falling housing prices, or perhaps some other factor, the positive effect on the net household growth between 2008 and 2010 must have been considerably large – as there were likely countervailing forces at work too. Unemployment in South Africa increased significantly in 2009 and 2010 (at a rate of approximately 4.0 percent per annum) - as a delayed consequence of the global financial crisis, and the recession subsequently experienced by South Africa in 2009 (World Bank, 2015). In this vein, Klasen and Woolard (2009) have shown that young individuals in South Africa delay leaving home to set up new households when faced with rising unemployment. They also show that rising unemployment can influence household dissolution decisions, as individuals migrate in order to access private safety nets (such as state transfers). Therefore, in the absence of any other effect, one would have expected such rising unemployment rates to have led to a simultaneous decrease in household formation. Such risk-mitigation migration decisions (or rather, decisions to delay migration) are suggested to be counterproductive towards future employment prospects, and can therefore have knock-on effects for economic growth (Klasen and Woolard, 2009). From a policy perspective, it is therefore important to note that the timely decrease in housing prices after 2008 (or perhaps some other concurrent shock) may have somewhat protected economic development through this period (2008-2010) – by encouraging helpful household formation and dissolution decisions.

5. AN APPLICATION OF THE PANEL TO SERVICE DELIVERY: ACCESS TO ELECTRICITY

5.1 Methodology

Having transformed NIDS into a panel of households, and investigated household formation and dissolution rates, we now turn to consider how this panel can be used to provide insights on service delivery outcomes. While the NIDS data offers the potential to assess a number of different service

[13] Albeit only for those within the formal housing segment, or those considering a transition into the formal housing segment.

delivery outcomes, given the scope of this paper, we choose here to focus solely on access to electricity.

We begin this analysis by reporting [weighted] electricity access proportions for panel households. These statistics are reported separately for each wave, treating each wave as a cross section. The results allow one to investigate changes in access to electricity over the period 2008 to 2012 at a broad level.

However, it is uncertain whether these aggregate estimates provide a good representation of the true national trends. The first reason for this is that such aggregate estimates may display bias as a result of disproportionate non-response. We have already noted that when viewed at a broad level, the household response rate in Wave 2 and Wave 3 of NIDS seem reasonably good for a panel study of its size. However, when viewed from the perspective of a household panel, under classifications of new and surviving households, these response rates become more concerning. In Wave 2 the response rate for surviving households is 88 percent, but the response rate for new households is only 28 percent. This is startling. Similarly, in Wave 3, the corresponding response rates are 86 percent and 51 percent respectively for surviving and newly formed households. If household formation is related to both non-response and electricity access (i.e. if individuals are setting up new households in order to access electricity, and newly formed households are also less likely to respond or be located), then this disproportionate non-response will lead to biased estimates – as the household probability weights do not account for such non-random data truncation. In addition, such aggregate estimates also fail to provide a measure of the proportion (or number) of households that actually experience real changes in electricity access – but merely provide an indication of average access for all households in a given year. Consequently, such aggregate measures could be driven by migration inasmuch as it they are influenced by improvements (or deteriorations) in service delivery.

We therefore move to make full use of the panel of households, and investigate electricity access trends by household type (i.e. new, surviving, and dissolving) – with these categories defined according to the lower bound of household formation, and the upper bound of household dissolution. We focus first on transitions for surviving households, analysing the sample of households that survive across all three periods. This analysis provides insight into the proportion (and number) of actual dwelling units that have gained (or lost) access to electricity over the period. We then focus on investigating electricity access for new and dissolving households, to determine

if there is any association between such service delivery outcomes and household formation and dissolution. Given the high level of non-response among newly formed households in Wave 2 and Wave 3, the results and discussion that follow assume these responses are missing at random, and are unrelated to the outcome of interest (i.e. electricity access).

Finally, we utilise the decomposition technique developed by Wittenberg and Collinson (2014) to investigate to what degree one can conclude that household formation and dissolution are connected to changes in aggregate service delivery trends, and to what degree improvements in electricity access are merely a result of an expansion of access to previously un-connected households. This adapted technique is outlined below.

Let y_t be the household's access to electricity outcome in year t (an indicator variable, with "Access"=1 and "No access"=0), $\bar{y}_{S,t}$ be the proportion of households surviving to period t+1 that have access to electricity in period t, $\bar{y}_{D,t}$ be the proportion of households that dissolve in period t that have access to electricity in period t, and $\bar{y}_{N,t+1}$ be the proportion of households that are newly formed in period t+1 that have access to electricity in period t+1 (Wittenberg and Collinson, 2014).

Therefore, the following holds:

$$\bar{y}_t = (1-\theta)\bar{y}_{D,t} + \theta\bar{y}_{S,t} \qquad (1)$$

$$\bar{y}_{t+1} = (1-\varphi)\bar{y}_{N,t+1} + \varphi\bar{y}_{S,t+1} \qquad (2)$$

where θ is the proportion of households surviving to period t+1 in the population at time t and φ is the proportion of survivors from period t at t + 1. Therefore, the change in the proportion of households with access to electricity between period t and t+1 is given by:

$$\Delta\bar{y}_{t+1} = \theta\Delta\bar{y}_{S,t+1} + (1-\theta)(\bar{y}_{N,t+1} - \bar{y}_{D,t}) + (\theta-\varphi)(\bar{y}_{N,t+1} - \bar{y}_{S,t+1}) \qquad (3)$$

As suggested by Wittenberg and Collinson (2014), these three effects can be defined as follows:

- The within household change effect $(\theta\Delta\bar{y}_{S,t+1})$, or the contribution made by changes in access for surviving households.

- The replacement effect $(1-\theta)(\bar{y}_{N,t+1}-\bar{y}_{D,t})$, or the contribution resulting from the difference in average electricity access for the population of new households which are replacing the dissolving units.
- The dilution effect $(\theta-\varphi)(\bar{y}_{N,t+1}-\bar{y}_{S,t+1})$, where "$(\theta-\varphi)$ is non-zero only if there is a net change in the number of households and the term $(\theta-\varphi)(\bar{y}_{N,t+1}-\bar{y}_{S,t+1})$ reflects how newly formed households differ from surviving ones". Therefore, if formation outpaces dissolution, the surviving households' contribution to an estimate of average electricity access is diluted by the introduction of new households.

5.2 Results

Table 3

Cross-sectional Analysis: Household Electricity Access, South Africa, 2008-2012

	Wave 1	Wave 2	Wave 3
	Proportion	Proportion	Proportion
Access	0.820	0.808	0.865

Table 3 provides estimates of the proportion of households that have access to electricity in 2008, 2010 and 2012, for the full sample of households in every period, treating each period as a cross section. Our results indicate that electricity access is relatively high across South Africa – with more than 80 percent of households experiencing positive service delivery outcomes in this regard (this is true regardless of whether we choose to focus on 2008, 2010 or 2012). However, it is the dynamics of these estimates which are particularly interesting – with estimated electricity access dropping from 82.0 percent in 2008 to 80.8 percent in 2010, before rising to 86.5 percent in 2012.[14]

Table 4

Panel Analysis: Electricity Access for Surviving Households, South Africa, 2008-2012

	Wave 1		Wave 2		Wave 3	
	Freq.	Proportion	Freq.	Proportion	Freq.	Proportion
No Access	1 990 637	0.186	2 094 799	0.196	1 499 954	0.140
Access	8 710 880	0.814	8 606 719	0.804	9 201 563	0.860
Total	10 701 517		10 701 518		10 701 517	

[14] If we use the original (untransformed) NIDS surveys, with the existing cross-sectional household weights, treating each of the waves as separate cross-sections, we also find a similar trend. The proportion of households with electricity access drops from 0.82 in 2008 to 0.81 in 2010, and then rises to 0.87 in 2012. This suggests that the identified trend is not a result of attrition in the population of panel households.

To provide more clarity on how this trend relates to changes in electricity access for given household units, we then investigate the proportion (and number) of *surviving* households that have access to electricity in 2008, 2010 and 2012. These results are reported in Table 4. Here, we see that the trend in average access to electricity for the panel of surviving households mirrors the trend estimated when treating each wave as a cross-section. In 2008, 81.4 percent of surviving households had access to electricity; in 2010 this dropped to 80.4 percent; and in 2012, it increased to 86.0 percent. The drop in access to electricity between 2008 and 2010 is curious. Given that the sample here is restricted to surviving households, the only explanation for this decline in electricity access is that a number of households that had electricity in 2008 were in fact somehow disconnected from this source of electricity between 2008 and 2010. This hypothesis is supported by the fact that estimated number of surviving households with access to electricity fell from 8 710 880 to 8 606 719 over the period.

Table 5

Panel Analysis: Transitions for Surviving Households, South Africa, 2008-2010
(Number (and proportion) of Households)

		Wave 2		
		No Access	**Access**	**Total**
Wave 1	**No Access**	1 627 198 (0.734)	590 054 (0.266)	2 217 252 (1.000)
	Access	698 129 (0.072)	8 936 050 (0.928)	9 634 179 (1.000)

Panel Analysis: Transitions for Surviving Households, South Africa, 2010-2012
(Number of Households)

		Wave 3		
		No Access	**Access**	**Total**
Wave 2	**No Access**	1 125 835 (0.537)	968 964 (0.463)	2 094 799 (1.000)
	Access	374 119 (0.043)	8 232 599 (0.957)	8 606 718 (1.000)

Tables 5 - which provides transition matrices for the sample of surviving households between 2008 and 2010, and 2010 and 2012 – show that between 2008 and 2010, while 547 066 surviving households (i.e. 27.5 percent of surviving households without electricity) gained access to electricity, 651 228 households (i.e. 7.3 percent of surviving households with electricity) lost access to electricity. This equates to 104 162 decline in the number of surviving households with access to electricity between 2008 and 2010. However, between 2010 and 2012, we see the opposite effect. While 374 119 surviving households (i.e. 4.3 percent of surviving households with electricity) lost

access to electricity, 968 964 households (i.e. 46.3 percent of surviving households without electricity) gained access to electricity. Therefore, the extent of the aggregate improvement in service delivery witnessed over the 2010 to 2012 period for surviving households came as a result of a two effects: a reduction in the annual number (and proportion) of households that lost access electricity, and an increase in the number (and proportion) of un-connected households that gained an electricity connection.

Table 6

Panel Analysis: Proportion of Households with Access to Electricity, South Africa, 2008-2012
(within each formation/dissolution category)

	Dissolving Households	Newly Formed Households
Wave 1 - Wave 2	0.842	0.788
Wave 2 - Wave 3	0.781	0.882

We now turn to investigate access to electricity for new and dissolving household units.[15] These results are presented in Table 6. Interestingly, while 82 percent of households had access to electricity in 2008, within the dissolving sample the access rate was 84 percent in this period, while in the surviving sample the access rate was 81.4 percent. In addition, in 2010, only 78.8 percent of newly formed households had access to electricity – an access rate which is lower than the access rate for the dissolving households these new households replaced, and lower than the rate evident for surviving households in 2010 (a rate of 80.4 percent). This means that households that dissolved between 2008 and 2010 were more likely to have access to electricity than those that survived over the period, while the households that formed between 2008 and 2010 demonstrated a lower degree of electricity access (on average) than those that had survived (and those that had dissolved). These results therefore imply that household dissolution and formation could have contributed to the deterioration in electricity access over the period.

Household formation and dissolution seem to have played a different role over the 2010-2012 period. Within the dissolving sample for this period, electricity access rates are low – with only an estimated 78.1 percent of dissolving units demonstrating access to electricity. Within the sample of households that then formed between 2010 and 2012, 88.2 percent had access to electricity. Accordingly, the proportion of new households that have access to electricity is far higher than the same proportion for dissolving units, and even slightly higher than the proportion for surviving

[15] Here we use the lower bound of household formation and upper bound of household dissolution.

households (86.0 percent). This suggests that household formation and dissolution likely contributed to improvements in electricity access between 2010 and 2012 in South Africa.

Table 7

Panel Analysis: Decomposition of Change in Household Electricity Access, South Africa, 2008-2012

	Wave 1 - Wave 2		Wave 2 - Wave 3	
Change in Surviving	-0.009		0.053	
New minus Dissolving	-0.054		0.101	
New minus Surviving	-0.016		0.024	
		Contribution to change (%)		**Contribution to change (%)**
Within Change Effect	-0.008	41.279	0.042	70.246
Replacement Effect	-0.009	51.215	0.017	29.144
Dilution Effect	-0.001	7.507	0.000	0.610
Total Change	-0.018		0.060	

However, in order to assess to what degree household formation and dissolution are connected to shifts in access to electricity, it is useful to apply the decomposition technique outlined above. The results of this decomposition are presented in Table 7 below. For the period 2008 to 2010, the results suggest that the change in aggregate access to electricity came primarily as a result of the replacement effect (which contributed 51 percent of the decline in access). In other words, the primary contributor to the decline in estimated electricity access resulted from the fact that a smaller proportion of newly formed households had electricity access than their dissolving counterparts. The within effect also played a key role in the service delivery decline, with changes in surviving households access contributing 41 percent to the deterioration in aggregate electricity access. As seen before, this is largely due to previously "connected" households being seemingly disconnected from their source of electricity. The dilution effect had a negative, but minor impact on aggregate electricity access.

A different process is evident for the period 2010 to 2012. The evident improvement in aggregate access to electricity is estimated to have come primarily as a result of the within effect (which contributed 70 percent to the increase in access). This means that conventional improvements in service delivery for surviving households (i.e. extensions of electricity access to households that previously had no access) are likely the key reason for the increase estimated electricity access. The replacement effect also contributed significantly to the service delivery improvement – with new

households demonstrating higher electricity access rates than those demonstrated by households that dissolved between 2010 and 2012. The dilution effect had an insignificant impact on the aggregate change in electricity access over this period.

5.3 Discussion

Access to Electricity in South Africa

Under the Integrated National Electrification Programme (INEP), it has been the government's aim to "address the electrification backlog of permanently occupied residential dwellings" (Department of Energy, 2013). So, with constant efforts being made to extend the electricity network, it is therefore both interesting and concerning that access to electricity seemingly decreased between 2008 and 2010.

The most alarming concern in this regard for those involved in coordinating service delivery efforts is the fact that this deterioration occurred, at least superficially, as a result of a large number household units actually "losing" access to electricity between 2008 and 2010. While disconnections seem to have occurred across all nine province, it is worth noting that more than one quarter of disconnections between 2008 and 2010 occurred in KwaZulu-Natal, while the highest proportional contributors to the disconnection statistic were Limpopo, Free State and Mpumalanga (i.e. highest disconnections relative to number of surviving household in province).[16] The majority of the disconnections occurred in urban areas (54 percent), but this may have been expected, since urban households constituted 63 percent of the population of households in 2008. Conversely, rural areas displayed a more than proportional number of household disconnections (40 percent vs. 29 percent), while disconnections were seemingly unrelated to dwelling type.[17] As may have been expected, poor household were more likely to be disconnected than non-poor households.[18]

Given the scope of this analysis, it is difficult to try and understand any further details regarding why the loss of electricity access is so widespread – or what "losing" a connection actually entails

[16] Tables 8, 9, 10 and 11 - showing the number of disconnections by province, area type, dwelling type, and poverty classification of household - are located in Section 3, Section 4, Section 5 and Section 6 of the Appendix, respectively.

[17] The number of disconnections within each dwelling type category is proportional to the number of dwellings of that type within the population of surviving households.

[18] A household was classified as poor in period t if the per capita household income in period t was below the poverty line of R507 per person (Statistics SA, 2014). Household income in every period was converted into real 2008 Rands, and then divided by the number of residents in the household to arrive at a value for per capita income.

for a given household unit.[19] Yet, it is fair to assume that given the number of negative transitions over the 2008-2010 period, these results do provide an indication of service delivery failure at a broad level.

Our results do also indicate a degree of positive change in service delivery outcomes over the 2010-2012 period. Not only was the number of households that "lost" connections significantly lower in the 2010-2012 period than in the 2008-2010 period[20], but, moreover, the number of households that gained a connection during this period was significantly higher. Consequently, despite the deterioration between 2008 and 2010, electricity access expanded by 4.3 percentage points over the four year period between 2008 and 2012 – or a net improvement of 113 132 households. If the extension of electricity access is to continue at this rate, it possible that INEP will achieve its stated goal of achieving universal electricity access by 2025 (Department of Energy, 2013). However, if further periods of decline are experienced (such as the deterioration witnessed between 2008 and 2010), it is also conceivable that electrification rollout will fall short of this goal.

It is therefore also important for those involved in directing the strategy of INEP to understand the interplay between household formation and dissolution, and service delivery outcomes. In addition to lost connections, a large part of the reason for the decline in access to electricity between 2008 and 2010 appears to have been rapid and "misdirected" household formation. In other words, rather than having households dissolve in locations that lack access to electricity, and form in locations that promote access to electricity – the converse pattern seems to have characterised the period. When viewed through this particular lens, household dynamics in South Africa can be said to have worked against the efforts of those involved in improving service delivery in this area during the 2008 to 2010 period.

Yet, household dynamics also have the potential to work in the favour of those involved in improving service delivery. As an example, we see that between 2010 and 2012, household formation and dissolution in South African contributed to the improvement in electricity access.

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[19] Due to the nature of the question, a recorded loss in electricity access is likely a result of one of the following: an administrative disconnection (a household that considers itself to be permanently disconnected, for administrative reasons i.e. payment), an infrastructural disconnection (a failure in electricity distribution infrastructure which has led to a connection loss), an economic disconnection (where an electricity connection remains, but the household considers itself to no longer have access due to unaffordability), or finally due to measurement error (i.e. a misunderstanding, or incorrect reporting, of the question or response).

[20] While there was a significant (and interesting) increase in the number of disconnections displayed in Gauteng, and a smaller increase in the number of disconnections in Western Cape and North West, this was outweighed by a very large decline in disconnections within KwaZulu-Natal, Mpumalanga, Limpopo and Free State.

Households that dissolved during this period displayed lower connection rates than those that survived, while households that formed had significantly higher connection rates that those that had dissolved. This suggests a likely trend of individuals migrating out of un-connected household between 2010 and 2012 (with these original units consequently dissolving), and setting up households in locations which already had electricity access - or at least were more likely to gain access to electricity by 2012. If such household formation and dissolution decisions can be influenced and directed, it provides policy makers with an additional mechanism to improve and extend public service delivery.

6. CONCLUSIONS

This findings of this paper offer a clear case for the value of a nationally representative panel of South African households. After transforming NIDS such that household units can be tracked longitudinally, novel estimates of national household formation and dissolution rates are presented and discussed. These results indicate that rapid household formation occurred between 2008 and 2010, an occurrence which was possibly due to depressed housing prices. After this period, household formation and dissolution processes seem to normalise, leading to a net household formation rate of approximately 1.0 percent. These results should be interesting for policy makers involved in providing basic public services, such as housing, water, electricity and sanitation, because such services are delivered at the household level, and policy makers thus need to consider how changes in the population of households may affect service delivery efforts. These results should also be valuable for those looking to understand the links between the labour market and migration processes, and those working within this realm should look to understand why household formation failed to respond negatively to rising unemployment over the 2008-2010 period.

As a further indication of the usefulness of the newly constructed household panel, this paper then explored the longitudinal dynamics of household electricity access. Our findings indicate that there are two key processes which ultimately determine the degree of improvement in aggregate electricity access: (1) net connections, and (2) household formation and dissolution.

In terms of the first process, we argue that is insufficient for policy makers to focus on extending electricity to a certain number of unconnected households ever year; because disconnections play as crucial a role in determining the development of service access. Those involved in coordinating

service delivery need to direct equal focus to identifying "at risk" locations - locations where infrastructure is poor and individuals stand to lose access – and work at maintaining (or improving) the quality of the electricity connections in these areas. In terms of the second process, we argue that a thorough understanding of household formation and dissolution processes is crucial to policy makers involved in coordinating service delivery. These processes can either work against service delivery efforts, and lead to a decline in aggregate electricity access (as happened between 2008 and 2010), or they can aid efforts to improve service delivery, and lead to significant improvements in access. Government should therefore consider one of two strategies: they should attempt to influence household formation and dissolution decisions so that these processes work to bolster service delivery efforts; or they should look to understand how household formation and dissolution processes are unfolding, and adapt service delivery strategies accordingly. Such actions would result in a more rapid movement toward INEP's goal of universal electricity access.

The newly developed NIDS household panel therefore offers significant insight into the dynamics of household electricity access in South Africa for policy makers. Further studies should look to use this household panel as a means to explore other elements of service delivery, such as sanitation or piped water, in a similar fashion. In addition, a follow-up study on electricity access should look to correct for the attrition among migrating families, and should assess whether accounting for this attrition issue has significant bearing on the results presented (although we do not expect this to be the case).

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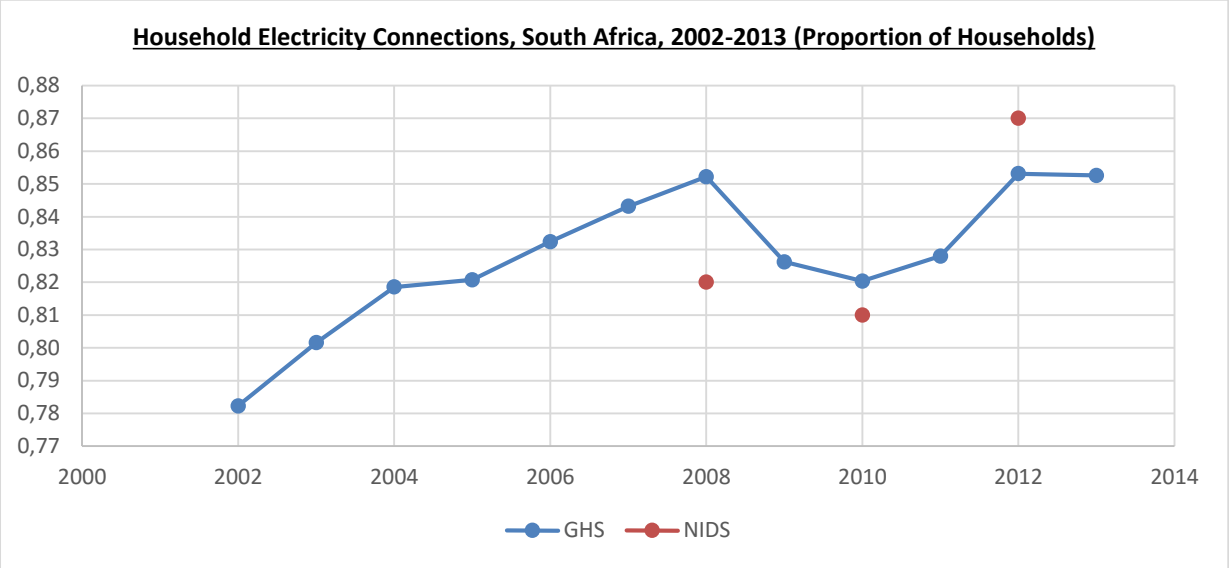
APPENDIX

Section 1: Household Electricity Access Dynamics (Cross-Sectional Estimates)

Figure 1



Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
GHS	0.78	0.80	0.82	0.82	0.83	0.84	0.85	0.83	0.82	0.83	0.85	0.85
NIDS							0.82		0.81		0.87	

Note: The GHS electricity access estimates, as well as the graph above, were compiled and provided by Martin Wittenberg (personal communication, 2016).

Section 2: Household Formation and Dissolution Definitions

Household Formation – Upper Bound and Lower Bound rules

Upper Bound:

For the upper bound of household formation, all new TSMs are assumed to be non-surviving residents in period t, and are only classified as surviving members of a household if the TSMs response indicates they moved to the suburb more than two years before period t - or if they indicate they have never moved. In other words, we assume that all new TSMs are non-surviving residents unless they indicate otherwise. All households that comprise entirely of non-surviving residents (whether CSMs or TSMs) are classified as a newly formed households.

Lower Bound:

For the lower bound of household formation, all new TSMs are assumed to be surviving residents in period t, and are only classified as non-surviving residents of a household if the TSM indicates they have moved to the suburb within the past two years of period t. In other words, we assume new TSMs are surviving residents unless they indicate otherwise. All households that comprise entirely of non-surviving residents (whether CSMs or TSMs) are classified as a newly formed households.

Household Dissolution – Upper Bound and Lower Bound rules

Upper Bound:

For the upper bound of household dissolution, all households that comprise entirely of non-surviving residents, and/or untracked TSMs/CSMs, are classified as a dissolving households (i.e. assuming that all untracked TSMs and CSMs are non-surviving residents). All remaining households are classified as surviving households.

Lower Bound:

For the lower bound of household formation, all households that were coded as dissolving households for the upper bound, but contain at least one untracked TSM in a given wave, are now classified as a surviving households (i.e. assuming all untracked TSMs and CSMs are surviving residents).

Section 3: Disconnections (or loss of access to electricity), by Province

Table 8

Panel Analysis: Disconnections by Province, South Africa, 2008-2010

Province	Total Households	Proportion	Households Disconnected	Proportion	Proportion of Province Disconnected
Western Cape	1 280 844	0.11	25 832	0.04	0.02
Eastern Cape	1 562 552	0.13	70 928	0.11	0.05
Northern Cape	283 940	0.02	3 447	0.01	0.01
Free State	691 014	0.06	90 342	0.14	0.13
KwaZulu-Natal	2 078 877	0.17	166 543	0.26	0.08
North West	812 194	0.07	31 237	0.05	0.04
Gauteng	3 012 289	0.25	81 632	0.13	0.03
Mpumalanga	1 029 373	0.09	81 961	0.13	0.08
Limpopo	1 153 736	0.10	99 305	0.15	0.09
Total	**11 904 819**		**651 227**		**0.05**

Panel Analysis: Disconnections by Province, South Africa, 2010-2012

Province	Total Households	Proportion	Households Disconnected	Proportion	Proportion of Province Disconnected
Western Cape	1 330 358	0.11	37 509	0.10	0.03
Eastern Cape	1 608 571	0.14	53 560	0.14	0.03
Northern Cape	285 962	0.02	8 609	0.02	0.03
Free State	724 887	0.06	14 179	0.04	0.02
KwaZulu-Natal	2 216 774	0.19	49 395	0.13	0.02
North West	833 775	0.07	41 985	0.11	0.05
Gauteng	3 275 562	0.28	126 058	0.34	0.04
Mpumalanga	1 032 731	0.09	31 997	0.09	0.03
Limpopo	1 244 428	0.10	10 827	0.03	0.01
Total	**12 553 048**		**374 119**		**0.03**

Section 4: Disconnections (or loss of access to electricity), by Area Type

Table 9

Panel Analysis: Disconnections by Area Type, South Africa, 2008-2010

Area Type	Total Households	Proportion	Households Disconnected	Proportion	Proportion of Area Type Disconnected
Traditional	3 428 008	0.29	262 558	0.40	0.08
Urban	7 555 759	0.63	351 286	0.54	0.05
Farms	921 051	0.08	37 383	0.06	0.04
Total	**11 904 818**		**651 227**		**0.05**

Panel Analysis: Disconnections by Area Type, South Africa, 2010-2012

Area Type	Total Households	Proportion	Households Disconnected	Proportion	Proportion of Area Type Disconnected
Traditional	3 474 689	0.28	109 680	0.29	0.03
Urban	7 870 678	0.64	221 728	0.59	0.03
Farms	887 501	0.07	42 712	0.11	0.05
Total	12 232 868		374 120		0.03

Section 5: Disconnections (or loss of access to electricity), by Dwelling Type

Table 10

Panel Analysis: Disconnections by Dwelling Type, South Africa, 2008-2010

Dwelling Type	Total Households	Proportion	Households Disconnected	Proportion	Proportion of Dwelling Type Disconnected
Formal dwelling	8 218 359	0.70	481 961	0.71	0.06
Informal Dwelling	2 229 473	0.19	106 757	0.16	0.05
Traditional Dwelling	1 230 654	0.11	91 275	0.13	0.07
Total	11 678 486		679 993		0.06

Panel Analysis: Disconnections **by Dwelling Type, South Africa, 2010-2012**

Dwelling Type	Total Households	Proportion	Households Disconnected	Proportion	Proportion of Dwelling Type Disconnected
Formal dwelling	7 054 818	0.71	270 078	0.71	0.04
Informal Dwelling	1 809 916	0.18	70 392	0.18	0.04
Traditional Dwelling	1 055 947	0.11	40 777	0.11	0.04
Total	9 920 681		381 247		0.04

Section 6: Disconnections (or loss of access to electricity), for Households above and below the Poverty Line

Table 11

Panel Analysis: Disconnections by Poverty Classification, South Africa, 2008-2012

	Total Households	Proportion	Households Disconnected	Proportion	Proportion of Poor/Non-Poor Disconnected
Non Poor	7616955	0.64	372045	0.53	0.05
Poor	4287863	0.36	326085	0.47	0.08
Total	**11904818**		**698130**		**0.06**

Panel Analysis: Disconnections by Poverty Classification, South Africa, 2008-2012

	Total Households	Proportion	Households Disconnected	Proportion	Proportion of Poor/Non-Poor Disconnected
Non Poor	9080257	0.71	269916	0.65	0.03
Poor	3662837	0.29	147061	0.35	0.04
Total	**12743094**		**416977**		**0.03**